Marine Strategy Framework Directive 2008/56/EC

Article 17 update to Ireland's Marine Strategy Part 1: Assessment (Article 8), Determination of Good Environmental Status (Article 9) and Environmental Targets (Article 10)

Assessment Sheets

June 2020

Prepared by the Department of Housing, Planning and Local Government
housing.gov.ie

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Descriptor 1 – Biodiversity

Descriptor 1 Biodiversity	**Assessment Sheet: Non-commercial fish** **Criteria D1C1, D1C2, D1C3, D1C4 & D1C5** **Species of non-commercially-exploited fish which are at risk from incidental by-catch**
Key message	In 2013, Ireland completed an Initial Assessment of its maritime area, under the 2008 Marine Strategy Framework Directive (MSFD; Directive 2008/56/EC). An updated assessment has now been carried out with respect to the original Directive and newly established criteria, elements and methodological standards as set out in Commission Decision (EU) 2017/848 and amending Commission Directive (EU) 2017/845. In relation to populations of non-commercially-exploited fish, the status of 56 species within Ireland's designated MSFD area was assessed. A key finding is that a total of 11 species are achieving Good Environmental Status (GES), while the environmental status of 23 species is currently unknown. In the case of 18 other species, GES is not being achieved. A further four species of non-commercial fish are classified as critically endangered and at a risk of extinction and are thus ineligible for GES assessment. Overall for this element of biodiversity the proportion of species achieving GES is currently 21%, which is below the threshold value of 60% advised by ICES.
Background	Certain fish species have been depleted by fishing in the past and are now on various lists of threatened and declining species. Although there are zero Total Allowable Catches (TACs) or prohibited listings for some species, most remain vulnerable to existing fisheries. Some are caught as bycatch in mixed demersal trawl fisheries and gillnet fisheries, and deep-water sharks are caught in the mixed deep-water trawl fishery. The latest Commission Decision on the MSFD (848/2017) requires member states to establish a list of species of conservation concern which are at risk of incidental by-catch. This list should be established through regional or sub-regional cooperation, pursuant to the obligations laid down in Article 25(5) of Regulation (EU) No 1380/2013 for data collection activities and taking into account the list

	of species in Table 1D of the Annex to Commission Implementing Decision (EU) 2016/1251. The fish species included in this assessment are those present in the Irish maritime area, which are listed in Decision (EU) 2016/1251, those on the OSPAR list of threatened species, elasmobranch species prohibited from being caught in commercial fisheries under the EU CFP legislation and those listed as endangered with extinction on the EU fish red list.
Objective	In its 2013 Initial Assessment, Ireland identified that marine biodiversity would be safeguarded in such a way that: • Overall biodiversity is maintained or where appropriate restored; • Ecosystem structure and function is not compromised; • Abundance, distribution, extent and condition of key species and habitats (i.e. the area or environment where an organism or ecological community occurs) are in line with prevailing physiographic, geographic and climate conditions; and • Species and habitats identified as needing protection under national or international agreements are effectively protected or conserved through the appropriate national, regional or international mechanisms. Of these, the last two are considered relevant to this descriptor. In 2018, ICES advised that “regionally established thresholds of fixed proportions of species in the order of 60–80% (to be decided by managers/decision-makers) be used to describe the extent to which Good Environmental Status (GES) has been achieved when integrating to species group” such as non-commercially-exploited fish species eligible under Descriptor 1. Taking the latest ICES advice, a threshold of 60% of species achieving GES is considered to be indicative of whether GES is achieved overall for non-commercial fish species of biodiversity concern under this Descriptor.
Drivers (Activities)	The predominant activities driving pressures on marine fish species, based on Commission Directive 845/2017 is extraction of living resources (fish and shellfish harvesting). At least 8 major fishing nations currently have fisheries targeting the many marine stocks within this diverse area. The greatest amount of landings is by Norway, UK, Ireland, Spain, and France. Lesser amounts are landed

	by Germany, and Belgium. Detailed descriptions of this driver are provided in the Commercial Fishes D3 Assessment Sheet. For large bodied marine fish that swim at the surface (e.g. basking shark) an additional potential driver is Transport (shipping). For diadromous species other drivers are as important or more important than fishing. These additional drivers have been identified under the Habitats Directive Article 17 submission by Ireland and can be summarised as: Hydropower; Climate change; Agriculture, Forestry, Recreational angling; Physical alteration of water bodies; Mixed source pollution to surface and ground waters; Abstraction of water; Aquaculture; and Interspecific biological interactions.
Pressures	The predominant pressure exerted on fish in Irish waters has been identified as extraction of or mortality/injury to wild species by commercial fishing. This is defined as a pressure under the MSFD Commission directive 2017/845. Such extraction of fish from a stock through fishing leads to mortality on by-catch species. This mortality is measured under criterion D1C1. The only other potentially relevant pressures on marine fish are from ship strikes and from recreational angling. For diadromous fish there are a number of other pressures that are as relevant as mortality from commercial fishing. The most important of these are: Dams and other modifications of hydrological conditions; Physical alteration of water bodies; Application of fertilisers on agricultural land; Mixed source pollution to surface and ground waters; Drainage for use as agricultural land; Aquaculture, including infrastructure; Recreational angling; Increases or changes in precipitation due to climate change; Freshwater fish and shellfish harvesting; Abstraction of water; and Interspecific relations.
State	The environmental status of 33 assessed species was determined to be known, with the state of the remaining 23 being unknown. Eleven (11) species' populations were in good state. These included several deep-water fish (blue ling, mora, bigeye, rabbitfish), several small-bodied deep-water sharks (black dogfish, longnose velvet dogfish, birdbeak dogfish, deep-water lanternshark, blackmouth catshark, velvetbelly lanternshark). The only shelf-dwelling fish included in the assessment which was in good state was turbot. Among the species not in good state were most of the diadromous species (Atlantic salmon, European eel, twaite shad, sea lamprey),

	the larger-bodied deep-water sharks (leafscale gulper shark, Portuguese dogfish, kitefin shark, six-gill shark), several deep-water fish (Baird's smoothhead, blackbelly rosefish, orange roughy, large-eyed rabbitfish). The pelagic sharks (basking shark and shortfin mako shark) were also found not to be in good state, along with several demersal shelf-dwelling species (undulate ray, spurdog and cod). The species of unknown status include river lamprey, some elasmobranchs (common thresher shark, Deep sea catsharks, Norwegian skate, knifetooth shark, tope shark, mouse catshark, sandy ray, starry smoothhound, sailfin roughshark, thornback ray, spotted ray, deep-water ray), some deep-water fish (wolffish, alfonsino, roundnose grenadier, snub-nose spiny eel, straightnose rabbitfish, spiny scorpionfish), along with the bluefin tuna.
Impact	The parameters and characteristics specified in Commission Directive 2017/845 that are likely to be impacted upon by loss of fish biodiversity can be divided in to species impacts, habitat impacts and ecosystem/food web impacts. The species impacts are: changes to distribution and/or biomass; size, age and sex structure, fecundity, survival and mortality/injury; behavior including movement and migration; habitat for the species (extent, suitability); and species composition within groups of species. The main habitat impacts are: species composition, abundance and/ or biomass (spatial and temporal variation); size and age structure of species; and physical, hydrological and chemical characteristics. The main ecosystem impacts can be summarised as: links between habitats and species of marine birds, mammals, reptiles, fish and cephalopods; pelagic-benthic community structure; and productivity.
Response	The EU Habitats Directive (92/43/EEC) requires protection of certain diadromous fish species of European importance, considered to be endangered, vulnerable, rare and/or endemic. The protection provisions are designed to ensure that the species listed in the Habitats Directive reach a Favourable Conservation Status within the EU. The Habitats Directive species and sub-species are protected in various ways. For species on Annex II (Atlantic salmon, lampreys and shads) core areas of their habitat – designated as Sites of Community Importance - must be protected under the Natura 2000 Network and the sites managed in accordance with the ecological requirements of the species. For species and sub-species listed in Annex V (Atlantic

	salmon, river lamprey and shads) Member States shall, if deemed necessary as a result of surveillance work, take measures to ensure that their exploitation and taking in the wild is compatible with maintaining them at a Favourable Conservation Status. There are special measures to protect European eel, which is not covered by the Habitats Directive. The EU management plan (EC Regulation No. 1100/2007; EU, 2007), aims to achieve the protection, recovery, and sustainable use of the stock. To achieve the objective, EU Member States must develop Eel Management Plans (EMPs) for their river basin districts, designed to reduce mortality to a level that allows at least 40% of the silver eel biomass to escape to the sea with high probability, relative to the best estimate of escapement that would have existed if no anthropogenic influences had impacted the stock. An eel management plan is in place in Ireland. There are four main management actions included in this plan aimed at reducing eel mortality and increasing silver eel escapement in Irish waters. These are: Cessation of the commercial eel fishery and closure of the market; Mitigation of the impact of hydropower, including a comprehensive silver eel trap and transport plan; Ensuring upstream migration of juvenile eel at barriers; and improvement to water quality including fish health and biosecurity issues. Marine fish, unlike diadromous fish, have no protection under the Habitats Directive. The main international protection for fish is under the EU's Common Fisheries Policy (CFP) prohibited species list. The species prohibited are a range of elasmobranchs (under the annual Total Allowable Catch (TAC) and quota regulations) and the orange roughy (under the biennial deep-sea TAC and quota regulation). Endangered fish, other than those mentioned already, have no other protection under CFP at present. Deep water species, including sharks and orange roughy, are also protected by the Northeast Atlantic Fisheries Commission (NEAFC). These prohibitions in EU and NEAFC essentially allow discarding of dead or alive by-catch. There are several technical regulations in EU fisheries legislation. They are not necessarily designed to limit mortality, but to achieve other aims such as improved selectivity or elimination of what are considered to be undesired practices. Since 1997 it has been forbidden to target pelagic sharks, billfish or tunas with pelagic gillnets. This was in response to concerns of cetacean by-catch (EC Regulations 894/97 and 809/2007). There has been a general ban on removal of fins from sharks in European fisheries, since 2003 (EC

	605/2013 and 1185/2003). This was in response to public concern about the practice of shark finning. There is a ban on gillnetting in depths deeper than 600 m in EU waters (EC Regulation 41/2007), and deeper than 200m in international waters (Northeast Atlantic Fisheries Commission). These measures were brought in to regulate ghost fishing by gill nets in deep water. There is also a general ban on trawling in waters deeper than 800 m (EU) 2016/2336). This measure would afford protection to fish that are mainly found in waters deeper than 800 m, including orange roughy and some deep-water sharks. The Convention on Migratory Species (CMS or Bonn Convention) promotes international cooperation for migratory species. Species threatened with extinction are listed on CMS Appendix I. Parties that are range states to Appendix I species are obliged to afford them strict protection through additional measures. Migratory species that need or would significantly benefit from international co-operation are listed in Appendix II of the Convention. CMS encourages, inter alia, the establishment of regional or global MoUs to promote cross-border conservation efforts. Ireland, and the European Union are signatories to CMS. Angel shark is listed on both appendices, while porbeagle and basking shark are listed on Appendix II. The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) seeks to identify species in its area that are being threatened and/or declining and are in need of protection. OSPAR lists such species, upon recommendation by contracting parties or observers. This list is not binding, but is intended to be used as a basis for future management/conservation action. OSPAR shares many of the species with other lists, but also considers thornback and spotted rays which are not otherwise considered to be of high conservation concern in Ireland. Under the EU Water Framework Directive (WFD), River Basin Management Plans (RBMP) address the ecological and chemical status objectives of water bodies, including marine waters extending to ≤ 1km from baseline). Where required, programmes of measures will be implemented to ensure the water body meets WFD targets of Good Ecological Status by 2027. In coastal water bodies, under the WFD, Good Ecological Status refers to a defined biological objective based on physico-chemical and hydromorphological parameters. Fish community monitoring is required only for transitional waters, potentially valuable breeding and nursery areas for some species,

	and includes assessments of species composition and abundance in addition to providing data on the presence of sensitive species. The International Plan of Action for Conservation and Management of Sharks (IPOA-SHARKS) was developed through the United Nations Food and Agricultural Organisation (UN FAO) in 1998. It is a voluntary framework to achieve the conservation and management of cartilaginous fishes and their long-term sustainable use. The EU, through the European Commission, produced a framework IPOA in 2009. This encompasses existing EU fisheries legislation and envisages further measures in the future. EU Member States may also develop national IPOAs. These can include stronger measures than the EU framework. There are no measures in Ireland to regulate ship strikes or harm by recreational vessels to surface swimming fish. However, the legal mechanism exists for countries to develop such measures, under the UN International Maritime Organisation (IMO), and examples exist elsewhere in the world for the protection of whales. The Wildlife Acts, in Ireland, do not offer protection to marine fish species. Policy Directive 1 of 2019 to the Registrar General of Fishing Boats under Section 3 of the Fisheries (Amendment) Act 2003, as amended by Section 99 of the Sea Fisheries and Maritime Jurisdiction Act 2006 provides that vessels over 18 metres in length will be excluded from trawling activity inside six nautical miles, including inside the baselines, from 1 January 2020 (with the exception of vessels over 18 metres LOA trawling for sprat which will be entirely curtailed from 2022 onwards). These measures aim to provide ecosystem benefits, including for nursery areas and juvenile fish stocks.
Assessment Method	The assessment is based on results of ICES, ICCAT, IFI-Habitats Directive or Marine Institute advice/additional assessments for individual stocks, giving results in terms of fishing mortality from by-catch (D1C1) and population abundance (D1C2). All stocks which have a landings value recorded in 2016 or 2017, in the FAO FISHSTAT database were included, if that species occurs the Irish MSFD area. The assessment was carried out for 56 species of fish. In order to qualify for this assessment a species must be regularly present in Ireland's maritime area and appear on one of the following lists:

	• Table 1D of Commission Implementing Decision (EU) 2016/1251 for collection, management and use of data in the fisheries and aquaculture sectors for the period 2017-2019. • The OSPAR List of Threatened and Declining Species. • EU Habitats Directive (92/43/EEC). • Species prohibited from being targeted under the EU's TAC and quota regulations relevant to Irish MSFD waters. • The EU fish Red List. Full details of ICES advice for fish stocks are provided in the Commercial Fish D3 assessment sheet. For those species not assessed by either ICES or ICCAT, survey trend analyses were performed. This assessment was calculated using survey abundance data from scientific groundfish surveys. These are standardized monitoring programmes that occur each year in the same period taking representative samples according to specific guidelines. The method used was based on the method used to construct OSPAR Common Indicator FC1. However, unlike the FC1 indicator, the method was used to provide status of individual species against two reference points, or thresholds. These reference points were the relationship between survey abundance over time versus the 25th and 75th percentiles. The 25th percentile was used as a metric of collapse of the species' abundance, whilst the 75th percentile measured its recovery. Species whose abundance was between these percentiles were considered to be recovering, but not recovered. Species' abundances greater than the 75th percentile were classified as meeting criteria D1C2. For the relevant species listed under the Habitats Directive, the latest Irish Habitat Directive assessments were used. These assessments were used to evaluate conformity with Criteria D1C2, D1C4 and D1C5. The latter two criteria are primary only for species listed on the relevant annexes of the Habitats Directive. Criterion D1C2 was deemed to be met, if the species achieved Favourable Conservation Status. Criterion D1C2 was deemed to be met if the current population size was equal to or above the Favourable Reference Population. Criterion D1C4 was deemed to be met if the current range was equal to or above the Favourable Reference Range. Criterion

	D1C5 was deemed to be met if the area and quality of occupied habitat was sufficient. The method for aggregating individual species advice to create an overall D1 assessment is based on the latest (2018) ICES advice on aggregating of criteria. Based on this advice, only criterion D1C2 is used to determine the achievement of GES or not as the case may be. Thus, if a species meets criteria D1C2 that species was deemed to have achieved GES. Following this ICES advice, species that are at risk of extinction should not be accounted for in determining the achievement of GES. Extinction risk was evaluated using the latest EU Red List for fishes, categories “Critically Endangered” and “Endangered” For threshold setting under this descriptor assessment the 2018 ICES advice was used: “that regionally established thresholds of fixed proportions of species in the order of 60–80% (to be decided by managers/decision-makers) be used to describe the extent to which Good Environmental Status (GES) has been achieved when integrating to species group and ecosystem component; the thresholds should balance the sensitivity to false alarms and missed alarms.” This advice was used to set the threshold as between 60% and 80% of species attaining GES within the assessment. Criterion D1C3 was not included in this assessment. This decision was based on advice for the analogous Criterion Element D3C3. Advice from ICES, in 2017, for D3C3 stated that until proof of concept has been validated, D3C3 could not be considered as operational for MSFD assessment purposes. Following this advice it was decided not to include D1C3 in this assessment because the same issues apply as for D3C3.
Assessment Result	The assessment of Good Environmental Status (GES) for non-commercial fish biodiversity was based on whether stocks are fished at or below a rate consistent with maximum sustainable yield (MSY), and whether their population abundance is above a level such that their long-term viability is ensured. The assessment was performed for 56 species. For by-catch mortality (D1C1) results were only available for 7 species, with 49 species unknown. Bluefin tuna, spurdog and blue ling were subject to by-catch mortality rates consistent with MSY or with recovery to levels capable of achieving MSY in the future. Cod,

	shortfin mako shark, porbeagle shark and the common skate complex were subject to by-catch mortality rates that were too high. For population abundance (D1C2), results were available for 33 species, with 23 unknown. Eleven (11) species met criterion D1C2, with 22 species not meeting it. Among those that met the population abundance criterion were turbot, and several deep-water fish such as blue ling, mora, several small deep-water sharks and rabbitfish. Among those not meeting the criterion were most of the diadromous species, cod, the larger deep-water sharks and orange roughy. The status of river lamprey, several deep-water fish, some shelf dwelling elasmobranchs and bluefin tuna were unknown in relation to D1C2. For criteria D1C4 (species distributional range and, where relevant, pattern is in line with prevailing physiographic, geographic and climatic conditions) and D1C5 (habitat for the species has the necessary extent and condition to support the different stages in the life history of the species) the assessment was only performed for the 4 diadromous species, for which D1C4 and D1 C5 are primary criteria. Only Atlantic salmon met the range criteria (D1C4), while twaite shad and sea lamprey did not. Atlantic salmon and river lamprey met criteria D1C5, but twaite shad and sea lamprey did not. Overall GES has been achieved for 11 species, while 18 species have not achieved GES. The environmental status of 23 species is currently unknown. A further four species of non-commercial fish are classified as critically endangered and at a risk of extinction and are thus ineligible for GES assessment. Apart from turbot, all the species that have achieved GES are deep-water forms. These include the small-bodied deep-water sharks, and some of the more productive deep-water bony fishes. Among those not achieving GES are most of the diadromous species, cod, undulate ray, the large-bodied deep-water sharks and the less productive deep-water bony fishes.

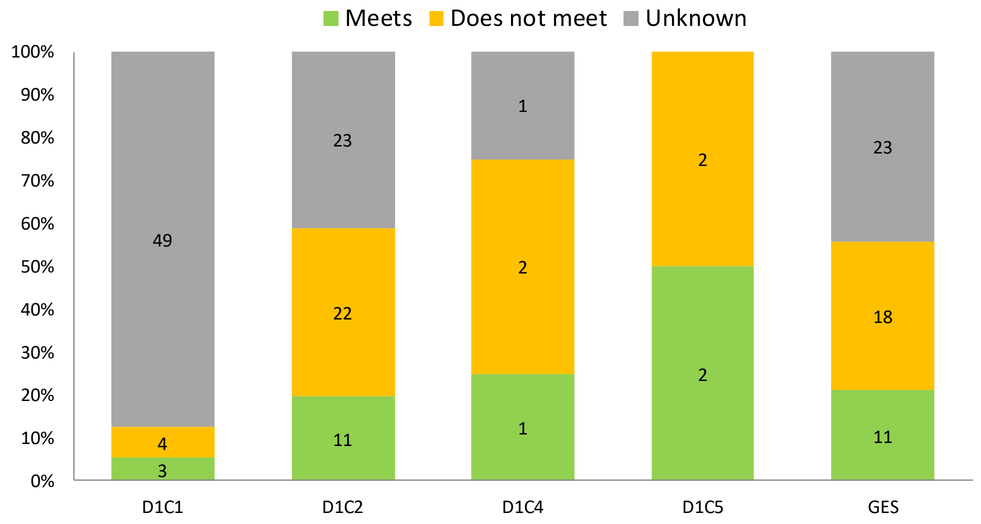
<table>
<tr>
<td>Results
(figures & tables)</td>
<td>


Figure 1. Number and percentage of eligible non-commercial fish species meeting criteria D1C1-D1C5, except D1C3, and also achieving GES overall.
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<td>Conclusion</td>
<td>Good environmental status (GES) has been achieved for a number of eligible non-commercial fish species in Ireland's maritime area, but not for all such species. In total, eleven species have achieved GES, while 18 species have not done so. The environmental status of 23 species is currently unknown. A further four species of non-commercial fish are classified as critically endangered and at a risk of extinction and are thus ineligible for GES assessment.

Overall for this element of biodiversity the proportion of species achieving GES is currently 21%, which is below the lower threshold value of 60% advised by ICES.</td>
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<td>Knowledge gaps</td>
<td>Almost all species in this assessment are caught in commercial fisheries by vessels from more than one country. In order to assess GES for these shared stocks in particular, international cooperation is required in the collation of landings and discards data and in assessment methodologies.

For species of unknown status new methods need to be found to assess them. This work should take place during the next MSFD cycle and this will require cooperation with OSPAR, ICES and other regional management/coordination-oriented organisations.

More work and international cooperation is required to analyse if age and size distribution data on populations of non-commercially-exploited species are indicative of healthy populations (under D1C3).</td>
</tr>
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	Assessment Data
Data Sources	Palma, S., Clarke, M. and Stokes, D. in prep. Status of non-assessed fish in Irish waters. Irish Fisheries Bulletin. Marine Institute, Galway. ICCAT, 2018. Report of the Standing Committee on Research and Statistics (SCRS). ICCAT, Madrid, 450 pp. ICES 2017. Advice on fish stocks. Accessed on the 4th October, 2019 from: http://www.ices.dk/community/advisory-process/Pages/Latest-advice.aspx ICES 2018a. Advice on fish stocks. Accessed on the 4th October, 2019 from: http://www.ices.dk/community/advisory-process/Pages/Latest-advice.aspx ICES 2018b EU request for guidance on an appropriate method to integrate criteria, species, species group to higher groups of birds, mammals, reptiles, fish and cephalopods for a Good Environmental Status assessment. ICES Special Request Advice Azores, Baltic Sea, Bay of Biscay and Iberian Coast, Celtic Seas, Greater North Sea Ecoregions Published 12July 2018. sr.2018.12 https://doi.org/10.17895/ices.pub.4494. Nieto, A., Ralph, G.M., Comeros-Raynal, M.T., Kemp, J., García Criado, M., Allen, D.J., Dulvy, N.K., Walls, R.H.L., Russell, B., Pollard, D., García, S., Craig, M., Collette, B.B., Pollom, R., Biscoito, M., Labbish Chao, N., Abella, A., Afonso, P., Álvarez, H., Carpenter, K.E., Clò, S., Cook, R., Costa, M.J., Delgado, J., Dureuil, M., Ellis, J.R., Farrell, E.D., Fernandes, P., Florin, A-B., Fordham, S., Fowler, S., Gil de Sola, L., Gil Herrera, J., Goodpaster, A., Harvey, M., Heessen, H., Herler, J., Jung, A., Karmovskaya, E., Keskin, C., Knudsen, S.W., Kobyliansky, S., Kovačić, M., Lawson, J.M., Lorance, P., McCully Phillips, S., Munroe, T., Nedreaas, K., Nielsen, J., Papaconstantinou, C., Polidoro, B., Pollock, C.M., Rijnsdorp, A.D., Sayer, C., Scott, J., Serena, F., Smith-Vaniz, W.F., Soldo, A., Stump, E. and Williams, J.T. 2015. European Red List of marine fishes. Luxembourg: Publications Office of the European Union. NPWS (2019a). The Status of EU Protected Habitats and Species in Ireland. Volume 1: Summary Overview. Unpublished NPWS report. NPWS (2019b). The Status of EU Protected Habitats and Species in Ireland. Volume 2: Habitat Assessments. Unpublished NPWS report.

	OSPAR 2018. CEMP Guideline Combined guideline for the common indicators FC1, FC2, FC3 and FW3 for fish and food webs. Accessed on the 4th October 2019 from: https://www.ospar.org/work-areas/cross-cutting-issues/cemp.			
Data Locations (URL)	www.marine.ie https://www.npws.ie/publications/article-17-reports https://www.npws.ie/maps-and-data			
Data Time Line	Start Date:	2013	End Date:	2017
Point of Contact	Maurice Clarke, Marine Institute FEAS, Rinville, Oranmore, Co. Galway			
Email	maurice.clarke@marine.ie			

Appendix: Assessment summary for 56 non-commercial fish species, for all Descriptor 1 criteria.

Species	D1C1	D1C2	D1C3	D1C4	D1C5	GES
Alepocephalus bairdii Baird's smoothhead	?	0	-	-	-	0
Alopias vulpinus Common thresher shark	?	?	-	-	-	?
Alosa fallax Twaite shad	?	0	-	0	0	0
Anarhichas denticulatus Wolffish	?	?	-	-	-	?
Anguilla anguilla European eel	?	0	-	-	-	0
Antimora rostrata antimora	?	0	-	-	-	0
Aphanopus carbo	?	?	-	-	-	?
Apristurus spp. Deep sea catharks	?	?	-	-	-	?
Beryx spp. Alfonsino	?	?	-	-	-	?
Cataetyx laticeps	?	?	-	-	-	?
Centrophorus squamosus Leafscale gulper shark	?	0	-	-	-	0
Centroscyllium fabricii Black dogfish	?	1	-	-	-	1
Centroscymnus coelolepis Portuguese dogfish	?	0	-	-	-	0
Centroselachus crepidater Longnose velvet dogfish	?	1	-	-	-	1
Cetorhinus maximus Basking shark	?	0	-	-	-	0
Chimaera spp. Rabbitfish	?	1	-	-	-	1
Coryphaenoides rupestris Roundnose grenadier	?	?	-	-	-	?
Dalatias licha Kitefin shark	?	0	-	-	-	0
Deania calcea Birdbeak dogfish	?	1	-	-	-	1
Dipturus batis Common skate complex	0	0	-	-	-	+
Dipturus nidarosiensis Norwegian skate	?	?	-	-	-	?
Epigonus telescopus Bigeye	?	1	-	-	-	1
Etmopterus princeps Deepwater lanternshark	?	1	-	-	-	1
Etmopterus spinax Velvetbelly lanternshark	?	1	-	-	-	1
Gadus morhua cod	0	0	-	-	-	0
Galeorhinus galeus Tope shark	?	?	-	-	-	?
Galeus melastomus Blackmouth catshark	?	1	-	-	-	1
Galeus murinus Mouse catshark	?	?	-	-	-	?
Helicolenus dactylopterus Blackbelly rosefish	?	0	-	-	-	0
Hexanchus griseus Six-gill shark	?	0	-	-	-	0
Hippoglossus hippoglossus Halibut	?	?	-	-	-	?
Hoplostethus atlanticus Orange roughy	?	0	-	-	-	0
Hydrolagus mirabilis Large-eyed rabbitfish	?	0	-	-	-	0
Isurus oxyrinchus Shortfin mako shark	0	0	-	-	-	0
Lamna nasus Porbeagle shark	0	0	-	-	-	+
Lampetra fluviatilis River lamprey	?	?	-	?	1	?
Leucoraja circularis Sandy ray	?	?	-	-	-	?
Molva dypterygia Blue ling	1	1	-	-	-	1
Mora moro Mora	?	1	-	-	-	1
Mustelus asterias Starry moothhound	?	?	-	-	-	?
Notocanthus chemnitzii Snub-nose spiny eel	?	?	-	-	-	?
Oxynotus paradoxus Sailfin roughshark	?	?	-	-	-	?
Petromyzon marinus Sea lamprey	?	0	-	0	0	0
Raja clavata Thornback ray	?	?	-	-	-	?
Raja montagui Spotted ray	?	?	-	-	-	?
Raja undulata Undulate ray	?	0	-	-	-	0
Rajella fyllae Deepwater ray	?	?	-	-	-	?
Rhinochimaera atlantica Straightnose rabbitfish	?	?	-	-	-	?
Rostroraja alba White skate	?	0	-	-	-	+
Salmo salar Atlantic salmon	?	0	-	1	1	0
Scophthalmus maximus Turbot	?	1	-	-	-	1
Scymnodon ringens Knitefooth shark	?	?	-	-	-	?
Squalus acanthias Spurdog	1	0	-	-	-	0
Squatina squatina Angel shark	?	0	-	-	-	+
Thunnus thynnus Bluefin tuna	1	?	-	-	-	?
Trachyscorpia cristulata Spiny scorpionfish	?	?	-	-	-	?

Legend	
Endangered with extinction, ineligible for GES	+
Meets criterion or GES	1
Does not meet criterion or GES	0
Unknown	?

D1 C1

Descriptor 1 Biodiversity	**Assessment Sheet: Reptiles, birds and mammals** **Criterion D1C1** **Mortality rate per species from incidental by-catch**
Key message	Since 2009 populations of Irish-breeding marine vertebrate species have been monitored relatively consistently using standard international practice. In some cases, (e.g. certain marine birds, small cetaceans and seals) this monitoring followed earlier comprehensive baseline research and surveillance. Key evidence on abundance to 2018 across a range of eight representative species supports the finding that the majority are maintaining a favourable conservation condition. The associated data and population status assessments of marine vertebrate species are significant factors in framing and interpreting the potential impact on such species arising from incidental by-catch mortality. Assessments of this criterion that have been conducted for eight vertebrate species show a range of results; from limited knowledge resulting in an environmental status that is currently unknown (i.e., Leatherback turtle, Black-legged kittiwake), to better knowledge, albeit with caveats, resulting in determinations that the observed by-catch mortality rate of representative species is considered not to be impacting on their achieving Good Environmental Status (GES) (i.e., Northern fulmar, Northern gannet, Bottlenose dolphin, Harbour porpoise, Grey seal, Harbour seal). An important additional finding is that considerable and more comprehensive scientific and risk-based observational work is required in order to build a more robust scientific picture of this negative interaction for representative species. [Note: While three key, comparatively well-studied species of marine bird and four species of marine mammal have been included in this assessment to represent important “Criteria elements” of marine biological diversity, there are of course many more species within each group occurring and/or breeding in Ireland’s marine area. In time additional representative species may be added to future assessments of biological diversity as the scientific knowledge base, data quality and understanding of their ecology and role in our marine ecosystems improves.]

Background	Ireland competed an Initial Assessment of its maritime area under the MSFD in October 2013. At the time, the assessment under biologically-orientated descriptors was largely restricted to (a) fisheries–related data for species and (b) broad-scale mapping data for habitats. In relation to biological diversity and associated environmental targets and indicators under Descriptor 1 the 2013 assessment concluded that more work was required to develop and coordinate parameters, elements and methods that would contribute to a more effective evaluation of Ireland's marine environmental status. Since then Ireland's approach, data collection and methods of assessment for this Descriptor under MSFD Articles 8, 9 and 10 have progressed considerably. This updated assessment considers elements of marine fauna that represent essential features and characteristics of biological diversity in Ireland's marine environment. It summarises (i) current knowledge of their environmental status, (ii)environmental targets for each faunal element that Ireland has established in order to achieve/maintain Good Environmental Status (GES) and, where possible, (iii) environmental threshold values per element that are proposed in order to secure and support the maintenance of GES in the long term. With regard to the assessment of incidental bycatch mortality (Criterion D1C1), details on the assessment methodology and its genesis are captured under the Assessment Method section below. This assessment work was conducted using "Criteria elements", i.e. a set of species considered to be representative of elements of the marine ecosystem, and for which national monitoring/assessment programmes have been established, namely: **a) Marine reptiles:** Leatherback turtle *Dermochelys coriacea* The most frequently recorded turtle species in Irish waters and the only turtle considered to use Irish waters as part of its natural range, mainly occurring in summer-autumn. Listed in Annex IV of the EC Habitats Directive (Directive 1992/EEC) as a species in need of strict protection; **b) Marine birds:** Black-legged kittiwake *Rissa tridactyla*, Northern fulmar *Fulmarus glacialis*, Northern gannet *Morus bassanus* Protected under the Birds Directive (Directive 2009/147/EC), all three are fully marine species that nest and breed in Ireland on islands and cliff-bound terrain that is less vulnerable to human

	interference and mammalian predators than the breeding habitat of other seabird species. **c) Marine mammals:** Bottlenose dolphin *Tursiops truncatus*, Harbour porpoise *Phocoena phocoena*, Grey seal *Halichoerus grypus*, Harbour seal *Phoca vitulina* All four species occur in coastal and offshore waters of Ireland's maritime area and are listed in Annex II of the Habitats Directive as species whose conservation requires the designation of special areas of conservation. Both cetacean species are also listed in Annex IV.
Objective	The overriding objective is that Ireland's newly established environmental targets for MSFD Descriptor 1 (Biological diversity) are achieved. With regard to incidental bycatch mortality of vertebrate species (excluding non-commercial fish species) the applicable target is: **Environmental Target D1T1: The mortality rate per species from incidental by-catch is below levels which threaten the species, such that its long-term viability is ensured.** In this regard Commission Decision (EU) 2017/848 states: "Member States shall establish the threshold values for the mortality rate from incidental by-catch per species, through regional or subregional cooperation."
Drivers (Activities)	Populations of larger marine vertebrate species, such as reptiles, birds and mammals, may be subject to adverse impacts arising from local and/or regional anthropogenic drivers (activities) throughout their North Atlantic range and in Irish coastal/offshore waters. The main human activities believed to be interacting as pressure mediators on Ireland's marine vertebrate populations involve commercial vessel-based or shipping-based activities that occur primarily on a local or regional scale and/or on a persistent or intermittent basis (e.g., commercial fisheries or geophysical seismic exploration). Foremost of these anthropogenic drivers in an Irish context is commercial fishing at sea by Irish-registered vessels and other European/international fleets operating within Ireland's Exclusive Economic Zone (EEZ), both through the removal of food biomass and

	potential prey resources from the marine environment and also through incidental captures (by-catch) or injurious entanglement of individual animals in a range of fishing gear types. In relation to seal by-catch the most significant fishing métiers involved in Ireland and the UK appear to be static nets (i.e., gill nets, tangle nets or trammel nets) targeting demersal fish and larger crustaceans, while for cetaceans and marine birds, pelagic trawlers and demersal trawlers may also be involved in this interaction. According to current evidence on a national scale in Ireland these drivers may not be reducing overall population abundance of representative vertebrate elements of the ecosystem. They may however act to impair natural population growth or normal fluctuations in the absence of potential stressors, and further scientific investigation or improved management of such activities may be necessary via a risk-based prioritisation approach.
Pressures	The predominant pressure identified in Commission Directive 2017/845 that is currently of known and/or potential significance regarding incidental by-catch mortality in Ireland's MSFD area, is considered to be: • Extraction of, or mortality/injury to, wild species (by commercial fishing, and/or recreational fishing and/or other activities) Due to its potential to injure or remove individual marine vertebrates from their natural environment and to potentially impact on local or regional populations and their productivity, this is a significant potential pressure in Ireland's maritime area. Yet current evidence indicates that some non-target species of vertebrate are more vulnerable to this pressure and its adverse effects than others. This can be a complex interaction involving, for example, the operational practices implemented from individual fishing vessels, the target fish/cephalopod species and their natural predators, as well as the location, season and the motivation/behaviour of vertebrate predators. This pressure type takes place in the water column (e.g. pelagic trawling) and also close to or on the sea-floor (e.g. demersal trawling or set nets). It is prevalent all year round and in much of Ireland's EEZ, and is driven by a wide range of international, European Union and national fishing fleets. These use diverse gear types, from jigging and long-lining to mobile nets, static nets of various kinds/arrangements, and stationary pots.

	Fishing-derived pressure is, to a large extent, measurable and it is therefore supported by scientific evidence, monitoring and assessment, as well as EU and international regulation and management (e.g. through the EU Common Fisheries Policy). However, the observation and measurement of by-catch mortality during fishing operations is more difficult in practice and is not currently implemented in a systematic or standardised scientific manner throughout the European Union. This can cause difficulties and introduce uncertainty in the accurate determination of by-catch mortality rates.
State	**Marine reptiles** Leatherback turtle With regard to the primary criteria and established Environmental Targets under Descriptor 1, there are currently significant limitations associated with assessing and reporting on the status of this ‘sea turtle’ species. While some recent progress has been made in data acquisition from Ireland and adjacent waters, the species’ population ecology, range, habitat use and the pressures/impacts it faces in Irish waters and the wider North-East Atlantic, are not well understood. The overall status of this species’ population in Irish waters is therefore assessed as Unknown. Consequently, it is not currently possible to accurately evaluate, in species population terms, the mortality rate due to incidental by-catch in Irish waters. **Marine birds** Black-legged kittiwake In relation to population abundance, there are clear indications that national figures have decreased significantly over the past 20 years (i.e. 24,728 pairs in 2015-2018, a short-term decrease of 32% from 1998/2002). This is driven by acute short-term declines at some of the most important breeding colonies in Ireland (i.e. Horn Head, Co. Donegal, Cliffs of Moher, Co. Clare and Great Saltee Island, Co. Wexford). Monitoring data collected in 2015-2018 describe a near 20% reduction in breeding population estimates at Lambay Island, Co. Dublin alone, which, owing to its relative colony size, significantly influenced the national population picture. While there is evidence of a substantially wider distribution of breeding colonies around the coast than was known heretofore, there is nevertheless an underlying question concerning Kittiwake reproductive success and the extent and condition of its natural habitats, given population declines seen at several breeding colonies.

	Causes of the declines are unclear at present. Some examples of potential factors involved are changes in food availability or prey distribution, or climate-related influences. Due to the uncertainties at present, the overall status of this species' population in Irish waters is assessed as Unknown. It is also difficult, therefore, to assess this MSFD criterion against a coherent regional or national population parameter. An evaluation with respect to Environmental Target D1T1 has nevertheless been undertaken. Northern fulmar The population abundance of this species in Ireland appears to be relatively stable since the 1990s (ca.33,000 pairs), having increased markedly from levels recorded in periodic surveys during 1969-70 and in the 1980s. Considerable variation in population trajectories between individual breeding colonies is noted however via the National Seabird Monitoring Programme and there is a need to continue scientific monitoring, at regional and national scales on land and at sea, in order to better understand the species' population dynamics and the role/influence (if any) of human activities and impacts on Fulmar reproductive success or abundance. In consideration of Environmental Targets D1T1 and D1T2 and the species' long-term viability, given that the available scientific evidence from Ireland shows an increasing breeding distribution and stable population figures nationally, it is concluded that GES has been achieved for this large petrel species. Northern gannet The Irish breeding population of Gannets has been surveyed on five census occasions since the late 1960s, along with the population in Britain and, where possible, the wider North Atlantic. The most recent breeding season census in Ireland took place primarily during 2013 and 2014. The data generated show that the Irish population has increased by an estimated 33% over a 10-year period to reach 47,946 pairs in 2014, and that its breeding distribution has expended accordingly (up 20% since 2004, up 50% since 1984/85). Regional populations at the traditional colonies have increased across the board such that, in historical terms, the population has increased by 121% since Operation Seafarer in 1969-70. In consideration of Environmental Targets D1T1 and D1T2 and the species' long-term viability, given that the available scientific evidence from Ireland shows an increasing breeding distribution and increasing

	population figures nationally, it is concluded that GES has been achieved for this large marine bird species. **Marine mammals** Bottlenose dolphin In a coastal context, high quality data collected from the Lower River Shannon, which comprises a Special Area of Conservation (SAC) for this Annex II species, describe a relatively stable local population of ca.120-160 individuals since at least the mid-1990s. A second and genetically distinct community of this species also inhabits coastal waters of Connacht and Ulster, and has been the subject of more intensive study since 2009-10. This wider-ranging community numbers approximately 190 individuals (95% HPDI: 162-232) and is in turn protected by a SAC designation (West Connacht Coast SAC). Knowledge of the species' regional distribution and summer abundance in western European waters has improved significantly in recent decades. There has also been improved population abundance data from a large part of Ireland's EEZ, yielding substantial new estimates numbering 68,714-147,267 individuals and exceeding all previous figures for the region. In consideration of Environmental Targets D1T1 and D1T2 and the species' long-term viability, it is concluded that GES has been achieved for this dolphin species. Harbour porpoise Knowledge of the species' seasonal distribution and summer abundance in western European waters has improved significantly in recent decades. There has also been improved population abundance data from a large part of Ireland's EEZ, yielding new estimates numbering 29,519-51,840 individuals and highlighting areas of apparent importance for the species (e.g. Irish Sea). In a coastal context, good quality data collected over the last decade from Ireland's three Special Area of Conservation for this Habitats Directive Annex II species, describe relatively high densities during the summer months in which calving and initial nursing of young porpoises is known to occur. In consideration of Environmental Targets D1T1 and D1T2 and the species' long-term viability, it is concluded that GES has been achieved for this small cetacean species. Grey seal Evidence from surveys carried out since the mid-1990s indicates that the all-age population of Grey seals has been growing in Ireland, driven largely by increases in pup production and recruitment to the

	population at each of the seven main breeding colonies. In this context the estimated 7,284-9,365 seals associated with breeding in Ireland (2013) is considered to be a minimum estimate. More recent information from annual surveillance (NPWS, 2018 unpublished data) suggests continued growth in pup production at the seven main breeding colonies during the period 2013-2018. Growing Grey seal abundance is also reflected in nationwide counts of this species in summer (August), underlining further a positive population status and trend. Since Irish estimates for Grey seal population size, derived from data on the principal breeding colonies, are periodic and variable figures depending on the year of coverage, and they represent a small number of samples of such abundance estimates, a precise Favourable Reference Population (FRP) since the Directive came into force remains difficult to determine. However, based on the estimates provided in this assessment along with previous abundance information, the FRP is considered to be less than the minimum population estimate provided here. In consideration of Environmental Targets D1T1 and D1T2 and the species' long-term viability, it is concluded that GES has been achieved for this seal species. Harbour seal The current minimum population estimate derived via moult data gathered in 2017-2018 is higher than ever recorded in Ireland and is greater than that recorded via comparable aerial surveys in 2011-12 (3,489 Harbour seals) and 2003 (2,905-2,955 Harbour seals of all ages). There are insufficient data available at this stage to statistically determine a population trend for this species and further scientific work is required in this area. Nevertheless, the short-term trend in Ireland's Harbour seal population is considered to be stable at least given the relative similarity in national population estimates between 2003, 2011-12 and 2017-2018. Furthermore, the results of site surveillance within the current reporting period also indicate comparatively stable numbers at a wide range of monitored sites. Since estimates of minimum Harbour seal population size derived from haul-out count data during the moult season are periodic and variable figures depending on the year of coverage, and they represent a small number of samples of such abundance estimates, a precise Favourable Reference Population (FRP) since the Habitats

	Directive came into force remains difficult to determine. However, based on the estimates provided in this assessment along with previous abundance information, the FRP is considered to be less than the minimum population estimate of 4,007 Harbour seals provided here. In consideration of Environmental Targets D1T1 and D1T2 and the species' long-term viability, it is concluded that GES has been achieved for this seal species.
Impact	The parameters and characteristics specified in Commission Directive 2017/845 that are likely to be impacted upon by loss of biological diversity can be divided in to species impacts, habitat impacts and ecosystem/food-web impacts. The species impacts are considered to operate via changes to: distribution and/or biomass; size, age and sex structure, reproductive potential, survival and mortality/injury; behaviour including movement and migration; habitat for the species (extent, suitability); and species composition within groups of species. The main habitat impacts are considered to operate via changes to: species composition, abundance and/ or biomass (spatial and temporal variation); size and age structure of species; and physical, hydrological and chemical characteristics. The main ecosystem impacts are considered to operate via changes to: links between habitats and species of marine birds, mammals, reptiles, fish and cephalopods; pelagic-benthic community structure; and productivity. The effects and consequences of the predominant pressures on biological diversity during the overall assessment period (2013-2018) and prior to that, if relevant, have been considered in the current assessment. For the marine vertebrates outlined above that have been included as criteria elements (i.e. eight reptile, bird and mammal species) this is primarily informed by Ireland's surveillance, assessments and reporting undertaken to meet requirements under the EU Habitats Directive and Birds Directive. In relation to the predominant pressures identified as known and/or of potential significance in Ireland's marine area, based on scientific evidence and knowledge of current human activity there are few such pressures that are considered to operate with potential population-level effects or consequences for these species in Ireland. Where commercial fishing is concerned, among them however is: • Extraction of, or mortality/injury to, wild species (by commercial fishing, and/or recreational fishing and/or other activities)

	In addition to the loss of potentially significant food biomass from the marine environment through human extraction, this pressure can also have direct population consequences (e.g. via reduced survival to breeding age or impaired reproductive success) if the level of mortality or injury to wild species is not compensated for by natural factors such as productivity or immigration. **Marine reptiles** Leatherback turtle With regard to this Environmental Target there are currently significant limitations associated with assessing human impacts upon this 'sea turtle' species in the North Atlantic Ocean and in Irish waters. While some recent progress has been made in data acquisition from this part of the North-East Atlantic, the species' population ecology, range, habitat use and the pressures/impacts it faces in these waters are not well understood. Leatherback turtles that migrate through Irish waters mate and breed in the tropics. In the North Atlantic, incidental by-catch in fishing gear (e.g., drift nets, gill nets, long-lines) has generally been identified as a significant conservation concern. However, the impacts of leatherback turtle interactions with commercial fishing have not been comprehensively or robustly quantified. In a regional context there is little scientific evidence of by-catch by Irish-registered vessels fishing in the open ocean. In coastal waters however, a small number of individual animals have died or been injured as a result of apparently occasional entanglement in ropes associated with lobster and crab fisheries. With regard to potential consequences arising from incidental by-catch mortality and/or injury, there is some evidence to suggest that the Leatherback turtle population in the North Atlantic has a positive trajectory, thus fishing-related mortality or injury could be sufficiently low as to cause no significant population-level impact. However, the scientific evidence base to support this possibility is insufficient. Furthermore, the understanding of the population ecology, migration patterns and habitat use of the species is also very limited. Active international, multi-disciplinary research is thus required to address such important knowledge gaps.

	Marine birds Black-legged kittiwake Regarding this Environmental Target this species is not one considered to be at a significant risk of impact due to incidental by-catch mortality. This is due to the fact that it feeds primarily at the sea surface on small pelagic shoaling fish and invertebrates, and appears to have a preference for live fish such as sandeels, sprat or juvenile herring, rather than for fishery discards. Therefore, based on current scientific knowledge and available fisheries monitoring data, it is considered unlikely that the species' long-term viability is currently impacted or threatened into the future by incidental mortality in commercial fisheries. Northern fulmar Although this species' close association with commercial fisheries and discarded offal or unwanted/incidental catches is well described, dietary studies indicate that Fulmars are very wide-ranging and feed on a wide variety of prey that occur near the sea surface including small pelagic fish, sandeels, squid, amphipods and copepods. Accidental by-catch interactions with certain fishing gears are known to occur in the North-east Atlantic (e.g., in long-lines and trawl nets). Yet the incidence of Fulmar by-catch by Irish-registered vessels would appear to be uncommon and may be below levels that could threaten the species in the long-term. Based on the stable population abundance and distribution expansion of Fulmars in Ireland and other monitoring data, there is currently no evidence that any pressures and their effect on this criteria element are operating at a population level. Actual mortality rates from incidental by-catch require active systematic monitoring and scientific research, however, since observational coverage of the use of different fishing gears (i.e. métiers) has been relatively low and robust conclusions are difficult to determine at present. Northern gannet There is substantial evidence of this species interacting opportunistically with a wide range of commercial fisheries; for example, by feeding directly on retained catches at the surface as they are taken on board, or by scavenging on discards or drop-outs from vessels and associated gear. Gannets otherwise naturally forage at the surface and sub-surface where they mainly target small shoaling fish (e.g. sandeels, mackerel, herring and other small- to mid-sized pelagic fish).

	The acquired tendency to forage around fishing operations may help to explain why the Gannet is one of the seabird species recorded as incidental by-catch and is assessed by the National Parks & Wildlife Service (NPWS) as a species that is highly sensitive to the threat of by-catch. Data currently available from the monitoring aboard Irish-registered vessels suggests that the overall rate of Gannet mortality from by-catch in Irish waters is low, however, with occasional by-catch events comprising numerous individual birds. Based on the increasing population abundance and distribution expansion of Gannets in Ireland and other monitoring data, there is currently no evidence that any pressures and their effect on this criteria element are operating at a population level. However improved observation effort at sea (e.g. a higher percentage and more representative sample of fishing vessels actively monitored), particularly around higher-risk fishing methods, is required to continually validate and further support this and future assessments. **Marine mammals** Bottlenose dolphin While the wider impacts of human activities on Bottlenose dolphin in Irish waters are not well understood, partly due to the species' extensive range and continuing uncertainty regarding population trends and ecology within Ireland's extensive marine area, none of the associated pressures are considered to be of sufficient magnitude to be causing an adverse impact on its populations in Irish waters. In keeping with this evaluation, the available evidence from Irish-registered fishing vessels, and from coastal strandings reported by the Irish Whale and Dolphin Group (IWDG) Cetacean Strandings Scheme, indicates that accidental catches of this larger dolphin are uncommon or quite rare in Irish commercial fisheries and are therefore unlikely to threaten the species in Irish waters. Thus, based on current evidence, the impact of incidental by-catch on this species is not considered to be significant at a population level in Ireland. However improved observation effort at sea (e.g., a higher % and more representative sample of fishing vessels actively monitored), particularly around higher-risk fishing methods, is required to continually validate and further support this and future assessments.

	Harbour porpoise Populations of Harbour porpoise may be subject to a number of local and/or regional environmental pressures and threats, including in Irish coastal/offshore waters. While the effect of these pressures may act on a temporary and/or regional scale and some (e.g., by-catch in certain commercial fisheries) are likely to continue to act as pressures into the future, none is considered to be of sufficient magnitude to be causing an adverse impact on populations of Harbour porpoise in Irish waters. Available evidence from Irish and non-Irish registered fishing vessels, and from coastal strandings recorded by the IWDG Cetacean Strandings Scheme, indicates that accidental catches of Harbour porpoise do occur in commercial operations, particularly in set net gears (e.g., gill nets). This detrimental interaction is complex and variable in space and time, and is currently difficult to measure with scientific confidence. Yet it could constitute a pressure on the species, particularly in the Celtic Seas subregion of the North-east Atlantic, which includes southern Irish waters. Significantly improved observation effort at sea (e.g. a higher % and more representative sample of fishing vessels actively monitored), particularly around higher-risk fishing methods, is required to investigate this occurrence further and to support future assessments. Grey seal Ireland's Grey seal population may be subject to a number of local and/or regional environmental pressures and threats on land in coastal areas, and in coastal and offshore waters. Incidental by-catch interactions with certain fishing métiers are known to occur, particularly with set net gears such as tangle-nets, trammel-nets and gill nets that are commonly used for demersal fishing in coastal and/or offshore waters. With regard to mortality rates from incidental by-catch, active scientific research into the rate, scale, reasons for and spatial/temporal extent of interactions is ongoing at present and definitive or robust conclusions are difficult to determine in the time-frame of this assessment. While the effect of such pressures may act on a temporary and/or regional scale, based on current information none is considered to be of sufficient magnitude to be causing an adverse impact on the Grey seal population in Ireland. The available evidence, as supported by ongoing robust surveillance, indicates continued growth in the species' breeding population size around the coastline.

	Harbour seal Ireland's Harbour seal population may be subject to a number of local and/or regional environmental pressures and threats on land in coastal areas, and in coastal and offshore waters. Incidental by-catch interactions with certain fishing métiers are known to occur, particularly with set net gears such as tangle-nets or gill nets that are commonly used for demersal fishing in coastal and/or offshore waters. With regard to mortality rates from incidental by-catch, active scientific research into the rate, scale, reasons for and spatial/temporal extent of interactions is ongoing at present and definitive or robust conclusions are difficult to determine in the time-frame of this assessment. While the effect of these pressures may act on a temporary and/or regional scale, based on current information none is considered to be of sufficient magnitude to be causing an adverse impact on the population of Harbour seal in Ireland. The available evidence, as supported by ongoing surveillance, indicates continued relative stability in the species' population size around the coastline.
Assessment Method	It should be here with respect to Environmental Target D1T1 (see above) that environmental threshold values for the mortality rate from incidental by-catch per species have not yet been established through regional or sub-regional cooperation, or nationally. Nevertheless, data and associated information concerning incidental catches of non-target species during commercial fishing are collated annually by the International Council for the Exploration of the Sea (ICES) and work on potential science-based threshold values is continuing via a number of international fora (e.g., OSPAR, HELCOM, ICES). Information on by-catches that is submitted to ICES by or on behalf of national competent authorities, is compiled and assessed annually by an associated ICES Working Group on Bycatch of Protected Species (WGBYC). Data covered by the associated data call include: 1. Data describing fishing effort, monitoring/sampling effort and incidental by-catch of cetaceans in pelagic trawl, high opening trawl, bottom set net, and drift net fisheries in accordance with the reporting requirements of Council Regulation (EC) No 812/2004; 2. Data describing monitoring/sampling effort and incidental by-catch of any non-cetacean protected species (i.e. species officially protected under national or international legislation),

	to include all other marine mammals (seals, etc), all seabird species, all sea turtle species and any protected, prohibited or zero Total Allowable Catch (TAC) elasmobranchs and protected fish species, from the same gear types as listed in point 1 above; 3. Data describing monitoring effort and incidental by-catch of all protected species (as defined in points 1 and 2 above) recorded from any other monitored gear types (demersal trawls, lines, etc) under national or international data collection programmes (e.g., Data Collection Framework (DCF), etc), or other monitoring programmes or projects. It is these data and information sources on annual by-catch records in commercial fisheries (e.g., ICES, 2018; ICES, 2019) that the assessment of this criterion is mainly reliant on, though some additional scientifically valid information that has not made its way to ICES WGBYC is also considered. Until recently, the main driver of (non-fish) by-catch data acquisition in Irish and neighbouring European Union waters has been Council Regulation (EC) No 812/2004 “laying down measures concerning incidental catches of cetaceans in fisheries”. This provided a legal framework for Member States’ introduction of observation-based monitoring, on-board or quayside surveillance and data-logging programmes, pilot studies, and voluntary or other initiatives, (a) seeking to collect scientific data on the interactions and (b) seeking to mitigate negative interactions for by-caught species, such as reductions in net entanglement and/or mortality for example. Starting in 2005 and first reporting to the EC in 2006, Ireland’s monitoring of the national fleet under Regulation 812/2004 focused primarily on relatively large-scale pelagic trawl and set net fisheries (e.g., using gill nets) and catches of cetacean species, as required under the Regulation. The associated observation effort comprised a variety of methods from independent observer programmes and pilot scientific projects to technical trials (e.g., using acoustic deterrence devices known as ‘pingers’), fisheries surveys and quayside data collection. More recently, observation effort and recording at sea has expanded to cover a wider swathe of the fishing fleet including demersal trawlers and also smaller inshore vessels, as outlined below.

	Prior to and in parallel with incidental by-catch monitoring under Regulation 812/2004, standard information on commercial catches (i.e., landings and discards) was being collected through a number of schemes whose aim and design are more oriented towards the monitoring of fish stocks. Such fisheries observer based schemes were established in Ireland in the 1990s and since 2002 they have been conducted through the DCF and development of the EU's Multi-annual Programme (EU-MAP). Under its remit for the Department of Agriculture, Food and the Marine, the Marine Institute through its Fisheries and Ecosystems Advisory Services is responsible for collecting and compiling scientific information on catches by the commercial fishing industry. With Regulation 812/2004 due to be repealed in 2019, since 2015 Ireland's DCF sampling by fisheries observers has been augmented to further develop and include a more standardised recording of incidental by-catch of a wider range of non-target species, including marine birds, reptiles and mammals. Data describing fishing effort, sampling/observation effort and all incidentally by-caught species are recorded by trained observers during a standard sampling procedure. A range of fishing operation types (i.e., gears or métiers) is targeted and the presence/absence of non-fish by-catches in every haul are required to be recorded, along with information on whether by-caught animals were dead or released alive, and ancillary data where possible (e.g., species, body length, sex, photographs). It should be noted that the principal commercial métiers are prioritised for monitoring due to the primary emphasis on fish stock assessment and there is a significant degree of voluntary facilitation by skippers involved; thus sampling is not distributed equally or proportionally across all métiers or operators, nor according to the by-catch risk profile of the fisheries concerned. There is also a high degree of variability in DCF observer coverage (usually presented as days-at-sea) per métier per year. This is partially linked to variable fishing effort for example but in nominal terms it can range from zero to 20% annually depending on the type of fishing operation and the year. A monitoring synopsis for Irish vessels covering the years 2005 to 2016 inclusive indicated that across the six most productive métiers examined – set gill net vessels ≥15m long; mid-water otter trawlers; mid-water paired trawlers (x2 – large and small pelagic fish species); set gill net vessels <15m long; mid-water otter/paired trawlers <15m long – the proportion of fishing effort *(*days at sea*)* that was subject to

	observational coverage was on average c. 5%. This figure is influenced by several good coverage years (i.e., c. 10% of days at sea or greater) for larger mid-water trawlers which tended to receive the highest and most consistent levels of coverage annually. Vessels <15m in length and larger gill net vessels demonstrated lower levels of observer effort overall with annual coverage aboard gill net vessels ranging from zero to 5.6% and averaging approximately 1.3% of the fishing effort. Within the above-mentioned monitoring context, the available data from Ireland in 2009 to 2018 were assessed for the following criteria elements and species, in view of knowledge of the population status and abundance of such species: **Marine reptiles:** Leatherback turtle; **Marine birds:** Black-legged kittiwake, Northern fulmar, Northern gannet; **Marine mammals:** Bottlenose dolphin, Harbour porpoise, Grey seal, Harbour seal [Note: While three key, comparatively well-studied species of marine bird and four species of marine mammal have been included in this assessment to represent important "Criteria elements" of marine biological diversity, there are of course many more species within each group occurring and/or breeding in Ireland's marine area. In addition, certain species of marine vertebrates may be more susceptible or more vulnerable to mortality or injurious interactions with fishing operations. In time additional representative species may be added to future assessments of this criterion and its Environmental Target as the scientific knowledge base, data quality and understanding of our marine ecosystems, and human activities therein, improves.]
Assessment Result	At the outset it is worth noting that the quality and quantity of submitted data available to the ICES WGBYC, and the levels of sample-based coverage of different fishing practices and operations, are not consistent and vary widely from one country/region/sub-region and from one year to the next. Along with uncertainties introduced by the methods or frequency of species' population estimation and/or regional animal movements for example, the accurate area- or population-based estimation of mortality rate and potential consequences for protected or vulnerable species represent challenging exercises; thus significant caution is required in the extrapolation and interpretation of their results.

	It should also be noted again here that environmental threshold values for the mortality rate from incidental by-catch per species have not yet been established through regional or sub-regional cooperation, or nationally. **Marine reptiles** Leatherback turtle Entanglements of Leatherback turtles in Irish fishing operations appear to be rare events, particularly since drift netting at sea for Atlantic salmon was banned nationally in 2007. This formerly extensive fishing practice was traditionally conducted in the spring, summer and autumn months and in the latter two cases it coincided with the periods when most sea turtle records have been obtained from Irish waters. There have been occasional by-catches of Leatherback turtle however, such as a single turtle caught in the summer fishery for Albacore tuna off south-west Ireland; this individual turtle was released alive. Given the relatively recent inclusion of monitoring for sea turtle by-catch under the Data Collection Framework and limited scientific knowledge of the species' distribution, abundance and ecology in Irish waters, the pressure on this species due to incidental by-catch by Irish-registered vessels is considered to be unknown. **Marine birds** Black-legged kittiwake Since the recording of incidental marine bird by-catch by Irish-registered vessels began under the DCF in 2015 there have as yet been no records of Kittiwakes being caught in the six primary métiers that have been subject to monitoring. Northern fulmar Since the recording of incidental marine bird by-catch by Irish-registered vessels began under the DCF in 2015 there have as yet been no records of Fulmars being caught in the six primary métiers that have been subject to monitoring. However, by-catches of this species by Icelandic and UK fishing fleets have been recorded and the data collated by ICES. Those incidental catches have occurred mainly in static gill nets but also on long-lines. Northern gannet Since the recording of marine bird by-catch by Irish-registered vessels began under the DCF in 2015, Gannets have emerged as the predominant species by-caught in fishing operations. While

	observation effort in most years has so far resulted in 1-2 individuals per year and relatively low by-catch mortality rates per unit effort (i.e., ≤0.03 specimens per observed day at sea), the year 2015 yielded a notable peak in numbers with a total of 80 Gannets that year, 45 of which were by-caught on one fishing trip. Efforts to generate robust mortality rates for this species are hampered by inconsistent and relatively low levels of observer coverage for some métiers and the relative rarity of incidences. Thus further and more intensive monitoring for incidental by-catch will be required to better determine the spatial, numerical and ecological scales of this negative interaction. By-catches of Gannets have also been recorded by Icelandic, UK and Portuguese fishing fleets and these are the data collated by ICES. Those incidental catches have occurred mainly in static gill nets but also on long-lines and in trawl gear. **Marine mammals** Bottlenose dolphin Since the recording of incidental cetacean by-catch by Irish-registered vessels began under Regulation 812/2004 (An Bord Iascaigh Mhara - BIM; 2005-2017) and continued under DCF monitoring from 2017 and a number of ancillary observational projects, there has been one confirmed record of a Bottlenose dolphin being caught in the six primary métiers that have been subject to monitoring. Occasional by-catches of this medium-sized dolphin species may nevertheless occur in Irish and adjacent waters, particularly in set net operations. In this regard there is some evidence of this occurrence from observation effort on Portuguese and Spanish fishing vessels, as the data collated by ICES. Harbour porpoise Since the recording of incidental cetacean by-catch by Irish-registered vessels began under Regulation 812/2004 (An Bord Iascaigh Mhara - BIM; 2005-2017) and continued under DCF monitoring from 2017 and a number of ancillary observational projects, there have been multiple records of Harbour porpoise by-catch (e.g., Cosgrove *et al*., 2013). Some secondary evidence of Harbour porpoise by-catches is also available from coastal strandings (i.e., IWDG Cetacean Strandings Scheme) and associated post-mortem examination; however, in such instances it is generally not possible to precisely determine the relevant fishing fleet or the métier concerned.

	Regarding the six primary métiers that have been subject to monitoring by Irish authorities, current evidence suggests that individual Harbour porpoises are not ordinarily at risk from pelagic trawl gears but are at a greater risk of being by-caught in bottom trawls and particularly set nets such as gill nets, trammel nets and tangle nets (e.g., ICES, 2019). Efforts to consistently estimate the mortality rate of Harbour porpoises due to incidental by-catch have not taken place at a national/EEZ level but they have been conducted on an (eco)regional basis by ICES WGBYC (ICES, 2019). Fisheries data were pooled from 2015-2017 and minimum and maximum bycatch rates were extrapolated using 2017 fishing effort data for nets, bottom trawls and pelagic trawls. Observed by-catch rates of Harbour porpoise were highest in nets. In the assigned "Celtic Seas ecoregion" which contains all of Ireland's marine waters, total porpoise by-catch in nets was estimated to be 230-471 individuals per annum. Framed against the most recent population estimates for the species, these by-catch estimates are below the 1.7% upper threshold of negative interaction supported by parties to the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS; http://www.ascobans.org). They are also below the 1% precautionary environmental limit defined by ASCOBANS for by-catch. Ireland is not a party to this agreement however. The same by-catch risk assessment by ICES WGBYC was also carried out for a new biologically-defined "Celtic Seas Assessment Unit" for Harbour porpoise. In this case total by-catch in nets in 2017 was estimated to be 536-1,409 porpoises (>2% of the population abundance) which exceeds both ASCOBANS thresholds. It is noteworthy that all of the by-catch estimates from ICES WGBYC (2019) are biased by the distribution and quality of monitoring effort and thus need to be interpreted with caution. Current by-catch sampling from sea-going fishing vessels of various sizes and operational configurations is not representative, and bias is introduced from various sources, not least the assessment area(s) and national fleet(s) to which the exercise is assigned. As an example, DCF monitoring of larger vessels and data collection using observers focused primarily on commercial fish stocks instead of independent, dedicated protected species observers, greatly dominates the existing dataset. There has as yet not been a quantitative scientific

	examination of the comparative merits and statistical power of either observational approach. For Harbour porpoise in Irish waters it is at least clear, based on current evidence, that a consistent and risk-based approach to the wider monitoring of commercial fishing métiers would provide an improved picture and more accurate estimate of mortality rates due to incidental by-catch. Grey seal Since targeted recording of seal interactions with commercial fisheries began in the 1970s and incidental captures were logged alongside emerging monitoring for cetacean entanglement/mortalities (e.g., Regulation 812/2004 monitoring, ancillary projects), there have been numerous by-catch records of Grey seal around Ireland. This occurrence has been particularly evident off the south, south-west and west coasts (e.g., Kiely et al., 2000; Cosgrove et al., 2013; Cosgrove et al., 2016; Luck et al., 2019). Some indicative secondary evidence of Grey seal by-catches is also available from coastal strandings and sightings of individuals entangled in various fishing gears (e.g., Irish Seal Sanctuary Dead Seal Database); however, in such instances it may not be possible to precisely determine the relevant fishing fleet or the métier concerned. Regarding the six primary métiers that have been subject to (a) monitoring by Irish authorities and/or (b) collaborative investigation with the fishing industry since 2005, current evidence suggests that individual Grey seals are not ordinarily at risk from most trawl gears. The evidence does indicate that they are potentially at a greater risk of being by-caught in localised bottom or pelagic trawls for dense aggregations of pelagic fish such as sprat and herring, for example. In addition, Grey seals are particularly at risk of entanglement and drowning in set nets such as gill nets, trammel nets and tangle nets (ICES, 2019; Luck et al., 2019). Efforts to consistently estimate the mortality rate of Grey seals due to incidental by-catch have not yet taken place at a national/EEZ level. However, some postgraduate research into this aspect of the interaction and also into the population genetics of both seal species around Ireland, is ongoing at present. Important ground-work has been conducted on a localised sub-sampling basis (e.g., Cosgrove et al., 2013; Luck et al., 2019) and also on an (eco)regional basis by ICES WGBYC (ICES, 2019). Work by Luck et al. (2019) reported the

	by-catch of 257 seals in 197 net hauls (various set net types) from 2010-2017, yielding a mean by-catch rate of 0.038 ±0.0006 (SE) seals per unit effort – i.e., approximately one seal per 26 km.days of set net effort. It is likely that, based on the identifiable specimens, most of the net-caught seals in this study were Grey seals but Harbour seals were also recorded in the identifiable sample set. Regarding the ICES WGBC (2019) work at a Celtic Seas ecoregion level, which contains all of Ireland's marine waters, fisheries data were pooled from 2015-2017 and minimum and maximum bycatch rates were extrapolated using 2017 fishing effort data for nets, bottom trawls and pelagic trawls. Somewhat unexpectedly, based on previous Irish by-catch data (e.g., Kiely et al., 2000; Cosgrove et al., 2013), the highest seal by-catch rate reported within the ecoregion was observed in bottom trawls. These records were mainly from French-registered vessels and were reported as incidents (i.e., not the number of individuals); in fact, this data feature was driven by an entry in French data of an incident with multiple individuals, which could not be verified. With the exception of these reports the observed by-catch of Grey seals was highest in set nets. In the assigned Celtic Seas ecoregion, using the reported fishing effort for 2017, total Grey seal by-catch in nets in that year was estimated by ICES WGBYC (2019) to be 101-282 individuals. It is noteworthy that all of the by-catch estimates from ICES WGBYC (2019) are biased by the distribution and quality of monitoring effort and thus need to be interpreted with caution. Current by-catch sampling from sea-going fishing vessels of various sizes and operational configurations is not representative, and bias is introduced from various sources, not least the assessment area(s) and national fleet(s) to which the exercise is assigned. As an example, DCF monitoring of larger vessels and data collection using observers focused primarily on commercial fish stocks instead of independent, dedicated protected species observers, greatly dominates the existing dataset. There has as yet not been a quantitative scientific examination of the comparative merits and statistical power of either observational approach. In 2017 the percentage mortality of Grey seals due to by-catch in the Celtic and Greater North Sea ecoregions combined was estimated to be 1.5 - 2.8% of the best estimate of abundance (ICES, 2019). However, ICES (2019) figures for the Celtic Seas ecoregion would appear to be low, when compared with local sampling-based figures

	from set nets off the south and west of Ireland (Luck et al., 2019). As noted earlier, environmental threshold values for this criterion have yet to be established and this will require considerable scientific and policy work. Concerning Grey seals in Irish waters it is at least clear, based on current evidence, that a consistent and risk-based approach to the wider monitoring of commercial fishing métiers would provide an improved picture and more accurate estimate of mortality rates due to incidental by-catch. Harbour seal Since targeted recording of seal interactions with commercial fisheries began in the 1970s and incidental captures were logged alongside emerging monitoring for cetacean entanglement/mortalities (e.g., Regulation 812/2004 monitoring, ancillary projects), there have been multiple by-catch records of Harbour seal around Ireland. This occurrence has been particularly evident off the south, south-west and west coasts (e.g., Kiely et al., 2000; Cosgrove et al., 2013; Cosgrove et al., 2016; Luck et al., 2019). Some indicative secondary evidence of Harbour seal by-catches is also available from coastal strandings and sightings of individuals entangled in various fishing gears (e.g., Irish Seal Sanctuary Dead Seal Database); however, in such instances it may not be possible to precisely determine the relevant fishing fleet or the métier concerned. Regarding the six primary métiers that have been subject to (a) monitoring by Irish authorities and/or (b) collaborative investigation with the fishing industry since 2005, current evidence suggests that individual Harbour seals are not ordinarily at risk from most trawl gears. The evidence does indicate that they are potentially at a greater risk of being by-caught in localised bottom or pelagic trawls for dense aggregations of pelagic fish such as sprat and herring, for example. In addition, Harbour seals appear to be particularly at risk of entanglement and drowning in set nets such as gill nets, trammel nets and tangle nets (Cosgrove et al., 2013; Luck et al., 2019). Efforts to consistently estimate the mortality rate of Harbour seals due to incidental by-catch have not yet taken place at a national/EEZ level. However, some postgraduate research into this aspect of the interaction and also into the population genetics of both seal species around Ireland, is ongoing at present. Important ground-work has been conducted on a localised sub-sampling basis (e.g., Cosgrove et

	al., 2013; Luck et al., 2019) and also on an (eco)regional basis by ICES WGBYC (ICES, 2019). Work by Luck et al. (2019) reported the by-catch of 257 seals in 197 net hauls (various set net types) from 2010-2017, yielding a mean by-catch rate of 0.038 ±0.0006 (SE) seals per unit effort – i.e., approximately one seal per 26 km.days of set net effort. It is likely that, based on the identifiable specimens, most of the net-caught seals in this study were Grey seals but multiple Harbour seals were also recorded in the identifiable sample set. Therefore, the potential for incidental by-catch of this species in set nets requires consideration and further investigation. Regarding the ICES WGBC (2019) work at a Celtic Seas ecoregion level, which contains all of Ireland's marine waters, fisheries data were pooled from 2015-2017 and minimum and maximum bycatch rates were extrapolated using 2017 fishing effort data for nets, bottom trawls and pelagic trawls. Somewhat unexpectedly, based on previous Irish by-catch data (e.g., Kiely et al., 2000; Cosgrove et al., 2013), the highest seal by-catch rate reported within the ecoregion was observed in bottom trawls. These records were mainly from French-registered vessels and were reported as incidents (i.e., not the number of individuals); in fact, this data feature was driven by an entry in French data of an incident with multiple individuals, which could not be verified. With the exception of these reports and just using specimens identified to species level, the observed by-catch of Harbour seals was only recorded in set nets. In the assigned Celtic Seas ecoregion, using pooled reported data for 2005-2017, total identified Harbour seal by-catch in nets was estimated by ICES WGBYC (2019) to occur at a rate of 0.004-0.011 individuals per observed days at sea (95% Confidence Intervals). This equates to approximately 1-3 Harbour seals by-caught per 250 observed days at sea. It is noteworthy that all of the by-catch estimates from ICES WGBYC (2019) are biased by the distribution and quality of monitoring effort and thus need to be interpreted with caution. Current by-catch sampling from sea-going fishing vessels of various sizes and operational configurations is not representative, and bias is introduced from various sources, not least the assessment area(s) and national fleet(s) to which the exercise is assigned. As an example, DCF monitoring of larger vessels and data collection using observers focused primarily on commercial fish stocks instead of independent, dedicated protected species observers, greatly dominates the existing dataset. There has as yet not been a quantitative scientific

	examination of the comparative merits and statistical power of either observational approach. Concerning Harbour seals in Irish waters it is at least clear, based on current evidence, that a consistent and risk-based approach to the wider monitoring of commercial fishing métiers would provide an improved picture and more accurate estimate of mortality rates due to incidental by-catch.
Knowledge gaps	• Coordinated and consistent regional systems for (1) risk assessment and robust targeted monitoring of commercial fisheries in European waters, (2) standardised observation, recording and reporting of mortality/injury interactions, and (3) the setting of scientifically coherent threshold values for non-target species' mortality rates, should be investigated further and advanced to full operability where this is practically possible. • Practical cost-effective methods to deter non-target marine vertebrates around identified problematic interactions with fisheries should be comprehensively investigated and field-tested, with the aim of significantly reducing and resolving incidental by-catch mortality and/or injury of non-target species. • Targeted and collaborative international research is required on the extent, severity and risk of impact on populations of Leatherback turtle from a wide range of commercial fishing practices in the North-East Atlantic.
	Assessment Data
Data Sources	Cosgrove, R., Cronin, M., Reid, D., Gosch, M., Sheridan, M., Chopin, N. & Jessopp, M. (2013) Seal depredation and bycatch in set net fisheries in Irish waters. BIM Fisheries Resource Series, Vol. 10. Cosgrove, R., Cronin, M., Reid, D., Gosch, M., Sheridan, M., Chopin, N. & Jessopp, M. (2016) Seal bycatch in gillnet and entangling net fisheries in Irish waters. Fisheries Research 183: 192-199. Cummins, S., Lauder, C., Lauder, A. & Tierney, T. D. (2019) The Status of Ireland's Breeding Seabirds: Birds Directive Article 12 Reporting 2013 – 2018. Irish Wildlife Manuals, No. 114. National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht, Ireland. 89pp.

	Doyle, T. K. (2007) Leatherback Sea Turtles (Dermochelys coriacea) in Irish waters. Irish Wildlife Manuals No. 32. National Parks and Wildlife Service, Department of the Environment, Heritage and Local Government, Dublin, Ireland. ICES. (2018) Report from the Working Group on Bycatch of Protected Species (WGBYC), 1–4 May 2018, Reykjavik, Iceland. ICES CM 2018/ACOM:25. 128 pp. ICES. (2019) Working Group on Bycatch of Protected Species (WGBYC). ICES Scientific Reports. 1:51. 163 pp. http://doi.org/10.17895/ices.pub.5563 Kiely, O., Lidgard, D.C., McKibben, M., Baines, M.E. & Connolly, N. (2000) Grey Seals: Status & Monitoring in the Irish & Celtic Seas. Maritime Ireland/Wales INTERREG report No. 3. Marine Institute, 80 Harcourt St., Dublin. Luck, C., Cronin, M. A., Gosch, M., Healy, K., Cosgrove, R., Tully, O., Rogan, E. & Jessopp, M. (2019) Drivers of spatiotemporal variability in bycatch of a top marine predator: First evidence for the role of water turbidity in protected species bycatch. J. Appl. Ecol. **57(2):** 219-228. DOI: 10.1111/1365-2664.13544 NPWS. (2019) The Status of EU Protected Habitats and Species in Ireland. Volume 1: Summary Overview. Unpublished NPWS report. Edited by: Deirdre Lynn and Fionnuala O'Neill. 99pp.
Data Locations (URL)	http://www.ices.dk/data/Pages/default.aspx http://bycatch.ices.dk/ https://www.npws.ie/maps-and-data https://www.npws.ie/publications https://www.npws.ie/marine/marine-reports
Data Time Line	Start Date: 2009 — End Date: 2018
Point of Contact	Oliver Ó Cadhla, Marine Environment section, DHPLG
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D1 C2

Descriptor 1 Biodiversity	**Assessment Sheet: Reptiles, birds and mammals** **Criterion D1C2** **Population abundance of the species**
Key message	Since 2009 populations of Irish-breeding marine vertebrate species have been monitored relatively consistently using standard international practice. In some cases, (e.g. certain marine birds, small cetaceans and seals) this monitoring followed earlier comprehensive baseline research and surveillance. Key evidence on abundance to 2018 across a range of eight representative species supports the finding that the majority are maintaining a favourable conservation condition and have therefore achieved Good Environmental Status (GES). This result is informed by Birds Directive and Habitats Directive assessments undertaken and reported by Ireland in 2019. Overall for this criterion, GES has been achieved for a total of six ecosystem elements. However, the environmental status of Leatherback turtle, which does not breed in Ireland, and of Black-legged kittiwake are currently unknown. For some species, threshold values for the population abundance criterion have been considered and are proposed for operation at a subdivision (i.e. national) level. [Note: While three key, comparatively well-studied species of marine bird and four species of marine mammal have been included in this assessment to represent important “Criteria elements” of marine biological diversity, there are of course many more species within each group occurring and/or breeding in Ireland’s marine area. In time additional representative species may be added to future assessments of biological diversity as the scientific knowledge base, data quality and understanding of their ecology and role in our marine ecosystems improves.]
Background	Ireland competed an Initial Assessment of its maritime area under the MSFD in October 2013. At the time, the assessment under biologically-orientated descriptors was largely restricted to (a) fisheries–related data for species and (b) broad-scale mapping data for habitats. In relation to biological diversity and associated environmental targets and indicators under Descriptor 1 the 2013 assessment concluded that more work was required to develop and coordinate parameters, elements and methods that would contribute to a more effective evaluation of Ireland’s marine environmental status.

	Since then Ireland's approach, data collection and methods of assessment for this Descriptor under MSFD Articles 8, 9 and 10 have progressed considerably. This updated assessment considers elements of marine fauna that represent essential features and characteristics of biological diversity in Ireland's marine environment. It summarises (i) current knowledge of their environmental status, (ii) environmental targets for each faunal element that Ireland has established in order to achieve/maintain Good Environmental Status (GES) and, where possible, (iii) environmental threshold values per element that are proposed in order to secure and support the maintenance of GES in the long term. With regard to the assessment of population abundance (Criterion D1C2), this work was conducted using "Criteria elements", i.e. a set of species considered to be representative of elements of the marine ecosystem, and for which national monitoring/assessment programmes have been established, namely: **a) Marine reptiles:** Leatherback turtle *Dermochelys coriacea* The most frequently recorded turtle species in Irish waters and the only turtle considered to use Irish waters as part of its natural range, mainly occurring in summer-autumn. Listed in Annex IV of the EC Habitats Directive (Directive 1992/EEC) as a species in need of strict protection; **b) Marine birds:** Black-legged kittiwake *Rissa tridactyla*, Northern fulmar *Fulmarus glacialis*, Northern gannet *Morus bassanus* Protected under the Birds Directive (Directive 2009/147/EC), all three are fully marine species that nest and breed in Ireland on islands and cliff-bound terrain that is less vulnerable to human interference and mammalian predators than the breeding habitat of other seabird species. **c) Marine mammals:** Bottlenose dolphin *Tursiops truncatus*, Harbour porpoise *Phocoena phocoena*, Grey seal *Halichoerus grypus*, Harbour seal *Phoca vitulina* All four species occur in coastal and offshore waters of Ireland's maritime area and are listed in Annex II of the Habitats Directive as species whose conservation requires the designation of special areas of conservation. Both cetacean species are also listed in Annex IV.

Objective	The overriding objective is that Ireland's newly established environmental targets for MSFD Descriptor 1 (Biological diversity) are achieved. With regard to population abundance of vertebrate species (excluding non-commercial fish species) the applicable target is: **Environmental Target D1T2: The population abundance of the species is not adversely affected due to anthropogenic pressures, such that its long-term viability is ensured.** In this regard Commission Decision (EU) 2017/848 states: "Member States shall establish threshold values for each species through regional or subregional cooperation, taking account of natural variation in population size and the mortality rates derived from D1C1, D8C4 and D10C4 and other relevant pressures."
Drivers (Activities)	Populations of larger marine vertebrate species, such as reptiles, birds and mammals, may be subject to adverse impacts arising from local and/or regional anthropogenic drivers (activities) throughout their North Atlantic range and in Irish coastal/offshore waters. The main human activities believed to be interacting as pressure mediators on Ireland's marine vertebrate populations involve commercial vessel-based or shipping-based activities that occur primarily on a local or regional scale and/or on a persistent or intermittent basis (e.g., commercial fisheries or geophysical seismic exploration). Foremost of these anthropogenic drivers in an Irish context is commercial fishing at sea by Irish-registered vessels and other European/international fleets operating within Ireland's Exclusive Economic Zone (EEZ), both through the removal of food biomass and potential prey resources from the marine environment and also through incidental captures (by-catch) or injurious entanglement of individual animals in a range of fishing gear types. In relation to seal by-catch the most significant fishing métiers involved in Ireland and the UK appear to be static nets (i.e., gill nets, tangle nets or trammel nets) targeting demersal fish and larger crustaceans, while for cetaceans and marine birds, pelagic trawlers and demersal trawlers may also be involved in this interaction.

	Less persistent but nevertheless periodically intensive geophysical surveying of the seafloor and underlying structure (e.g., for oil/gas deposits) may also introduce a significant environmental pressure on mammal populations at local and/or regional scales, mainly through potential acoustic injury or disturbance, spatial and/or temporal displacement or potential impacts on the natural availability of prey, for example. Coastal tourism and other recreational/industrial activities around breeding or resting sites (e.g., shellfish gathering, intertidal aquaculture, coastal walking, wildlife watching) may also introduce environmental pressures, such as disturbance, for marine birds and mammals. According to current evidence on a national scale in Ireland these drivers may not be reducing overall population abundance of representative vertebrate elements of the ecosystem. They may however act to impair natural population growth or normal fluctuations in the absence of potential stressors, and further scientific investigation or improved management of such activities may be necessary via a risk-based prioritisation approach.
Pressures	The predominant pressures identified in Commission Directive 2017/845 that are currently of known and/or potential significance to populations of vertebrate species in Ireland's MSFD area, are considered to be: • Loss of, or change to, natural biological communities due to cultivation of animal or plant species • Disturbance of species due to human presence • Extraction of, or mortality/injury to, wild species (by commercial fishing, and/or recreational fishing and/or other activities) • Physical disturbance to the seabed (temporary or reversible) • Input of nutrients (diffuse and/or point sources, atmospheric deposition) • Input of organic matter (diffuse sources and/or point sources) • Input of other substances (e.g. synthetic/non-synthetic substances, diffuse and/or point sources, acute events)

	• Input of litter (solid waste matter, including micro-sized litter) • Input of anthropogenic sound (impulsive, continuous) Among the items listed above the most significant anthropogenic pressure on vertebrate populations in Ireland's maritime area is the extraction of fish and shellfish biomass (both commercial and non-commercial species) and associated disturbance introduced by human fishing activity. This occurs in the water column (e.g. pelagic trawling) and also close to or on the sea-floor (e.g. demersal trawling or set-nets, benthic dredging). It is prevalent all year round and in much of Ireland's EEZ, and is driven by a wide range of international, European Union and national fishing fleets that use diverse gear types, from jigging and long-lining to mobile nets and stationary pots. Fishing-derived pressure is, to a large extent, measurable and it is therefore supported by scientific evidence, monitoring and assessment, as well as EU and international regulation and management (e.g. through the EU Common Fisheries Policy). There are also significant human pressures that can carry with them significant adverse impacts on populations of particular species and/or their habitats, e.g. through the disturbance or deterioration of species' breeding habitats. Many of these pressures relate to land-based human activities and industries, and are covered by other policy and legal provisions designed to protect the environment, for which there are assessment and reporting obligations (e.g. Water Framework Directive, Nitrates Directive, Common Agricultural Policy). For larger marine vertebrate species, along with the potential pressures introduced by biomass removal, biological competition for prey resources and incidental mortality, the introduction of anthropogenic sound, disturbance of species and input of litter are considered to present the greatest secondary pressures after commercial fisheries extraction.
State	**Marine reptiles** Leatherback turtle With regard to the primary criteria and established Environmental Targets under Descriptor 1, there are currently significant limitations associated with assessing and reporting on the status of this 'sea turtle' species. While some recent progress has been made in data acquisition from Ireland and adjacent waters, the species' population ecology, range, habitat use and the pressures/impacts it faces in Irish

	waters and the wider North-East Atlantic, are not well understood. The overall environmental status of this species' population in Irish waters is assessed as unknown. **Marine birds** Black-legged kittiwake In relation to population abundance, there are clear indications that national figures have decreased significantly over the past 20 years (i.e. 24,728 pairs in 2015-2018, a short-term decrease of 32% from 1998/2002). This is driven by acute short-term declines at some of the most important breeding colonies in Ireland (i.e. Horn Head, Co. Donegal, Cliffs of Moher, Co. Clare and Great Saltee Island, Co. Wexford). Monitoring data collected in 2015-2018 describe a near 20% reduction in breeding population estimates at Lambay Island, Co. Dublin alone, which, owing to its relative colony size, significantly influenced the national population picture. While there is evidence of a substantially wider distribution of breeding colonies around the coast than was known heretofore, there is nevertheless an underlying question concerning Kittiwake reproductive success and the extent and condition of its natural habitats, given population declines seen at several breeding colonies. Causes of the declines are unclear at present. Some examples of potential factors involved are changes in food availability or prey distribution, or climate-related influences. Due to the uncertainties at present, the overall status of this species in Irish waters is assessed as Unknown. Northern fulmar The population abundance of this species in Ireland appears to be relatively stable since the 1990s (ca.33,000 pairs), having increased markedly from levels recorded in periodic surveys during 1969-70 and in the 1980s. Considerable variation in population trajectories between individual breeding colonies is noted however via the National Seabird Monitoring Programme and there is a need to continue scientific monitoring, at regional and national scales on land and at sea, in order to better understand the species' population dynamics and the role/influence (if any) of human activities and impacts on Fulmar reproductive success or abundance. In consideration of the Environmental Target described above, given that the available scientific evidence from Ireland shows an increasing breeding distribution and stable population figures nationally, it is

	concluded that GES has been achieved for the population of this large petrel species. Northern gannet The Irish breeding population of Gannets has been surveyed on five census occasions since the late 1960s, along with the population in Britain and, where possible, the wider North Atlantic. The most recent breeding season census in Ireland took place primarily during 2013 and 2014. The data generated show that the Irish population has increased by an estimated 33% over a 10-year period to reach 47,946 pairs in 2014, and that its breeding distribution has expended accordingly (up 20% since 2004, up 50% since 1984/85). Regional populations at the traditional colonies have increased across the board such that, in historical terms, the population has increased by 121% since Operation Seafarer in 1969-70. In consideration of the Environmental Target described above, given that the available scientific evidence from Ireland shows an increasing breeding distribution and increasing population figures nationally, it is concluded that GES has been achieved for the population of this large marine bird species. **Marine mammals** Bottlenose dolphin In a coastal context, high quality data collected from the Lower River Shannon, which comprises a Special Area of Conservation (SAC) for this Annex II species, describe a relatively stable local population of ca.120-160 individuals since at least the mid-1990s. A second and genetically distinct community of this species also inhabits coastal waters of Connacht and Ulster, and has been the subject of more intensive study since 2009-10. This wider-ranging community numbers approximately 190 individuals (95% HPDI: 162-232) and is in turn protected by a SAC designation (West Connacht Coast SAC). Knowledge of the species' regional distribution and summer abundance in western European waters has improved significantly in recent decades. There has also been improved population abundance data from a large part of Ireland's EEZ, yielding substantial new estimates numbering 68,714-147,267 individuals and exceeding all previous figures for the region. In consideration of the Environmental Target described above, it is concluded that GES has been achieved for this species' population. Robust long-term data on Bottlenose dolphin population abundance and trends in Irish waters as a whole are

	not yet available. However, with continued good quality survey effort in coastal and offshore waters it is intended that this aspect will be explored into the future. Harbour porpoise Knowledge of the species' seasonal distribution and summer abundance in western European waters has improved significantly in recent decades. There has also been improved population abundance data from a large part of Ireland's EEZ, yielding new estimates numbering 29,519-51,840 individuals and highlighting areas of apparent importance for the species (e.g. Irish Sea). In a coastal context, good quality data collected over the last decade from Ireland's three Special Area of Conservation for this Habitats Directive Annex II species, describe relatively high densities during the summer months in which calving and initial nursing of young porpoises is known to occur. In consideration of the Environmental Target described above, it is concluded that GES has been achieved for this species' population. Grey seal Evidence from surveys carried out since the mid-1990s indicates that the all-age population of Grey seals has been growing in Ireland, driven largely by increases in pup production and recruitment to the population at each of the seven main breeding colonies. In this context the estimated 7,284-9,365 seals associated with breeding in Ireland (2013) is considered to be a minimum estimate. More recent information from annual surveillance (NPWS, 2018 unpublished data) suggests continued growth in pup production at the seven main breeding colonies during the period 2013-2018. Growing Grey seal abundance is also reflected in nationwide counts of this species in summer (August), underlining further a positive population status and trend. Since Irish estimates for Grey seal population size, derived from data on the principal breeding colonies, are periodic and variable figures depending on the year of coverage, and they represent a small number of samples of such abundance estimates, a precise Favourable Reference Population (FRP) since the Directive came into force remains difficult to determine. However, based on the estimates provided in this assessment along with previous abundance information, the FRP is considered to be less than the minimum population estimate provided here. In consideration of the

	Environmental Target described above, it is concluded that GES has been achieved for this species' population. Harbour seal The current minimum population estimate derived via moult data gathered in 2017-2018 is higher than ever recorded in Ireland and is greater than that recorded via comparable aerial surveys in 2011-12 (3,489 Harbour seals) and 2003 (2,905-2,955 Harbour seals of all ages). There are insufficient data available at this stage to statistically determine a population trend for this species and further scientific work is required in this area. Nevertheless, the short-term trend in Ireland's Harbour seal population is considered to be stable at least given the relative similarity in national population estimates between 2003, 2011-12 and 2017-2018. Furthermore, the results of site surveillance within the current reporting period also indicate comparatively stable numbers at a wide range of monitored sites. Since estimates of minimum Harbour seal population size derived from haul-out count data during the moult season are periodic and variable figures depending on the year of coverage, and they represent a small number of samples of such abundance estimates, a precise Favourable Reference Population (FRP) since the Habitats Directive came into force remains difficult to determine. However, based on the estimates provided in this assessment along with previous abundance information, the FRP is considered to be less than the minimum population estimate of 4,007 Harbour seals provided here. In consideration of the Environmental Target described above, it is concluded that GES has been achieved for this species' population.
Impact	The parameters and characteristics specified in Commission Directive 2017/845 that are likely to be impacted upon by loss of biological diversity can be divided in to species impacts, habitat impacts and ecosystem/food-web impacts. The species impacts are considered to operate via changes to: distribution and/or biomass; size, age and sex structure, reproductive potential, survival and mortality/injury; behaviour including movement and migration; habitat for the species (extent, suitability); and species composition within groups of species. The main habitat impacts are considered to operate via changes to: species composition, abundance and/ or biomass (spatial and temporal variation); size and age structure

	of species; and physical, hydrological and chemical characteristics. The main ecosystem impacts are considered to operate via changes to: links between habitats and species of marine birds, mammals, reptiles, fish and cephalopods; pelagic-benthic community structure; and productivity. The effects and consequences of the predominant pressures on biological diversity during the overall assessment period (2013-2018) and prior to that, if relevant, have been considered in the current assessment. For the marine vertebrates outlined above that have been included as criteria elements (i.e. eight reptile, bird and mammal species) this is primarily informed by Ireland's surveillance, assessments and reporting undertaken to meet requirements under the EU Habitats Directive and Birds Directive. In relation to the predominant pressures identified as known and/or of potential significance in Ireland's marine area, based on scientific evidence and knowledge of current human activity there are few such pressures that are considered to operate with potential population-level effects or consequences for these species in Ireland. Among them, however, are: • Disturbance of species due to human presence Certain species that avoid interaction with humans or animal predators may be highly vulnerable to human disturbance during times of the year that are critical for their populations and for survival (e.g. during migration, foraging, nesting, breeding or resting phases). Human presence may also mediate additional impacts that cause disturbance to the species' natural history, such as the introduction of problematic predators (e.g. mink at seabird breeding sites), disease or invasive species. • Extraction of, or mortality/injury to, wild species (by commercial fishing, and/or recreational fishing and/or other activities) In addition to the loss of potentially significant food biomass from the marine environment through human extraction, this pressure can also have direct population consequences (e.g. via reduced survival to breeding age or impaired reproductive success) if the level of mortality or injury to wild species is not compensated for by natural factors such as productivity or immigration. [Note: Certain non-commercial fish species have been depleted by fishing in the past and are now on various lists of threatened and declining species. Although there are zero total allowable catches (TACs) or "prohibited" listings for some species, most remain vulnerable to existing fisheries. For example, some are caught as bycatch in mixed demersal trawl

	fisheries and gillnet fisheries, and deep-water sharks are caught in the mixed deep-water trawl fishery.] • Physical disturbance to the seabed (temporary or reversible) The effect of this pressure, if it acts at a population-relevant scale, may be to deter or displace animals from their natural habitat or reduce foraging opportunities, for example, thereby influencing individual survival or reproductive performance. • Input of other substances (e.g. synthetic/non-synthetic substances, diffuse and/or point sources, acute events) Several substances of industrial origin are known to be prevalent and persistent in coastal/marine environments, including being present in deposited sediments and in the tissues of prey species. Internationally, where their levels are high in the environment some synthetic organic compounds (e.g., PCBs) have been shown to impair the reproductive performance and immune function of affected individuals and, potentially, aggregations of animals (e.g. colonies, social groups). • Input of litter (solid waste matter, including micro-sized litter) A number of vertebrate species appear to be vulnerable to ingestion of plastic and other litter in the marine environment. While active research into the effects of water-borne litter and its ingestion is ongoing, for species such as Leatherback turtle and other surface-feeding vertebrates, the impairment of natural nutritive physiology is a potential effect of this pressure. • Input of anthropogenic sound (impulsive, continuous) Individual species (e.g. some marine mammals) and their populations may also be sensitive to certain types of underwater sound transmitted by human practices in the sea and ocean environment. This is an area under active research in relation to several anthropogenic sound sources and the individual or population-level consequences of disturbance or acoustically-driven injury. **Marine reptiles** Leatherback turtle Leatherback turtles that migrate through Irish waters mate and breed in the tropics. The most significant threats and pressures acting on the North Atlantic population occur outside Irish waters. The main known pressures relate to anthropogenic mortalities of adults, eggs and

	juveniles at nesting beaches in the Caribbean and northern coast of South America (e.g. French Guiana). These include direct predation by humans and dogs, disturbance of nesting females, damage to nests and eggs, and mortality of hatchlings due to disorientation arising from artificial light pollution and other tourist-related activities. Entanglement in fishing equipment in the coastal waters adjacent to nesting beaches can also lead to mortality. There is some evidence to suggest that the Leatherback turtle population in the North Atlantic has a positive trajectory but understanding of the population ecology, migration patterns and habitat use of the species is very limited. Active international, multi-disciplinary research is required to address such important knowledge gaps. **Marine birds** Black-legged kittiwake Based on declining Kittiwake abundance despite breeding distribution expansion in Ireland and other monitoring data, there are some indications that this finding may be environmental and/or human pressure-related. Data from the UK show that the species' population declined by 72% between 1983 and 2013. Research indicates that Kittiwakes need to produce a mean of 0.8 - 1.5 fledged young per pair each year in order to maintain breeding numbers in Britain, where a fall in reproductive productivity is considered to be the primary driver of breeding population declines. In Ireland, annual Kittiwake productivity estimates at Rockabill fell from 1.2 chicks per pair (1999-2007) to 0.86 chicks per pair more recently. The practice of pair-trawling of spawning inshore sprat has increased in recent years. With a herring fishery in the Irish and Celtic Seas, the existence of these fisheries operating within the foraging areas of Kittiwakes and other seabirds may have implications for the breeding success of Kittiwakes along these coasts, particularly if they target young sprat (Cummins et al., 2019). Northern fulmar Based on the stable population abundance and distribution expansion of Fulmars in Ireland and other monitoring data, there is currently no evidence that any pressures and their effect on this criteria element are operating at a population level. The introduction of the landing obligation (LO) under the reformed Common Fisheries Policy came into force on 1 January 2019. This

	means that commercial fishing vessels are required to retain and land all species that have been assigned a catch quota, albeit non-quota species can still be discarded. Fulmar foraging behaviour commonly includes feeding on a variety of marine prey, including fish offal and discards from commercial fisheries. With the implementation of the LO there might be future repercussions in terms of food availability for Ireland's Fulmar population or some component of it and continued monitoring of the Fulmar population will be necessary in this regard. Northern gannet Based on the increasing population abundance and distribution expansion of Gannets in Ireland and other monitoring data, there is currently no evidence that any pressures and their effect on this criteria element are operating at a population level. The introduction of the landing obligation (LO) under the reformed Common Fisheries Policy came into force on 1 January 2019. This means that commercial fishing vessels are required to retain and land all species that have been assigned a catch quota, albeit non-quota species can still be discarded. Gannet feeding behaviour has included feeding and scavenging on discarded fish from vessels in Irish and neighbouring waters. With the implementation of the LO there may be future repercussions in terms of food availability for Ireland's Gannet population. However, ongoing declines in global catches of fish may have longer-term impacts on this long-lived seabird (Cummins et al., 2019). Continued monitoring of the Gannet population will be necessary in this regard. **Marine mammals** Bottlenose dolphin Populations of Bottlenose dolphin may be subject to a number of local and/or regional environmental pressures and threats, including in Irish coastal/offshore waters. The main pressures thought to be acting on this species in Ireland are considered to involve commercial shipping-based or vessel-based activities that occur primarily on a local or regional scale and/or on a temporary or intermittent basis (e.g., impacts arising from geophysical seismic exploration; impacts from local/regional prey removal by commercial fisheries or incidental by-catch in fishery operations; impacts from local seasonal marine tourism). Some are likely to continue to act as pressures into the future, thereby constituting a potential threat. However, in most cases in Ireland there is little evidence that existing pressures on this species are acting at a population level. An exception

	might occur in the case of the resident population of Bottlenose dolphins inhabiting the Shannon Estuary, which is genetically distinct and appears to be ecologically adapted to living in this comparatively discrete coastal region. In this context the monitoring of local dolphin-watching tourism has been an important method of surveillance for significant impacts on the resident population, while regular scientific surveys indicate that the population abundance and productivity has been relatively stable over the last two decades. While the wider impacts of human activities on Bottlenose dolphin in Irish waters are not well understood, partly due to the species' extensive range and continuing uncertainty regarding population trends and ecology within Ireland's marine area, none of the associated pressures are considered to be of sufficient magnitude to be causing an adverse impact on its populations in Irish waters. In parallel with continued surveillance and monitoring of this protected species, ongoing pressures and threats to its populations have been and continue to be identified and managed appropriately, thus the status of and prospects for populations of this species into the future are favourable. Harbour porpoise Populations of Harbour porpoise may be subject to a number of local and/or regional environmental pressures and threats, including in Irish coastal/offshore waters. The main pressures thought to be acting on this species in Ireland are considered to involve commercial shipping-based or vessel-based activities that occur primarily on a local or regional scale and/or on a temporary or intermittent basis (e.g., impacts arising from geophysical seismic exploration; impacts from local/regional prey removal by commercial fisheries or incidental by-catch in fishery operations; impacts from local maritime development). Some are likely to continue to act as pressures into the future, thereby constituting a potential threat. While the effect of these pressures may act on a temporary and/or regional scale and some (e.g. disturbance or displacement due to anthropogenic noise, by-catch in certain commercial fisheries) are likely to continue to act as pressures into the future, none is considered to be of sufficient magnitude to be causing an adverse impact on populations of Harbour porpoise in Irish waters. In this context, although robust and long-term data on Harbour porpoise population size and trends in Irish waters as a whole are not available, knowledge of the species' seasonal distribution and summer abundance in

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<td>western European waters and in Ireland has improved significantly over the last two decades.

There is no evidence to suggest a change in the main pressures thought to be acting on this species in the near future. However, surveillance of the species and the pressures potentially acting upon it will continue, while the application of strong management measures (e.g., via the statutory/regulatory process) to avoid potentially significant impacts is also expected to continue; thus the status of and prospects for populations of this species into the future are favourable.

Grey seal
Ireland's Grey seal population may be subject to a number of local and/or regional environmental pressures and threats on land in coastal areas, and in coastal and offshore waters. The main pressures thought to be acting on this species around Ireland are considered to involve commercial vessel-based or shipping-based activities that occur primarily on a local or regional scale and/or on a persistent or intermittent basis (e.g. impacts from local/regional prey removal by commercial fisheries or incidental by-catch in fishery operations; impacts arising from geophysical seismic exploration). Some are likely to continue to act as pressures into the future, thereby constituting a potential threat.

It should be noted, in relation to Grey seal interactions with commercial fisheries, including accidental by-catch interactions with certain fishing métiers, that active research into the scale and extent of interactions is ongoing and definitive conclusions are difficult to determine at present. While the effect of these pressures may act on a temporary and/or regional scale, based on current information none is considered to be of sufficient magnitude to be causing an adverse impact on the population abundance of Grey seal in Ireland. The available evidence, as supported by ongoing robust surveillance, indicates continued growth in the species' breeding population size around the coastline.

There is no evidence to suggest a change in the main pressures thought to be acting on this species in the near future. However, surveillance of the species and the pressures potentially acting upon it will continue, while the application of strong management measures (e.g., via the statutory/regulatory process) to avoid potentially significant impacts is also expected to continue; thus the status of and prospects for Ireland's Grey seal population into the future are favourable.</td>
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	Harbour seal Ireland's Harbour seal population may be subject to a number of local and/or regional environmental pressures and threats on land in coastal areas, and in coastal and offshore waters. The main pressures thought to be acting on this species around Ireland are considered to involve commercial vessel-based or shipping-based activities that occur primarily on a local or regional scale and/or on a persistent or intermittent basis (e.g. impacts from local/regional prey removal by commercial fisheries or incidental by-catch in fishery operations; impacts arising from geophysical seismic exploration). Other possible impacts may occur from coastal tourism and localised human disturbance at haul-out sites, though further research into this aspect is currently required to assess the degree and nature of such potential impacts around the Irish coast. Some are likely to continue to act as pressures into the future, thereby constituting a potential threat. It should be noted, in relation to Harbour seal interactions with commercial fisheries, including accidental by-catch interactions with certain fishing métiers, that active research into the scale and extent of interactions is ongoing and definitive conclusions are difficult to determine at present. While the effect of these pressures may act on a temporary and/or regional scale, based on current information none is considered to be of sufficient magnitude to be causing an adverse impact on the population of Harbour seal in Ireland. The available evidence, as supported by ongoing surveillance, indicates continued relative stability in the species' population size around the coastline. There is no evidence to suggest a change in the main pressures thought to be acting on this species in the near future. However surveillance of the species and the pressures potentially acting upon it will continue, while the application of strong management measures (e.g., via the statutory/regulatory process) to avoid potentially significant impacts is also expected to continue; thus the status of and prospects for Ireland's Harbour seal population into the future are favourable.
Assessment Method	**Marine reptiles** Leatherback turtle Recent studies have shown that after nesting in the tropics the majority of North Atlantic Leatherback turtles head north towards cooler temperate waters. Some of these individuals head north towards the

	north-east Atlantic and Irish waters where they forage on jellyfish for the summer months before turning south again in the autumn as water temperatures decline. The TURTLE database is used to collate all Leatherback turtle records from Ireland and the UK. It is clear that turtles migrate through Irish waters each year (with 198 records since 2000) and while most records are from sightings near to the coast, or strandings, they can also be encountered off-shore. Records of the Leatherback turtle are sporadic and scattered around Irish waters however. At present, population estimation is further complicated by inherent variability in turtle occurrence between years as a result of climate, long-term population cycles and intrinsic variation in their gelatinous zooplankton prey. With regard to population trends it is not possible to judge whether numbers are increasing, decreasing or stable. Despite extensive offshore survey work in recent years (e.g. the ObSERVE project covered ca. 300,000 km^2 in 2015 and ca. 340,000 km^2 in 2016) almost no data on Leatherback numbers were acquired. We still have much to learn about the migration patterns and seasonal behaviour of Leatherbacks in the Northeast Atlantic. For now, a definitive statement cannot be made on Favourable Reference Population. **Marine birds** The majority of surveys conducted as part of the national seabird monitoring programme followed guidance on sampling and census methods for seabirds as well as species-specific methodology detailed in the Seabird Monitoring Handbook for Britain and Ireland (Walsh et al., 1995). This facilitated the assessment of population sizes and to estimate the changes in numbers since the last national census carried out in Seabird 2000. A summary of the methods employed and recommended timings of surveys are set out in Cummins et al. (2019). These Census Instructions are based on Walsh et al. (1995)'s handbook and are the recommended methods for the Seabirds Count census work across Ireland, Northern Ireland and Britain. Black-legged kittiwake Approximately 90% of the total contemporary population estimate is derived from single visit surveys undertaken across Ireland in 2015. Over 80% of the counts were undertaken during the period mid-May – June with the remaining sites covered in July. There is high confidence in both contemporary population and distribution estimates. The

	confidence in short-term estimates of change is medium, based on greater recent coverage and more targeted timing of surveys compared to Seabird 2000. The long-term estimates of change in abundance are also qualified as medium. Northern fulmar Over 70% of counts were conducted in June, which is the noted ideal month for surveying this species and greater than the 64% figure for Seabird 2000. Approximately 66% of the total contemporary population estimate is derived from single visit surveys undertaken in 2015. NPWS confidence in both the contemporary national population estimate and the breeding range is at least a medium. The confidence in short-term estimates of change is medium based on greater coverage in this round compared to Seabird 2000. The estimated long-term population change is also qualified as medium, as coverage was not as comprehensive in the Seabird Colony Register even though some corrections for surveyed colonies were made. Northern gannet The results of the census of Irish Gannet colonies (gannetries) were largely derived from aerial photographs taken in 2013 and 2014 and supplemented by additional land-based vantage point counts at the smaller colonies, i.e. Clare Island, Ireland's Eye and Lambay Island. The count unit for aerial surveys is the Apparently Occupied Site (AOS) as usually it is not possible to see whether one or two birds are present on the site. For the three largest colonies (Little Skellig, Bull Rock and Great Saltee), estimates were derived by taking the mean (or average) of three independent observer counts of the aerial imagery following published guidance. The contemporary population estimate and distribution for this species is high due to the conspicuous nature of gannetries and that the survey data came from a single species national survey of the seven known colonies, conducted during 2013 – 2014. Both the short- and long-term comparisons are against high quality counts; therefore, confidence in these estimates is also high. Due to the limited number of Gannet colonies in Ireland, confidence in the estimated change in distribution is also high. **Marine mammals** Bottlenose dolphin Coastal populations of Bottlenose dolphins are more accessible and readily studied, and their populations can be estimated using mark-

	recapture analyses mediated by photo-identification studies. This has been the standard scientific technique for abundance estimation employed across a range of known sub-populations in western Europe, including the Shannon Estuary, Cardigan Bay (Wales) and the Moray Firth (Scotland), for example. Comprehensive data for the continental shelf and offshore parts of western Europe have been lacking until recently, particularly with regard to sufficient temporal (i.e., beyond one or more summer months or one year) and spatial coverage (i.e., spanning continental shelf, slope and deeper abyssal waters, all of which may represent Bottlenose dolphin habitat). Within the North-East Atlantic, based on aerial survey effort approximately 19,200 Bottlenose dolphins were estimated to occur in the summer of 2016 in waters off western Europe but excluding Ireland; a further 8,496 Bottlenose dolphins were estimated from ship-based survey data collected further offshore during the same period. In a new departure for data acquisition in Irish offshore and inshore waters a series of extensive aerial line-transect surveys were carried out in 2015-2017 under Ireland's ObSERVE Programme. These methods enabled abundance estimates to be derived from observation data acquired in the summer and in the winter months. Due to difficulties distinguishing visual records of this species from other small- to medium-sized dolphins, particularly Atlantic white-sided dolphins and White-beaked dolphins, for this assessment it was necessary to use only those estimates derived from confirmed sightings of the species. The most robust and reliable of two summer and two winter estimates (i.e., that with the lowest Coefficient of Variation [CV] = 0.21; summer 2016) has been presented below via minimum and maximum 95% Confidence Limits. While Bottlenose dolphin data from the ObSERVE Programme have not yet been integrated into a European-wide assessment of population size for the species, this should now be feasible given simultaneous aerial survey efforts in the summer of 2016. Harbour porpoise Important coastal sites inhabited by Harbour porpoises, including designated Special Areas of Conservation (SACs) for the species, have been monitored in Ireland for over a decade, mainly using single platform boat-based transects seeking to map sighting distributions and to determine abundance (i.e., estimates of density or abundance) or relative abundance (e.g., number of individuals per km of transect or

	per hour of observation effort). Acoustic monitoring (e.g., a point sampling approach) has also been employed in some instances in order to investigation patterns in occurrence and behaviour at selected sites. Comprehensive data for the wider continental shelf and offshore waters of western Europe have been lacking until recently, particularly with regard to sufficient temporal (i.e., beyond one or more summer months or one year) and spatial coverage (i.e., spanning coastal, continental shelf, slope and deeper basin waters, all of which may represent Harbour porpoise habitat). Within the North-East Atlantic, based on aerial survey effort approximately 424,000 Harbour porpoises were estimated to occur in the summer of 2016 in waters off western Europe but excluding Ireland; a further 73,573 Harbour porpoises were estimated from ship-based survey data collected further offshore during the same period. In a new departure for data acquisition on Harbour porpoises in Irish offshore and inshore waters a series of extensive aerial line-transect surveys were carried out in 2015-2017 under Ireland's ObSERVE Programme. These methods enabled abundance estimates to be derived from the species sighting data acquired in summer and winter. The most comprehensive and most robust of these four seasonal estimates (i.e., those with the lowest CV = 0.22; summer 2016) has been presented below via minimum and maximum 95% Confidence Limits. Harbour porpoise data from the ObSERVE Programme have not yet been integrated into a European-wide assessment of population size for the species, although this should now be feasible given simultaneous aerial survey efforts in the summer of 2016. Grey seal Following background research in 1994-2004 and a comprehensive nationwide population assessment in 2005 three key regions have been subject to renewed aerial surveillance over subsequent breeding seasons (east/southeast: 2009, 2013, 2017; west/southwest: 2011, 2015; west/northwest: 2012, 2016). Current estimates of minimum and maximum population abundance are based on Grey seal pup production estimates from the seven most important breeding areas for the species in Ireland, collectively representing approximately 84-85% of the total breeding population.

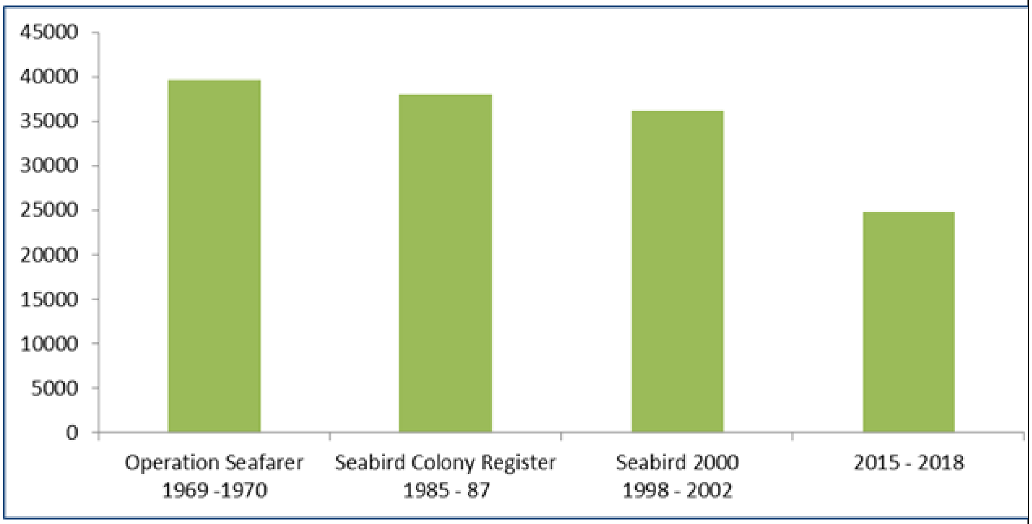
	The resultant pup production figures for all seven areas were combined with pupping data from 2005 for sites of lesser importance on national/regional scales, to yield a total Irish production estimate (P) for the period 2009-2012. This figure was then scaled up to minimum and maximum all-age population estimates using standard multipliers (3.5x[P] and 4.5x[P], respectively) that have been applied consistently in Irish studies. While some inter-annual variability in Grey seal pup production is commonplace, the overall population figures are considered a representative sample at the start of the last reporting period (2013). An assumption is made that the breeding sites of lesser importance (c. 16% of the 2005 total) have not seen nationally/regionally significant increases or declines in pup production since they were last surveyed. Additional Grey seal count data are also collected during nationwide and site-based surveys targeting Harbour seal during the annual moult in August-September (see above). The relationship between such counts and breeding population size is poorly understood however but the count data do provide some indication of trends in the numbers of Grey seals that are hauling out around the coastline in the summer months. Harbour seal Since the mid-1990s when the EC Habitats Directive came into force the population abundance of Harbour seal in Ireland has been estimated on three occasions. In all cases, in accordance with best international practice across the range of habitats occupied by the species, the required field survey work has been carried out during the annual moult season (Aug-Sept) when the greatest proportion of the population is likely to be ashore and available for counting. Subsequent image analysis, spatial analysis and numerical analysis and reporting have been undertaken as desk-based tasks. Following the first comprehensive nationwide assessments in 2003 and 2011-12 using aerial thermal-imaging technology, a near-identical follow-up survey of the entire coastline of Ireland was carried out in two parts in August 2017 and August 2018 using updated state-of-the-art technology. This yielded the current estimate of minimum population size given below. A relevant assumption here is that no significant change in seal haul-out behaviour or regional distribution occurred between the two

	successive survey legs in 2017 and 2018, thus the final minimum count results should be interpreted with a level of caution. Production of a robust maximum or best all-age population estimate for Harbour seals is more difficult since the proportion of all animals hauled out ashore during the period of survey is required in order to correct for the animals not available for counting and scale up appropriately. Evidence from annual site-based monitoring in Ireland by the National Parks & Wildlife Service and a range of international studies suggests that the proportion of Harbour seals available for counting can be variable depending on the site, environmental covariates and ecological factors, for example. Since there are no statistical data available for this parameter across the broad range of Irish sites surveyed in 2017-2018, an accurate national population maximum could not be determined and the minimum estimate remains the appropriate descriptor of population size (abundance).
Assessment Result	**Marine reptiles** Leatherback turtle Providing even a rough estimate of the number of Leatherback turtles foraging within Irish waters is difficult as the area in question is enormous and the animal's numbers may be extremely low. Population estimates are further complicated by the inherent variability between years as a result of climate, long-term population cycles and variation in gelatinous zooplankton biomass and distribution. Also, many animals may simply be passing through Irish waters whereas others may reside for longer periods. Using Leatherback sightings as an index of abundance can be informative, however variability in the reporting mechanisms, their consistency and effort, can mask any real trends. Determining if two sightings were of the same animal or two different animals can also add confusion to this index. The aerial survey estimates provided by Doyle et al. (2008) - 0.25 Leatherbacks per 1000 km (or 0.06 Leatherbacks per 100 km^2) - represent the only real estimate of Leatherback activity in Irish waters to date. That figure was extrapolated to an estimate to 2-3,000 Leatherbacks passing through or residing in Irish waters each year - which may be equivalent to 2-5% of the Atlantic population.

	However, it must be recognised that the confidence intervals for this estimate would be very large and that figures will vary annually for natural reasons. To complicate matters further, the ObSERVE project, which resulted in over 600,000 km^2 of aerial coverage in 2015-2016, only recorded three turtles, suggesting that numbers may be lower and/or even more variable than previously thought. For now, it is not possible to estimate the number of Leatherbacks using Irish waters and this figure of three turtles seen is provided as an absolute minimum population estimate. **Marine birds** Black-legged kittiwake Population estimate (2015 – 2018): 24,728 pairs Short-term trend (1998/2002 - 2015/2018): -32% Long-term trend (1985/87 - 2015/2018): -35% The contemporary national population estimate for Kittiwake is significantly down from that of Seabird 2000 and previous survey estimates, despite an increase in survey effort. The large estimated national population decline is in part driven by acute (circa 50%) short-term population declines at some of the most important colonies, i.e. Horn Head, Co. Donegal, Cliffs of Moher, Co. Clare and Great Saltee Island, Co. Wexford. A near 20% decline was recorded at Lambay Island, which owing to its relative colony size, also significantly influences the estimated national population decline. Northern fulmar Population estimate (2015 - 2018): 32,899 pairs Short-term trend (1998/2002 - 2015/2018): 0 Long-term trend (1985/87 - 2015/2018): + 68% Ireland’s contemporary population of Fulmars is very similar to the corresponding estimate from Seabird 2000, and represents a sizable increase from the previous survey during the 1980s. However, the overall stability in recent years masks marked changes in the breeding population estimates at site level. It is interesting to note that the Cliffs of Moher and Clare Island, two of the most important colonies as identified by Seabird 2000, have both undergone marked but contrasting changes in their site estimates (+36% and -31% respectively). The contrasting fortunes of some of the large traditional colonies across Ireland indicate that the relationship between factors influencing the recorded colony abundances in Ireland may be a complex one. For example, it could be that a recent increase in survey effort may be masking a short-term decline in the actual breeding population, hence continued and consistent monitoring is required.

	Northern gannet Population estimate (2013 - 2014): 47,946 pairs Short-term trend (2004 - 2014): + 33% Long-term trend (1984/85 - 2013/2014): + 94% The most recent census of breeding Gannets in Ireland largely took place in during the breeding seasons of 2013 and 2014. Gannets have been breeding on Great Saltee (Co. Wexford), Bull Rock (Co. Cork) and Little Skellig (Co. Kerry) since at least the 1970s. The most recent colonisation is on Lambay Island where breeding first occurred in 2007. Ireland's population of Gannets has increased by an estimated 33% over the 10-year period from 2004 to 2014, with 36,111 apparently occupied sites (AOS; i.e. a proxy for breeding pairs) in 2004 increasing to 47,946 AOS in 2014. Across the traditional colonies, populations increased across the board with the highest increase recorded at the Great Saltee (93%), followed by Ireland's Eye (92%), the Bull Rock (73%) and Little Skellig (19%). In 2015, the gannetry on Lambay Island was re-surveyed using a land-based vantage point method and was found to have increased from 728 AOS in 2013 to 926 AOS in 2015, an increase of 27% in just two years. In historical terms, the population has increased by 121% since Operation Seafarer in 1969-1970. **Marine mammals** Bottlenose dolphin Minimum population size (2016; lower 95% C.L.): 68,714 Bottlenose dolphins Maximum population size (2016; upper 95% C.L.): 147,267 Bottlenose dolphins The most robust and reliable of two summer and two winter estimates (i.e., that with the lowest CV = 0.21; summer 2016) has been presented above. It should be noted that higher estimates and lower CVs were obtained from extensive aerial survey data gathered in winter 2016; however, the latter figures are somewhat unusual in the context of what is known about the species' abundance and distribution in the North-East Atlantic and the record figures could be influenced by significant breaks in survey effort across the full 2016-2017 winter period. The Favourable Reference Population under the Habitats Directive has been set as approximately equal to the current population to account for improved knowledge. Although the short-term trends are uncertain this value is considered to represent the minimum necessary to ensure the long-term survival of the species.

	Against this background, Ireland's **threshold value for Good Environmental Status** under this criterion is proposed as follows: At or greater than the current Favourable Reference Population value Harbour porpoise Minimum population size (2016; lower 95% C.L.): 29,519 Harbour porpoises Maximum population size (2016; upper 95% C.L.): 51,840 Harbour porpoises The most robust and reliable of two summer and two winter estimates (i.e., that with the lowest CV = 0.22; summer 2016) has been presented above. The Favourable Reference Population under the Habitats Directive has been set as approximately equal to the current population to account for improved knowledge. Although the short-term trends are uncertain, this value is considered to represent the minimum necessary to ensure the long-term survival of the species. Against this background, Ireland's **threshold value for Good Environmental Status** under this criterion is proposed as follows: At or greater than the current Favourable Reference Population value Grey seal Minimum population size (2013): 7,284 Grey seals Maximum population size (2013): 9,365 Grey seals The current evidence from annual pup production and also ancillary data collected outside the breeding season indicates that the population abundance of this species is increasing and has been doing so since at least the mid-1990s when more regular and standardised monitoring effort began around Ireland's coast and offshore islands. This effort has been stepped up significantly since 2004. The Favourable Reference Population under the Habitats Directive has been set as less than the current minimum population estimate based on improving knowledge of this species' population status. Although the numerical trends in population abundance are uncertain at present, this value is considered to represent the minimum necessary to ensure the long-term survival of the species. Against this background, Ireland's **threshold value for Good Environmental Status** under this criterion is proposed as follows:

	At or greater than the current Favourable Reference Population value Harbour seal Minimum population size (2018): 4,007 Harbour seals The current evidence indicates that the population abundance of this species is relatively stable and may be increasing since the early 2000's when more comprehensive monitoring effort began around Ireland's coast. This effort has been stepped up significantly since 2009. A national programme of annual site-based monitoring by NPWS, which began in 2009 and covers key regional colonies and several Special Areas of Conservation, also indicates comparative stability or growth in the numbers of Harbour seals found ashore during the moult season. The Favourable Reference Population under the Habitats Directive has been set as less than the current minimum population estimate based on improving knowledge of this species' population status. Although the numerical trends in population abundance are uncertain at present, this value is considered to represent the minimum necessary to ensure the long-term survival of the species. Against this background, Ireland's **threshold value for Good Environmental Status** under this criterion is proposed as follows: At or greater than the current Favourable Reference Population value
Results (figures & tables)	**Marine birds** Black-legged Kittiwake  **Figure 1.** National breeding population estimates for Kittiwake, from Operation Seafarer to the current National Seabird Monitoring Programme 2013-2018 (NPWS; Cummins et al., 2019).

Northern fulmar

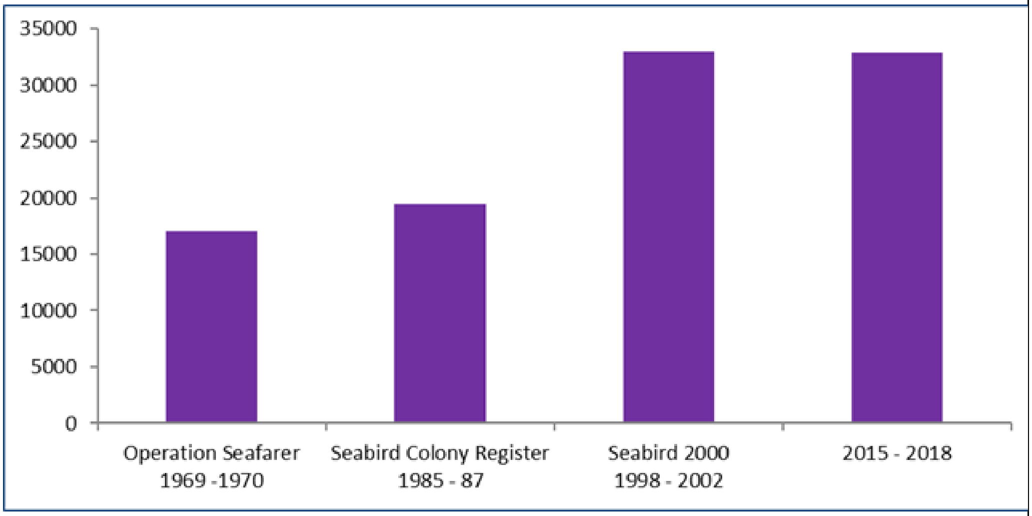
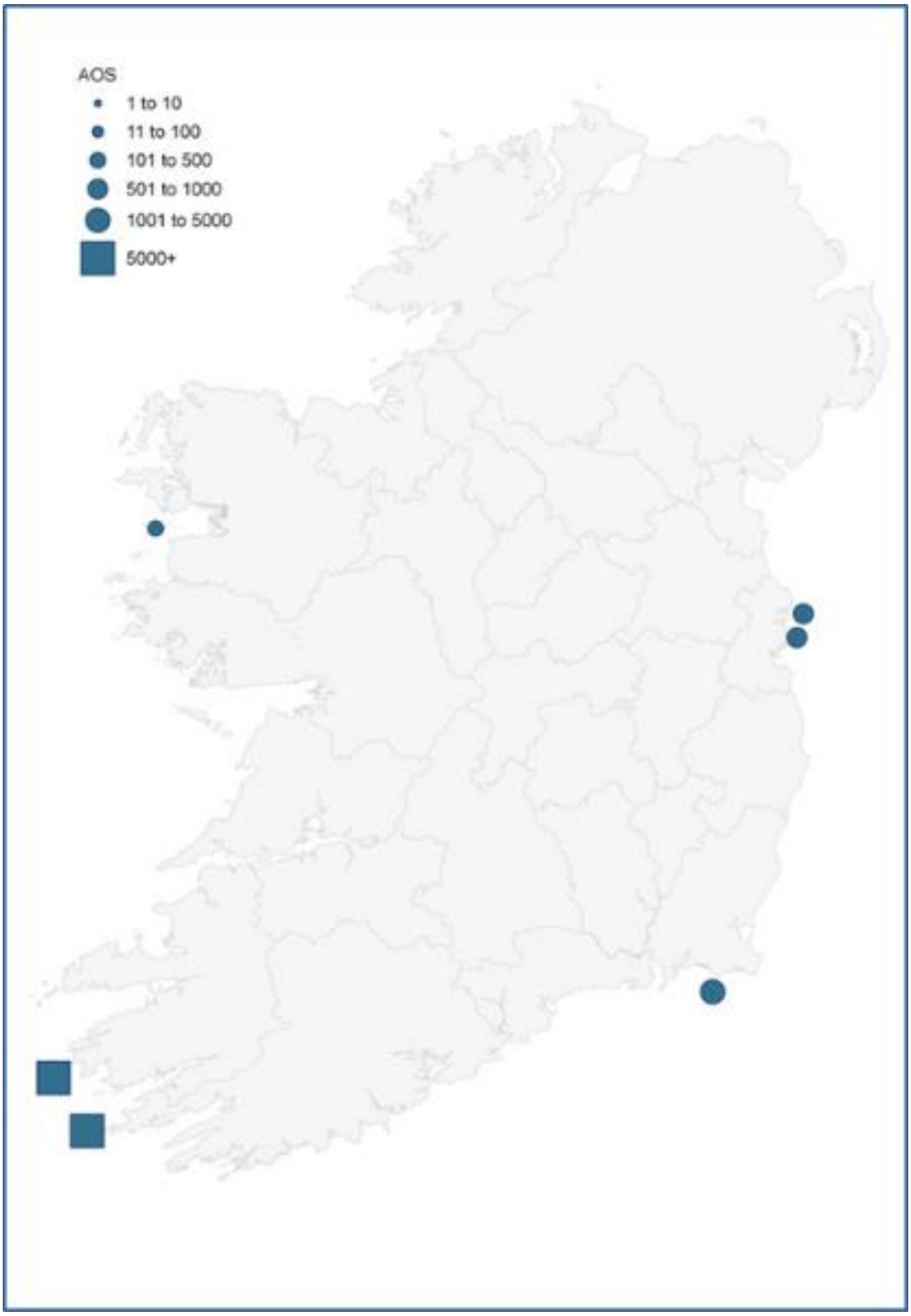
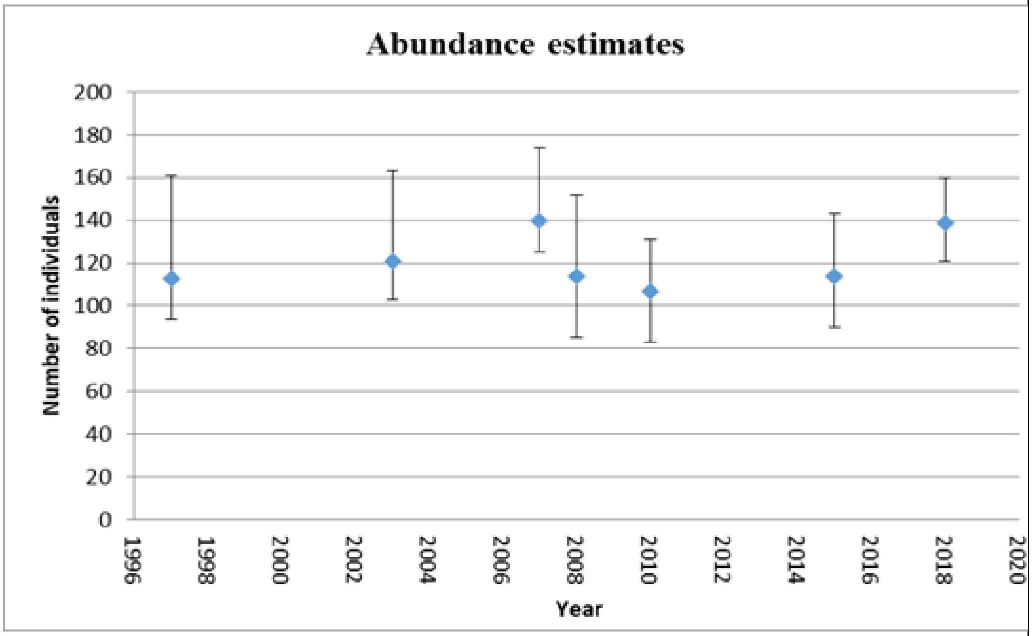


Figure 2. National breeding population estimates for Fulmar from Operation Seafarer to the current National Seabird Monitoring Programme (2013-2018). Figures are based on apparently occupied nests (AONs) (NPWS; Cummins et al., 2019).

	Northern gannet  **Figure 3.** Gannet abundance and breeding distribution in Ireland for the period 2013–2014. Figures are based on apparently occupied sites (AOSs) (NPWS; Cummins et al., 2019).

	Marine mammals Bottlenose dolphin  **Figure 4.** Estimates of population abundance (point estimate & 95% Confidence Intervals) for Bottlenose dolphins in the Lower River Shannon SAC (i.e. Shannon Estuary), from mark-recapture photo-identification surveys conducted since 1996 (NPWS; Rogan et al., 2018).

Harbour porpoise

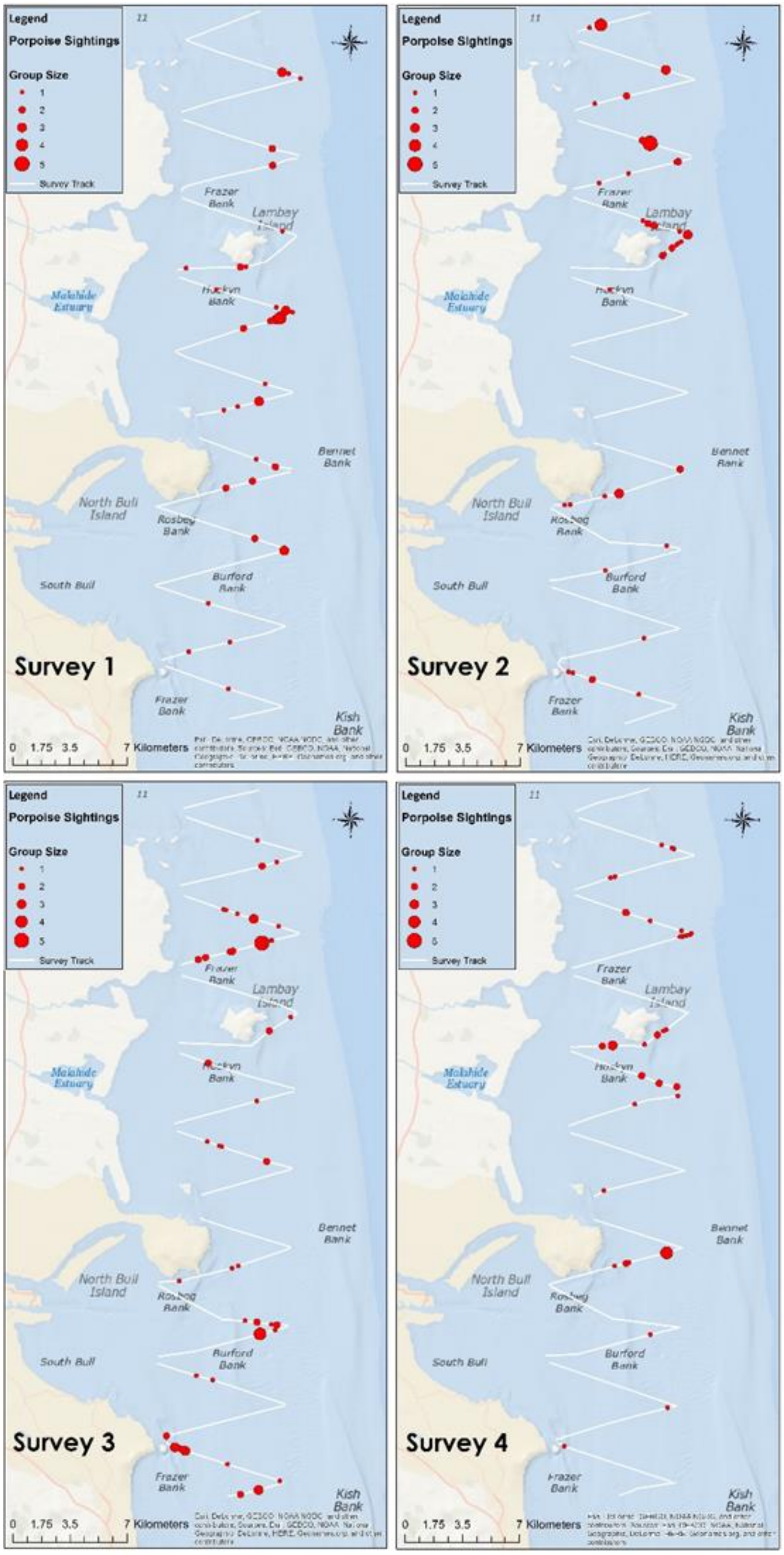
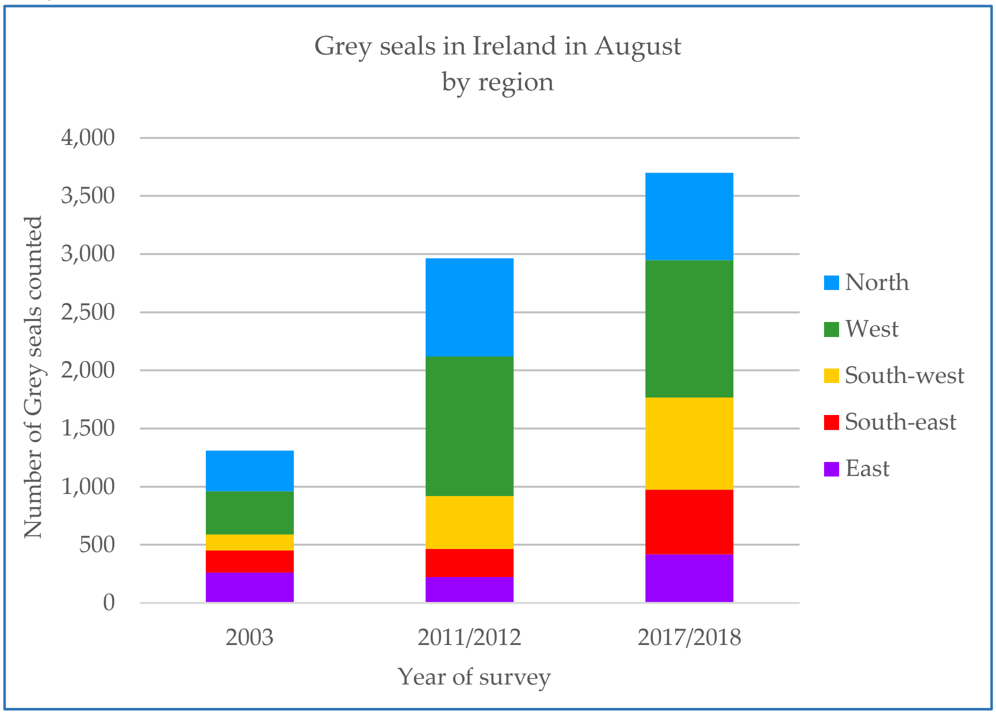
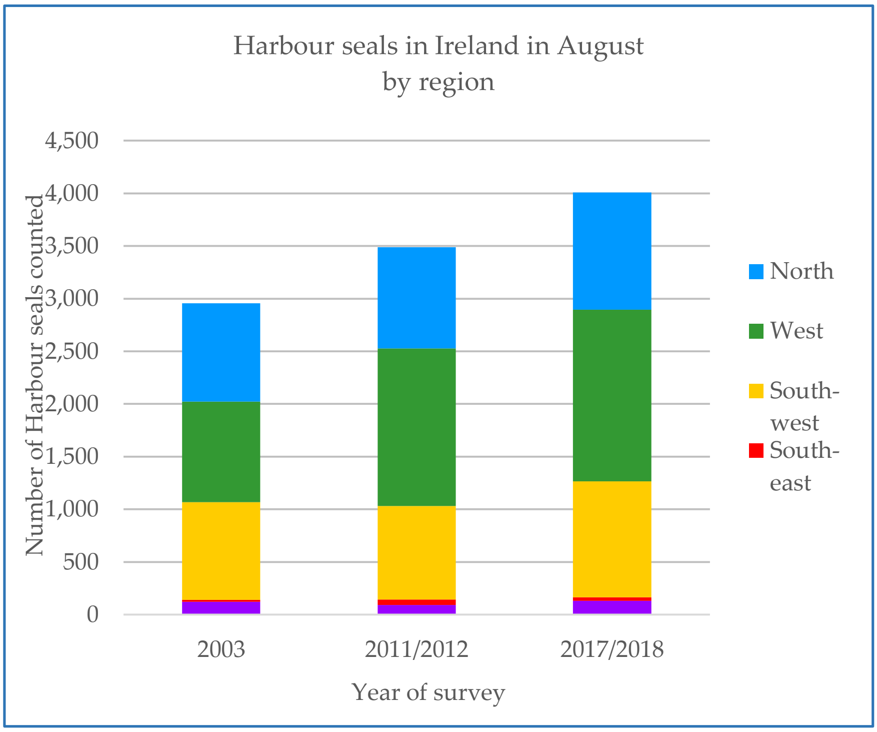


Figure 5. Mapped survey tracks, Harbour porpoise sighting locations and corresponding group sizes (red circles) recorded during line-transect surveys of Rockabill to Dalkey Island SAC off the Co. Dublin coast in the summer of 2016 (NPWS; O'Brien et al., 2018).

	Grey seal  **Figure 6.** A comparison of the summer counts of Grey seals in five assigned coastal regions of Ireland that were gathered during three successive nationwide aerial surveys for Harbour seal in the period 2003-2018 (Morris & Duck, 2019) Harbour seal  **Figure 7.** Total counts of Harbour seals recorded during the species' moult season in Ireland, divided into five assigned coastal regions and

	gathered during three comprehensive aerial surveys of the national coastline in the period 2003-2018 (Morris & Duck, 2019).
Knowledge gaps	• Targeted and collaborative international research is required on (a) the population ecology of Leatherback turtles in the North Atlantic and (b) the extent, severity and risk of impact from human activities on populations of this species. • The population dynamics of Black-legged kittiwake in the North-East Atlantic and the extent, severity and risk of impact from human activities on its populations, should be investigated further. • Knowledge of the breeding population, breeding ecology and productivity of Harbour seals around the country is very limited. This key aspect should be investigated comprehensively to ensure that all important breeding sites are identified and managed effectively, enhancing the conservation prospects for this species.
	Assessment Data
Data Sources	Cummins, S., Lauder, C., Lauder, A. & Tierney, T. D. (2019) The Status of Ireland's Breeding Seabirds: Birds Directive Article 12 Reporting 2013 – 2018. Irish Wildlife Manuals, No. 114. National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht, Ireland. 89pp. Doyle, T. K. (2007) Leatherback Sea Turtles (Dermochelys coriacea) in Irish waters. Irish Wildlife Manuals No. 32. National Parks and Wildlife Service, Department of the Environment, Heritage and Local Government, Dublin, Ireland. Doyle, T., Houghton, J.D.R., Ó Súilleabháin, P.F., Hobson, V., Marnell, F., Davenport, J. & Hays, G.C. (2008) Leatherback turtles satellite-tagged in European waters. Endangered Species Research 4:23-31. Morris, C.D. & Duck, C.D. (2019) Aerial thermal imaging survey of seals in Ireland, 2017-2018. Report (unpublished) for the National Parks and Wildlife Service of the Department of Culture, Heritage and the Gaeltacht, Dublin. NPWS. (2019) The Status of EU Protected Habitats and Species in Ireland. Volume 1: Summary Overview. Unpublished NPWS report. Edited by: Deirdre Lynn and Fionnuala O'Neill. 99pp.

	O'Brien, J. & Berrow, S.D. (2018) Harbour porpoise surveys in Blasket Islands SAC, 2018. Report to the National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht. Irish Whale and Dolphin Group. 23pp. Rogan, E., Garagouni, M., Nykänen, M., Whitaker, A. & Ingram, S. (2018) Bottlenose dolphin survey in the Lower River Shannon SAC, 2018. Report to the National Parks and Wildlife Service, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs. University College Cork. 19pp. Walsh, P.M., Halley, D.J., Harris, M.P., del Nevo, A., Sim, I.M.W. & Tasker, M.L. (1995) Seabird monitoring handbook for Britain and Ireland: a compilation of methods for survey and monitoring of breeding seabirds. Peterborough, JNCC/RSPB/ITE/Seabird Group.
Data Locations (URL)	https://www.npws.ie/maps-and-data https://www.npws.ie/publications https://www.npws.ie/marine/marine-reports https://www.dccae.gov.ie/observe
Data Time Line	Start Date: 2009 / End Date: 2018
Point of Contact	Oliver Ó Cadhla, Marine Environment section, DHPLG
Email	oliver.ocadhla@housing.gov.ie

D1 C4

Descriptor 1 Biodiversity	**Assessment Sheet: Reptiles, birds and mammals** **Criterion D1C4** **Species' distributional range and, where relevant, pattern**
Key message	Since 2009 populations of Irish-breeding marine vertebrate species have been monitored relatively consistently using standard international practice. In some cases, (e.g. certain marine birds, small cetaceans and seals) this monitoring followed earlier comprehensive baseline research and surveillance. Key evidence on species' range and distribution to 2018 across a range of eight representative species supports the finding that the majority are maintaining a favourable conservation condition and have therefore achieved Good Environmental Status (GES). This result is informed by Birds Directive and Habitats Directive assessments undertaken and reported by Ireland in 2019. Overall for this criterion, GES has been achieved for a total of seven ecosystem elements. However, the environmental status of Leatherback turtle, which does not breed in Ireland, is currently assessed as unknown. For some species, threshold values for the distributional range & pattern criterion have been considered and are proposed for operation at a subdivision (i.e. national) level. [Note: While three key, comparatively well-studied species of marine bird and four species of marine mammal have been included in this assessment to represent important "Criteria elements" of marine biological diversity, there are of course many more species within each group occurring and/or breeding in Ireland's marine area. In time additional representative species may be added to future assessments of biological diversity as the scientific knowledge base, data quality and understanding of their ecology and role in our marine ecosystems improves.]
Background	Ireland competed an Initial Assessment of its maritime area under the MSFD in October 2013. At the time, the assessment under biologically-orientated descriptors was largely restricted to (a) fisheries–related data for species and (b) broad-scale mapping data for habitats. In relation to biological diversity and associated environmental targets and indicators under Descriptor 1 the 2013 assessment concluded that more work was required to develop and

	coordinate parameters, elements and methods that would contribute to a more effective evaluation of Ireland's marine environmental status. Since then Ireland's approach, data collection and methods of assessment for this Descriptor under MSFD Articles 8, 9 and 10 have progressed considerably. This updated assessment considers elements of marine fauna that represent essential features and characteristics of biological diversity in Ireland's marine environment. It summarises (i) current knowledge of their environmental status, (ii)environmental targets for each faunal element that Ireland has established in order to achieve/maintain Good Environmental Status (GES) and, where possible, (iii) environmental threshold values per element that are proposed in order to secure and support the maintenance of GES in the long term. With regard to the assessment of distributional range and pattern (Criterion D1C4), this work was conducted using "Criteria elements", i.e. a set of species considered to be representative of elements of the marine ecosystem, and for which national monitoring/assessment programmes have been established, namely: **a) Marine reptiles:** Leatherback turtle *Dermochelys coriacea* The most frequently recorded turtle species in Irish waters and the only turtle considered to use Irish waters as part of its natural range, mainly occurring in summer-autumn. Listed in Annex IV of the EC Habitats Directive (Directive 1992/EEC) as a species in need of strict protection; **b) Marine birds:** Black-legged kittiwake *Rissa tridactyla*, Northern fulmar *Fulmarus glacialis*, Northern gannet *Morus bassanus* Protected under the Birds Directive (Directive 2009/147/EC), all three are fully marine species that nest and breed in Ireland on islands and cliff-bound terrain that is less vulnerable to human interference and mammalian predators than the breeding habitat of other seabird species. **c) Marine mammals:** Bottlenose dolphin *Tursiops truncatus*, Harbour porpoise *Phocoena phocoena*, Grey seal *Halichoerus grypus*, Harbour seal *Phoca vitulina* All four species occur in coastal and offshore waters of Ireland's maritime area and are listed in Annex II of the Habitats Directive as species whose conservation requires the designation of

	special areas of conservation. Both cetacean species are also listed in Annex IV.
Objective	The overriding objective is that Ireland's newly established environmental targets for MSFD Descriptor 1 (Biological diversity) are achieved. With regard to the distribution of vertebrate species (excluding non-commercial fish species) the applicable target is: **Environmental Target D1T4: The species distributional range and, where relevant, pattern is in line with prevailing physiographic, geographic and climatic conditions.** In this regard Commission Decision (EU) 2017/848 states: "Member States shall establish threshold values for each species through regional or subregional cooperation."
Drivers (Activities)	The population range and distribution of larger marine vertebrate species, such as reptiles, birds and mammals, may be subject to adverse impacts arising from local and/or regional anthropogenic drivers (activities) throughout their North Atlantic range and in Irish coastal/offshore waters. The main human activities believed to be interacting as pressure mediators on the range and distribution of Ireland's marine vertebrate populations involve commercial vessel-based or shipping-based activities that occur primarily on a regional scale and/or on a persistent or intermittent basis (e.g., commercial fisheries or geophysical seismic exploration). Foremost of these anthropogenic drivers in an Irish context is commercial fishing at sea by Irish-registered vessels and other European/international fleets operating within Ireland's Exclusive Economic Zone (EEZ), both through the removal of food biomass and potential prey resources from the marine environment. Less persistent but nevertheless periodically intensive geophysical surveying of the seafloor and underlying structure (e.g., for oil/gas deposits) may also introduce a significant environmental pressure on the distribution of mammal populations at local and/or regional scales, mainly through potential disturbance, spatial and/or temporal displacement or potential impacts on the natural availability of prey, for example.

<table>
<tr><td></td><td>Coastal tourism and other recreational/industrial activities around breeding or resting sites (e.g., shellfish gathering, intertidal aquaculture, coastal walking, wildlife watching) could also introduce environmental pressures, such as disturbance, that affect the range and distribution of marine bird and mammal populations.

According to current evidence on a national scale in Ireland these drivers may not be reducing overall population range or distribution of representative vertebrate elements of the ecosystem. They may however act to impair natural range and/or distribution or normal fluctuations in distribution in the absence of potential stressors, and further scientific investigation or improved management of such activities may be necessary via a risk-based prioritisation approach.</td></tr>
<tr><td>Pressures</td><td>The predominant pressures identified in Commission Directive 2017/845 that are currently of known and/or potential significance to the range and distribution of populations of vertebrate species in Ireland’s MSFD area, are considered to be:
• Disturbance of species due to human presence

• Extraction of, or mortality/injury to, wild species (by commercial fishing, and/or recreational fishing and/or other activities)

• Physical disturbance to the seabed (temporary or reversible)

• Input of anthropogenic sound (impulsive, continuous)

Among the items listed above the most significant anthropogenic pressure on the range and distribution of vertebrate populations in Ireland’s maritime area is the extraction of fish and shellfish biomass (both commercial and non-commercial species) and associated disturbance introduced by human fishing activity. This occurs in the water column (e.g. pelagic trawling) and also close to or on the sea-floor (e.g. demersal trawling or set-nets, benthic dredging). It is prevalent all year round and in much of Ireland’s EEZ, and is driven by a wide range of international, European Union and national fishing fleets that use diverse gear types, from jigging and long-lining to mobile nets and stationary pots. Fishing-derived pressure is, to a large extent, measurable and it is therefore supported by scientific evidence, monitoring and assessment, as well as EU and international regulation and management (e.g. through the EU Common Fisheries Policy).</td></tr>
</table>

	There are also significant human pressures that can carry with them significant adverse impacts on the range and distribution of populations of particular species and/or their habitats, e.g. through the disturbance or deterioration of species' breeding or foraging habitats. For larger marine vertebrate species, along with the potential pressures introduced by biomass removal and biological competition for prey resources, the introduction of anthropogenic sound and disturbance of species are considered to present the greatest secondary pressures after commercial fisheries extraction.
State	**Marine reptiles** Leatherback turtle With regard to the primary criteria and established Environmental Targets under Descriptor 1, there are currently significant limitations associated with assessing and reporting on the status of this 'sea turtle' species. While some recent progress has been made in data acquisition from Ireland and adjacent waters, the species' population ecology, range, habitat use and the pressures/impacts it faces in Irish waters and the wider North-East Atlantic, are not well understood. The overall status of this species in Irish waters is assessed as Unknown. **Marine birds** Black-legged kittiwake This is most numerous gull species globally and is the most oceanic in its habits, preferring to nest on vertical rocky sea-cliffs in colonies from a few pairs to several thousand pairs. In Ireland Kittiwake breeding sites are well distributed around the coast. Tracking studies in the Atlantic indicate that ca.80% of the adult population winters in waters west of the mid-Atlantic Ridge while birds from Ireland and Britain mainly occupy oceanic waters situated east of the Ridge. There is evidence of a substantially wider distribution of breeding colonies around the coast than was known heretofore and surveys at sea describe the species' occupancy of waters throughout Ireland's Exclusive Economic Zone (EEZ), as would be expected. While there is an underlying question concerning Kittiwake reproductive success and the extent and condition of its natural habitats given an observed breeding population decline, causes of the decline are unclear at present. Some examples of potential factors involved are changes in food availability or prey distribution, or climate-related influences but further investigation is required.

	Nevertheless, in consideration of the Environmental Target described above, given that the available scientific evidence from Ireland shows an increasing breeding distribution nationally and no restrictions on the species' natural range, it is concluded that GES has been achieved for the distributional range and pattern of this species. Northern fulmar This distinctive large petrel species is a common sight around the Irish coast, particularly in the northwest, west and south of the country where it nests on steep vertical slopes and broad ledges near the top of vegetated cliffs. Fulmar breeding distribution was once mainly restricted to the Arctic but since the 1700s its range has expanded southwards from Iceland to the coasts of Britain, Ireland and France. During the breeding season nesting Fulmars are widely dispersed along our coasts as illustrated by the most recent national seabird census (2015 – 2018) which recorded the species breeding at over 120 sites across Ireland. In consideration of the Environmental Target described above, given that the available scientific evidence from Ireland shows an increasing breeding distribution, an extensive distributional range at sea and stable population figures nationally, it is concluded that GES has been achieved for the distributional range and pattern of this species. Northern gannet The Gannet is an iconic seabird species and the largest marine bird commonly inhabiting the North Atlantic. A wide-ranging pelagic forager, its breeding adults mainly occur in temperate waters and they are site-faithful, with most breeding colonies occupied by individual birds for decades or longer. In a national context, Gannets breed gregariously on a few isolated sea stacks, small uninhabited islets and on occasion, inaccessible cliffs on larger islands (e.g., Ireland's Eye and Lambay Island, off Co. Dublin). The Irish population of this species has increased by an estimated 33% over a 10-year period to reach 47,946 pairs in 2014, and its breeding distribution has expended accordingly (up 20% since 2004, up 50% since 1984/85). Regional populations at the traditional colonies have increased across the board such that, in historical terms, the population has increased by 121% since Operation Seafarer in 1969-70. In consideration of the Environmental Target described above, given that the available scientific evidence from Ireland shows an increasing breeding distribution, an extensive distributional range at sea and

	increasing population figures nationally, it is concluded that GES has been achieved for the distributional range and pattern of this species. **Marine mammals** Bottlenose dolphin The distribution and natural range of Bottlenose dolphins in Irish waters, and marine waters covered by the Directive, is a small component of the species' wider North Atlantic range, while ongoing evidence from repeated high quality surveys continues to confirm the species' occurrence in Irish waters in all seasons. Sighting records from ongoing dedicated surveillance effort in Irish waters provide no evidence of a decline in distribution/range in the recent past. Therefore, the short-term trend for Range is considered to be stable. The long-term trend over the period 1994-2018 is considered to be uncertain for this species (NPWS, 2019) due to limited data availability prior to 1999-2000. Since there is no evidence of a decline in distributional range since the Directive came into force the current range is set as the Favourable Reference Range (NPWS, 2019). There is an assumption that the current range in Irish waters is large enough (a) to encompass all of the ecological variation required by this species during its occurrences therein and (b) to contribute to the long-term survival of the species. In consideration of the Environmental Target described above, given that the available scientific evidence from Ireland shows a widespread distribution and no evidence of a decline in range or distribution nationally, it is concluded that GES has been achieved for the distributional range and pattern of this species. Harbour porpoise The distribution and natural range of Harbour porpoises in Irish waters, and marine waters covered by the Directive, is a small component of the species' wider North Atlantic range, while ongoing evidence from repeated high quality surveys continues to confirm the species' occurrence in Irish waters in all seasons. Sighting records from ongoing dedicated surveillance effort in Irish waters provide no evidence of a decline in distribution/range in the recent past. Therefore, the short-term trend for Range is considered to be stable. The long-term trend over the period 1994-2018 is

	considered to be uncertain for this species (NPWS, 2019) due to limited data availability prior to 1999-2000. Since there is no evidence of a decline in distributional range since the Directive came into force the current range is set as the Favourable Reference Range (NPWS, 2019). There is an assumption that the current range in Irish waters is large enough (a) to encompass all of the ecological variation required by this species during its occurrences therein and (b) to contribute to the long-term survival of the species. In consideration of the Environmental Target described above, given that the available scientific evidence from Ireland shows a widespread distribution and no evidence of a decline in range or distribution nationally, it is concluded that GES has been achieved for the distributional range and pattern of this species. Grey seal The natural range of Grey seals in Irish waters has been shown to be part of the species' wider range in the waters of western Europe, particularly those of neighbouring states the UK and France with offshore movements primarily occurring in waters overlying the continental shelf and upper continental slope. The species' Range map provided in the recent NPWS HD assessment (NPWS, 2019) covers a surface area measuring 264,900km^2 that is distributed in Irish coastal and marine waters up to 1,000m deep including shallow coastal bays and estuaries and excluding the eastern margin of the Rockall Bank. Over the last two decades records of the occurrence of this species around Ireland have increased considerably in parallel with more active surveillance and assessment and continued seal population monitoring since 2005-06. The accurate assessment of seal population occurrence at sea presents significant challenges, however, particularly when attempting to work at a regional or population scale and offshore. Sighting records may be obtained incidentally during ship-based surveys but in general seals are not easily detected and identified in the open sea except at close range and such data may be recorded erratically introducing uncertainty into the assessment of true distribution.

	Knowledge of current Grey seal distribution in Ireland is therefore concentrated on records gathered at haul-out sites since the mid-1990s including during the annual moult, breeding and summer seasons. This information, along with inshore/offshore range data for Ireland, indicate that a decline in range within Irish waters is unlikely to have occurred in the recent past; therefore, accordingly in HD terms the short-term trend for Range is considered to be stable. In consideration of the Environmental Target described above, given that the available scientific evidence from Ireland shows an increased distribution and increasing population figures nationally, it is concluded that GES has been achieved for the distributional range and pattern of this species. Harbour seal The natural range of Harbour seals in Irish waters is likely to be part of the species' wider range in the waters of western Europe, especially those of the UK, according to information currently available on regional Harbour seal movements. However, some degree of geographic and possibly even genetic isolation by distance of Irish Harbour seal communities (e.g., in the west of Ireland) cannot be ruled out at this time, based on the comparatively short-range movements shown by a sample of animals tagged in the southwest of Ireland. While individual Harbour seal movements measuring several hundred kilometres have been recorded these have tended to occur in the waters of shallow regional seas (e.g., the North Sea) and/or overlying the continental shelf. The species' Range map provided in the recent NPWS HD assessment (NPWS, 2019) covers a surface area measuring 176,300km^2 that is distributed in Irish coastal and marine waters up to 200m deep, including shallow coastal bays and estuaries and excluding the offshore Porcupine Bank. Prior to the early 2000s there was limited information available concerning the population status and distribution of Harbour seals around Ireland and the extent to which these animals travelled within Irish and neighbouring waters. From 2004 the results of research and monitoring involving key Irish breeding and non-breeding haul-out sites began to emerge. Increased emphasis was placed on completion of (i) a national evaluation of Harbour seal distribution and population size, and (ii) the

	first in-depth regional studies of Harbour seal ecology and movement within Irish waters. Consequently, with regard to this species and its Range parameter under the HD it is considered that the years 2007-2018 represent an appropriate period for the evaluation of short-term trends. Records from a range of collaborative telemetry studies conducted since the 1990s demonstrate this species' capacity for wide-ranging travel at sea as first suggested by early flipper-tagging experiments. This information, along with current Harbour seal distribution data for Ireland, indicate that a decline in Range within Irish waters is unlikely to have occurred in the recent past; therefore, accordingly in HD terms the short-term trend for Range is considered to be stable. In consideration of the Environmental Target described above, given that the available scientific evidence from Ireland shows a comparatively stable distribution and population figures nationally, it is concluded that GES has been achieved for the distributional range and pattern of this species.
Impact	The parameters and characteristics specified in Commission Directive 2017/845 that are likely to be impacted upon by loss of biological diversity can be divided in to species impacts, habitat impacts and ecosystem/food-web impacts. The species impacts are considered to operate via changes to: distribution and/or biomass; size, age and sex structure, reproductive potential, survival and mortality/injury; behaviour including movement and migration; habitat for the species (extent, suitability); and species composition within groups of species. The main habitat impacts are considered to operate via changes to: species composition, abundance and/ or biomass (spatial and temporal variation); size and age structure of species; and physical, hydrological and chemical characteristics. The main ecosystem impacts are considered to operate via changes to: links between habitats and species of marine birds, mammals, reptiles, fish and cephalopods; pelagic-benthic community structure; and productivity. The effects and consequences of the predominant pressures on biological diversity during the overall assessment period (2013-2018) and prior to that, if relevant, have been considered in the current assessment. For the marine vertebrates outlined above that have been included as criteria elements (i.e. eight reptile, bird and mammal

	species) this is primarily informed by Ireland's surveillance, assessments and reporting undertaken to meet requirements under the EU Habitats Directive and Birds Directive. In relation to the predominant pressures identified as known and/or of potential significance in Ireland's marine area, based on scientific evidence and knowledge of current human activity there are few such pressures that are considered to operate with potential effects or consequences for the distributional range and/or pattern of species' populations in Ireland. Among them, however, are: • Disturbance of species due to human presence Certain species that avoid interaction with humans or animal predators may be highly vulnerable to human disturbance during times of the year that are critical for their populations and for survival (e.g. during migration, foraging, nesting, breeding or resting phases). Human presence may also mediate additional impacts that cause disturbance to the species' natural history, such as the introduction of problematic predators (e.g. mink at seabird breeding sites), disease or invasive species. • Extraction of, or mortality/injury to, wild species (by commercial fishing, and/or recreational fishing and/or other activities) In addition to the loss of potentially significant food biomass from the marine environment through human extraction, this pressure can also have direct population-level consequences (e.g. regional distribution changes, population displacement) if the level of mortality or injury to wild species is not compensated for by natural factors such as productivity or immigration. • Physical disturbance to the seabed (temporary or reversible) The effect of this pressure, if it acts at a population-relevant scale, may be to deter or displace animals from their natural habitat or reduce foraging opportunities, for example, thereby influencing patterns in population distribution and/or range. • Input of anthropogenic sound (impulsive, continuous) Individual species (e.g. some marine mammals) and their populations may also be sensitive to certain types of underwater sound transmitted by human practices in the sea and ocean environment. This is an area under active research in relation to several anthropogenic sound sources and the individual or population-level consequences of disturbance or acoustically-driven injury. Examples of potential impacts include spatial

	and/or temporal changes in distribution, movement patterns or range driven by displacement due to underwater noise. **Marine reptiles** Leatherback turtle Leatherback turtles that migrate through Irish waters mate and breed in the tropics. The most significant threats and pressures acting on the distribution and range of the North Atlantic population, while at sea, are not well understood but are thought to include incidental capture (i.e. bycatch) in commercial fisheries, anthropogenic noise and, potentially, pressures arising as a result of climate change (e.g. changes in sea temperature or ocean circulation systems). However, the degree of impact arising from such pressures is poorly known since the understanding of the population ecology, distribution, migration patterns and habitat use of the species in the North-East Atlantic is very limited. Active international, multi-disciplinary research is required to address such important knowledge gaps. **Marine birds** Black-legged kittiwake Despite some evidence of breeding distribution expansion in Ireland this species' population abundance is shown to be declining and there are some indications that this may be environmental and/or human pressure-related. There are insufficient data at present to determine which pressures are critical in this regard and what the effects and consequences for Kittiwake population range and distribution patterns might be. Further active research is required nationally and internationally to improve this picture and to determine the impacts of environmental and/or human pressures on the species' natural population distribution and range. Northern fulmar Based on the stable population abundance and distribution expansion of Fulmars in Ireland and other monitoring data, there is currently no evidence that any pressures and their effect on this criteria element are causing changes to population distribution and/or range. With implementation of the landing obligation under the reformed Common Fisheries Policy there might be future repercussions in terms of food availability for Ireland's Fulmar population or some component of it and continued monitoring of this species' population and its distribution will be necessary in this regard.

	Northern gannet Based on the increasing population abundance and distribution expansion of Gannets in Ireland and other monitoring data, there is currently no evidence that any pressures and their effect on this criteria element are causing changes to population distribution and/or range. With implementation of the landing obligation under the reformed Common Fisheries Policy there might be future repercussions in terms of food availability for Ireland's Gannet population or some component of it and continued monitoring of this species' population and its distribution will be necessary in this regard. **Marine mammals** Bottlenose dolphin The distribution and range of Bottlenose dolphin may be subject to a number of local and/or regional environmental pressures and threats, including in Irish coastal/offshore waters. The main pressures thought to be acting on this species' distribution in Ireland are considered to involve commercial shipping-based or vessel-based activities that occur primarily on a local or regional scale and/or on a temporary or intermittent basis (e.g., impacts arising from geophysical seismic exploration; impacts from local/regional prey removal by fisheries; impacts from local seasonal marine tourism). Some are likely to continue to act as pressures into the future, thereby constituting a potential threat. However, in most cases in Ireland there is little evidence that existing pressures on this species are acting on its distribution or range at a population level. An exception might occur in the case of the resident population of Bottlenose dolphins inhabiting the Shannon Estuary, which is genetically distinct and appears to be ecologically adapted to living in this comparatively discrete coastal region. In this context the monitoring of local dolphin-watching tourism has been an important method of surveillance for significant impacts on the resident population, while regular scientific surveys indicate that the distribution and range within the Shannon Estuary has been relatively stable over the last two decades. While the wider impacts of human activities on Bottlenose dolphin in Irish waters are not well understood, partly due to the species' extensive range and continuing uncertainty regarding population trends and ecology within Ireland's marine area, none of the associated pressures are considered to be of sufficient magnitude to

	be causing an adverse impact on the distribution or range of its populations in Irish waters. In parallel with continued surveillance and monitoring of this protected species, ongoing pressures and threats to its populations have been and continue to be identified and managed appropriately, thus the status of and prospects for distributional range of this species into the future are favourable. Harbour porpoise The distribution and range of Harbour porpoise may be subject to a number of local and/or regional environmental pressures and threats, including in Irish coastal/offshore waters. The main pressures thought to be acting on this species' distribution in Ireland are considered to involve commercial shipping-based or vessel-based activities that occur primarily on a local or regional scale and/or on a temporary or intermittent basis (e.g., impacts arising from geophysical seismic exploration; impacts from local/regional prey removal by fisheries; impacts from local maritime development). Some are likely to continue to act as pressures into the future, thereby constituting a potential threat. While the effect of these pressures may act on a temporary and/or regional scale and some (e.g. disturbance or displacement due to anthropogenic noise) are likely to continue to act as pressures into the future, none is considered to be of sufficient magnitude to be causing an adverse impact on the distribution or range of its populations in Irish waters. There is no evidence to suggest a change in the main pressures thought to be acting on this species' distribution or range in the near future. However, surveillance of the species and the pressures potentially acting upon it will continue, while the application of strong management measures (e.g., via the statutory/regulatory process) to avoid potentially significant impacts is also expected to continue; thus the status of and prospects for distributional range of this species into the future are favourable. Grey seal The distribution and range of Ireland's Grey seal population may be subject to a number of local and/or regional environmental pressures and threats on land in coastal areas, and in coastal and offshore waters. The main pressures thought to be acting on this species' distribution or range around Ireland are considered to involve commercial vessel-based or shipping-based activities that occur

	primarily on a local or regional scale and/or on a persistent or intermittent basis (e.g. impacts from local/regional prey removal by fisheries; impacts arising from geophysical seismic exploration). Some are likely to continue to act as pressures into the future, thereby constituting a potential threat. While the effect of these pressures may act on a temporary and/or regional scale, based on current information none is considered to be of sufficient magnitude to be causing an adverse impact on the population distribution or range of Grey seal in Ireland. The available evidence, as supported by ongoing robust surveillance, indicates continued growth in the species' breeding population size around the coastline. There is no evidence to suggest a change in the main pressures thought to be acting on this species' distribution or range in the near future. However, surveillance of the species and the pressures potentially acting upon it will continue, while the application of strong management measures (e.g., via the statutory/regulatory process) to avoid potentially significant impacts is also expected to continue; thus the status of and prospects for distributional range of Ireland's Grey seal population into the future are favourable. Harbour seal The distribution and range of Ireland's Harbour seal population may be subject to a number of local and/or regional environmental pressures and threats on land in coastal areas, and in coastal and offshore waters. The main pressures thought to be acting on this species' distribution or range around Ireland are considered to involve commercial vessel-based or shipping-based activities that occur primarily on a local or regional scale and/or on a persistent or intermittent basis (e.g. impacts from local/regional prey removal by fisheries; impacts arising from geophysical seismic exploration). Other possible impacts may occur from coastal tourism and localised human disturbance at haul-out sites, though further research into this aspect is currently required to assess the degree and nature of such potential impacts around the Irish coast. Some are likely to continue to act as pressures into the future, thereby constituting a potential threat. While the effect of these pressures may act on a temporary and/or regional scale, based on current information none is considered to be of sufficient magnitude to be causing an adverse impact on the

	population distribution or range of Harbour seal in Ireland. The available evidence, as supported by ongoing surveillance, indicates continued relative stability in the species' population size around the coastline. There is no evidence to suggest a change in the main pressures thought to be acting on this species' distribution or range in the near future. However surveillance of the species and the pressures potentially acting upon it will continue, while the application of strong management measures (e.g., via the statutory/regulatory process) to avoid potentially significant impacts is also expected to continue; thus the status of and prospects for distributional range of Ireland's Harbour seal population into the future are favourable.
Assessment Method	**Marine reptiles** Leatherback turtle The Leatherback turtle is the most widely distributed living reptile species, being found in all oceans except the Southern Ocean. Within the North Atlantic its range extends from the tropics to the high latitudes of Newfoundland right across to Europe's north-westerly fringe. It is a widely roaming species, with individuals making extensive pan-oceanic movements. Breeding is confined to warm tropical regions because of thermal constraints on egg incubation, but the species has many unique anatomical and physiological adaptations that permit it, unlike other marine turtles, to forage seasonally into cooler temperate waters. Consequently, Leatherback populations have a very dynamic range. During the summer months their range is at its greatest extent with individuals located throughout the North Atlantic, whereas during the winter months their range is restricted to areas where the sea surface temperature is >15 °C. Recent studies have shown that after nesting in the tropics the majority of North Atlantic Leatherbacks head north towards cooler temperate waters. Some of these individuals head north towards the north-east Atlantic and Irish waters where they forage on jellyfish for the summer months before turning south again in the autumn as water temperatures decline. The TURTLE database is used to collate all Leatherback records from Ireland and the UK. It is clear that Leatherbacks migrate through Irish waters each year (with 198 records since 2000) and while most records are from sightings near to the coast, or strandings, they can also be encountered off-shore. For the 2013 Habitats Directive

	assessment, it was assumed that the entire extent of Ireland's EEZ could constitute the range of the Leatherback turtle. However, the results from the extensive ObSERVE aerial survey project in 2015-2016 may indicate a more restricted range than previously thought. That project was aimed at off-shore cetaceans but also recorded other megafauna and resulted in over 600,000 km^2 of sea being surveyed, but only recorded three turtles, all from the Celtic shelf. Consequently, pending further survey work, the range of this species is taken as the area incorporating the distribution records for 2000-2018. **Marine birds** The majority of surveys conducted as part of the national seabird monitoring programme followed guidance on sampling and census methods for seabirds as well as species-specific methodology detailed in the Seabird Monitoring Handbook for Britain and Ireland (Walsh et al., 1995). This facilitated the assessment of population sizes and to estimate the changes in numbers since the last national census carried out in Seabird 2000. A summary of the methods employed and recommended timings of surveys are set out in Cummins et al. (2019). These Census Instructions are based on Walsh et al. (1995)'s handbook and are the recommended methods for the Seabirds Count census work across Ireland, Northern Ireland and Britain. Black-legged kittiwake Approximately 90% of the total contemporary population estimate is derived from single visit surveys undertaken across Ireland in 2015. Over 80% of the counts were undertaken during the period mid-May – June with the remaining sites covered in July. There is high confidence in both contemporary population and distribution estimates. The confidence in short-term estimates of change is medium, based on greater recent coverage and more targeted timing of surveys compared to Seabird 2000. The long-term estimates of change in abundance are also qualified as medium. Northern fulmar Over 70% of counts were conducted in June, which is the noted ideal month for surveying this species and greater than the 64% figure for Seabird 2000. Approximately 66% of the total contemporary population estimate is derived from single visit surveys undertaken in 2015. NPWS confidence in both the contemporary national population estimate and the breeding range is at least a medium. The confidence

	in short-term estimates of change is medium based on greater coverage in this round compared to Seabird 2000. The estimated long-term population change is also qualified as medium, as coverage was not as comprehensive in the Seabird Colony Register even though some corrections for surveyed colonies were made. Northern gannet The results of the census of Irish Gannet colonies (gannetries) were largely derived from aerial photographs taken in 2013 and 2014 and supplemented by additional land-based vantage point counts at the smaller colonies, i.e. Clare Island, Ireland's Eye and Lambay Island. The count unit for aerial surveys is the Apparently Occupied Site (AOS) as usually it is not possible to see whether one or two birds are present on the site. For the three largest colonies (Little Skellig, Bull Rock and Great Saltee), estimates were derived by taking the mean (or average) of three independent observer counts of the aerial imagery following published guidance. The contemporary population estimate and distribution for this species is high due to the conspicuous nature of Gannet colonies and that the survey data came from a single species national survey of the seven known colonies, conducted during 2013 – 2014. Both the short- and long-term comparisons are against high quality counts; therefore, confidence in these estimates is also high. Due to the limited number of Gannet colonies in Ireland, confidence in the estimated change in distribution is also high. **Marine mammals** Bottlenose dolphin This is one of the most frequently recorded and familiar cetaceans occurring in Ireland, with contemporary sighting records showing its wide occurrence throughout Irish coastal and offshore waters, from those overlying the continental shelf and continental slope to deeper ocean basins. Prior to 1999-2000, survey effort targeting cetacean species in Irish offshore waters was comparatively limited in coverage, both spatially and temporally. Since 1999-2000 a number of dedicated multi-annual surveillance programmes for cetaceans have operated in Irish waters, with visual and acoustic surveys extending to the limits of Ireland's EEZ and beyond. With regard to this species it is considered that the years 2007-2018 represent an appropriate period for the evaluation of

	short-term trends (NPWS, 2019) since all survey efforts intensified further during this period. Over the last two decades there have been continuing and widespread records of Bottlenose dolphins in Irish waters, particularly to the south, west and north of Ireland. The surveillance programmes, projects and publications that contributed sighting data to Ireland's current distribution projection for the species are cited in NPWS (2019). In this regard a key component of Ireland's visual monitoring for this species and its range/distribution has been a series of aerial surveys carried out under Ireland's ObSERVE Programme (Rogan et al., 2018). It should be noted that the spatial and temporal distribution of Bottlenose dolphins could be somewhat underestimated due to the difficulty in discriminating various dolphin species from one another, particularly in the offshore Atlantic environment. Nevertheless, the distribution of sightings since 2012-13, along with regional sighting records obtained across three preceding decades, indicate a predominant distribution in waters overlying the continental shelf and the continental slope plus adjacent deeper ocean waters and topographical basins. The species can also occur in enclosed bays and in close proximity to the Irish coast, such as in the Shannon Estuary and waters along the western seaboard. Harbour porpoise The Harbour porpoise is the smallest cetacean species occurring in Irish waters yet is one of the most frequently recorded, though this can be more difficult offshore due to its size and inconspicuous nature. Prior to 1999-2000, survey effort targeting cetacean species in Irish offshore waters was comparatively limited in coverage, both spatially and temporally. Since 1999-2000 a number of dedicated multi-annual surveillance programmes for cetaceans have operated in Irish waters, with visual and acoustic surveys extending to the limits of Ireland's EEZ and beyond. With regard to this species it is considered that the years 2007-2018 represent an appropriate period for the evaluation of short-term trends (NPWS, 2019) since all survey efforts intensified further during this period. Over the last two decades there have been continuing and widespread records of Harbour porpoises in Irish waters, particularly

	to the south, west and north of Ireland. The surveillance programmes, projects and publications that contributed sighting data to Ireland's current distribution projection for the species are cited in NPWS (2019). In this regard a key component of Ireland's visual monitoring for this species and its range/distribution has been a series of aerial surveys carried out under Ireland's ObSERVE Programme (Rogan et al., 2018). It should be noted that the spatial and temporal distribution of Harbour porpoises could be somewhat underestimated due to the difficulty in discriminating small and inconspicuous cetacean species from one another, particularly in the offshore Atlantic environment. Nevertheless, the distribution sightings and acoustic records since 2012-13 along with regional sighting records obtained across three preceding decades indicate a predominant distribution in coastal waters and those overlying the continental shelf and the continental slope. They are also occasionally recorded in adjacent deeper basin waters (e.g., the Porcupine Seabight; Rogan et al., 2018). Grey seal Following background research in 1994-2004 and a comprehensive nationwide assessment of Grey seal population size and distribution in 2005 three key regions have been subject to renewed aerial surveillance over subsequent breeding seasons (east/southeast: 2009, 2013, 2017; west/southwest: 2011, 2015; west/northwest: 2012, 2016). While the current emphasis for monitoring is based around ongoing pup production at the seven most important breeding areas for the species, collectively representing approximately 84-85% of the total breeding population, some additional or opportunistic coverage of areas/sites of secondary importance is also carried out during the breeding season. This is mainly to reconfirm the presence of breeding animals, newborn pups and/or non-breeding haul-out groups in the months of September to December. Grey seals in Ireland are also known to occupy numerous haul-out sites outside the breeding season; during the annual moult, for example, or also in summer. In this regard the intertidal/terrestrial distribution of the species may be significantly more dispersed around the coast than is seen during breeding. Along with breeding population information, additional Grey seal distribution and range data are also collected during nationwide and site-based surveys targeting Harbour seal during the annual moult in

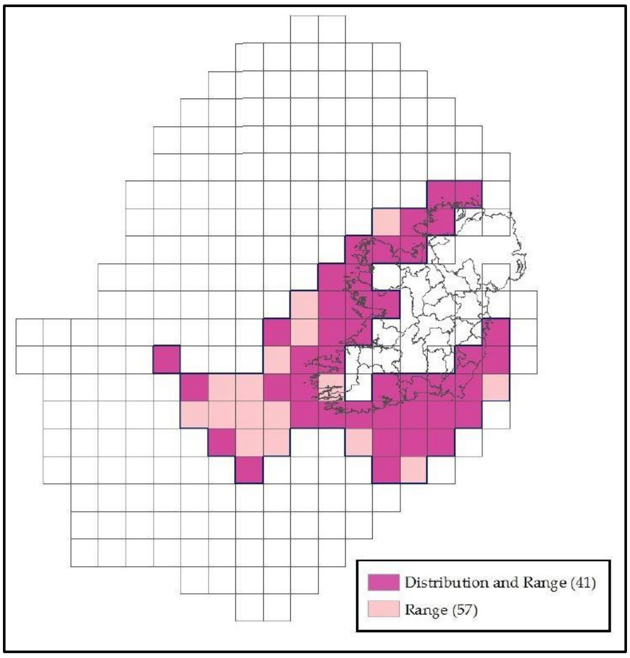
	August-September (see above). The relationship between such counts and breeding population size is poorly understood however but the data do provide an indication of the distribution of Grey seals hauling out around the coastline in the summer months. Harbour seal Since the mid-1990s when the EC Habitats Directive came into force the national distribution and minimum population size of Harbour seal in Ireland has been estimated on three occasions. In all cases, in accordance with best international practice across the range of habitats occupied by the species, the required field survey work has been carried out during the annual moult season (Aug-Sept) when the greatest proportion of the population is likely to be ashore and available for counting. Subsequent image analysis, spatial analysis and numerical analysis and reporting have been undertaken as desk-based tasks. Following the first comprehensive nationwide assessments in 2003 and 2011-12 using aerial thermal-imaging technology, a near-identical follow-up survey of the entire coastline of Ireland was carried out in two parts in August 2017 and August 2018 using updated state-of-the-art technology. This yielded the current estimate of minimum population size and an updated picture of the species' distribution around haul-out sites given below. A relevant assumption here is that no significant change in seal haul-out behaviour or regional distribution occurred between the two successive survey legs in 2017 and 2018, thus the final distribution data should be interpreted with a level of caution. Evidence from annual site-based monitoring in Ireland by the National Parks & Wildlife Service and a range of international studies suggests that the precise position and proportion of Harbour seals available for counting can be variable depending on the site, environmental covariates and ecological factors, for example. Since there are no statistical data available for the latter parameter across the broad range of Irish sites surveyed in 2017-2018, the current spatial representation remains the appropriate descriptor of haul-out/resting site distribution within the wider natural range.
Assessment Result	**Marine reptiles** Leatherback turtle Range estimate (surface area) = 142,500 km^2

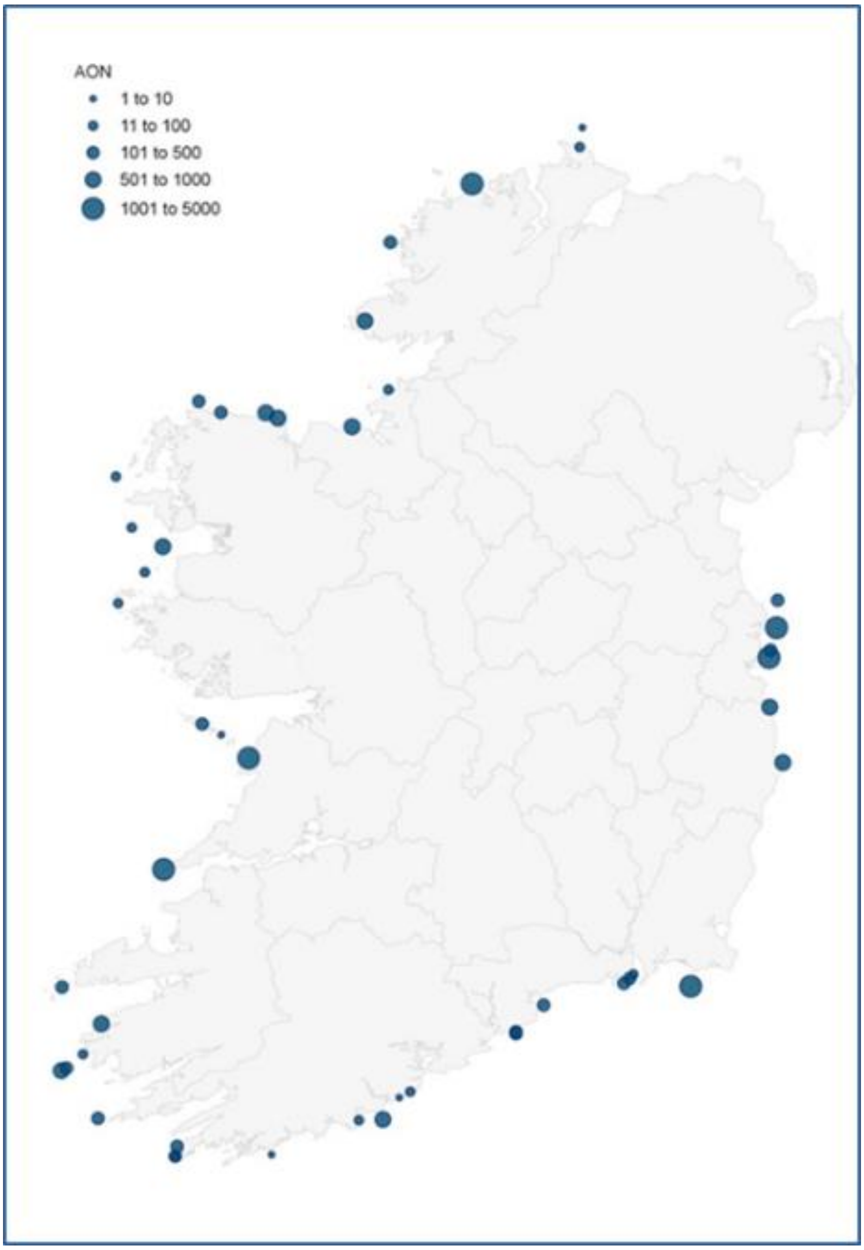
	Records of the Leatherback turtle are sporadic and scattered around Irish waters; there is no information available to allow us to calculate changes in the range of this species and no trend can be estimated. Despite extensive offshore survey work in recent years (e.g. the ObSERVE project covered *ca*. 300,000 km^2 in 2015 and ca. 340,000 km^2 in 2016) almost no data on Leatherback distribution were acquired. We still have much to learn about the migration patterns and seasonal behaviour of Leatherbacks in the Northeast Atlantic. For now, a definitive statement cannot be made on Favourable Reference Range. The map shows all known records from 2000 to 2018, i.e. 198 records, covering 41 x 50km grid cells. The distribution records included in the map come primarily from the TURTLE database – a collation of records from Ireland and the UK managed by Marine Environment Monitoring – with some additional records from Cape Clear Observatory collated by Dr Tom Doyle of University College Cork. The quality of the data is considered to be good as the Leatherback turtle is a distinctive species and the data comes from reliable sources. **Marine birds** Black-legged kittiwake Breeding distribution (2015 – 2018): 65 x 10km grid squares Short-term trend in distribution (1998/2002 - 2015/2018): + 38% Long-term trend in distribution (1988/91 - 2015/2018): + 23% The at-sea distribution of this species is extensive throughout Irish waters and in the MSFD assessment area. Kittiwake breeding distribution around Ireland has been shown to be increasing significantly both in the short-term and long-term. Northern fulmar Breeding distribution (2015 – 2018): 140 x 10km grid squares Short-term trend in distribution (1998/2002 – 2015/2018): + 14% Long-term trend in distribution (1988/91 - 2015/2018): + 4% The at-sea distribution of this species is extensive throughout Irish waters and in the MSFD assessment area. Breeding distribution around Ireland has been shown to be increasing at a modest rate both in the short-term and long-term. Northern gannet Breeding distribution (2015 – 2018): 6 x 10km grid squares Short-term trend in distribution (2004 - 2014): + 20%

	Long-term trend in distribution (1984/85 - 2013/2014): + 50% The at-sea distribution of this species is extensive throughout Irish waters and in the MSFD assessment area. While the number of breeding colonies is comparatively small relative to other cliff-nesting or island-nesting marine birds, the breeding distribution around Ireland has been shown to be increasing significantly both in the short-term and long-term. **Marine mammals** Bottlenose dolphin The most recent estimate of Range for this toothed cetacean species is as follows, drawn from the latest HD assessment (NPWS, 2019): 620,000km^2 The range map provided in that assessment consists of the species' recorded and likely predominant natural range based on comparatively recent data (2001-2018) and expert judgement, and is partly derived from all sighting records available to NPWS in 2018. It consisted of a block of contiguous 50km x 50km grid cells distributed in Irish marine waters including the Irish Sea and coastal areas, and includes the relevant assessment area under the MSFD. The range value derived from the map referred to above is considered to be a revised baseline for this species and has been set as the Favourable Reference Range under the Habitats Directive. This surface area calculation is slightly greater than that reported by NPWS in 2013. Against this background, Ireland's **threshold value for Good Environmental Status** under this criterion is proposed as follows: Equivalent to the current Favourable Reference Range Harbour porpoise The most recent estimate of Range for this small toothed cetacean species is as follows, drawn from the latest HD assessment (NPWS, 2019): 400,000km^2 The range map provided in that assessment consists of the species' recorded and likely predominant natural range based on comparatively recent data (2001-2018) and expert judgement, and is partly derived from all sighting records available to NPWS in 2018. It consisted of a block of contiguous 50km x 50km grid cells distributed

	in Irish marine waters including the Irish Sea and coastal areas, and includes the relevant assessment area under the MSFD. The range value derived from the map referred to above is considered to be a revised baseline for this species and has been set as the Favourable Reference Range under the Habitats Directive. This surface area calculation is slightly greater than that reported by NPWS in 2013. Against this background, Ireland's **threshold value for Good Environmental Status** under this criterion is proposed as follows: Equivalent to the current Favourable Reference Range Grey seal The most recent estimate of Range for this seal species is as follows, drawn from the latest HD assessment (NPWS, 2019): 264,900km^2 The current evidence from annual pup production surveys and also ancillary data collected outside the breeding season indicates that the distributional range of this species may be increasing and doing so since at least the mid-1990s when more regular and standardised monitoring effort began around Ireland's coast and offshore islands. This effort has been stepped up significantly since 2004. The distribution map presented for this species by NPWS (2019) represents the approximate location of terrestrial and intertidal haul-out sites at which Grey seals were recorded during targeted surveillance between 2017 and 2018. The surveillance programme that contributed data to that projection is reported on in Morris & Duck (2019). The data highlight a very widespread distribution by Grey seals around the entire coastline of Ireland including many offshore islands and skerries. It should be noted that the described distribution may not fully represent the localised use of certain caves for resting or breeding (e.g., along parts of the south and west coasts), since the relevant data collection was focused on the annual moult season for Harbour seals and pre-breeding period for Grey seals (August-September). Nevertheless, the map drawn for this species in NPWS (2019) provides a good representation of its principal observed distribution and range around the Irish coastline. The range value referred to above is considered to be a revised baseline for this species and has been set as the Favourable

	Reference Range under the Habitats Directive. This surface area calculation is slightly lower than that reported by NPWS in 2013. Against this background, Ireland's **threshold value for Good Environmental Status** under this criterion is proposed as follows: Equivalent to the current Favourable Reference Range Harbour seal The most recent estimate of Range for this seal species is as follows, drawn from the latest HD assessment (NPWS, 2019): 176,300km^2. The current evidence indicates that the distributional range of this species is relatively stable and may be increasing since the early 2000's when more comprehensive monitoring effort began around Ireland's coast. This effort has been stepped up significantly since 2009. A national programme of annual site-based monitoring by NPWS, which began in 2009 and covers key regional colonies and several Special Areas of Conservation, also indicates comparative stability or growth in the numbers and locations of Harbour seals found ashore during the moult season. The distribution map presented for this species by NPWS (2019) represents the approximate location of terrestrial and intertidal haul-out sites at which Harbour seals were recorded during targeted surveillance between 2017 and 2018. The surveillance programme that contributed data to this projection is reported on in Morris & Duck (2019). The data highlight a widespread distribution by Harbour seals around the entire coastline of Ireland including skerries and some offshore islands (e.g., the Aran Islands) but with more limited occurrence in the western Irish Sea and along the south coast. It should be noted that the described distribution may not fully represent the localised use of certain sites for resting or breeding, since primary surveillance effort is focused on the annual moult season (August-September). Nevertheless, the map drawn for this species in NPWS (2019) provides a good representation of its principal observed distribution and range around the Irish coastline. The range value referred to above is considered to be a revised baseline for this species and has been set as the Favourable Reference Range under the Habitats Directive. This surface area calculation is slightly lower than that reported by NPWS in 2013.

	Against this background, Ireland's **threshold value for Good Environmental Status** under this criterion is proposed as follows: Equivalent to the current Favourable Reference Range
Results (figures & tables)	**Marine reptiles** Leatherback turtle  **Figure 1.** Observed coastal and marine Distribution and Range of Leatherback turtle in Ireland's MSFD and Habitats Directive assessment area. The map covers all known records from 2000 to 2018 (n=198) collectively displayed as coloured 50km grid cells (NPWS, 2019).

	Marine birds Black-legged kittiwake  **Figure 2.** Breeding Kittiwake abundance and distribution for the period 2015 – 2018. Figures are based on apparently occupied nests (AONs) (NPWS; Cummins et al., 2019).

Northern fulmar

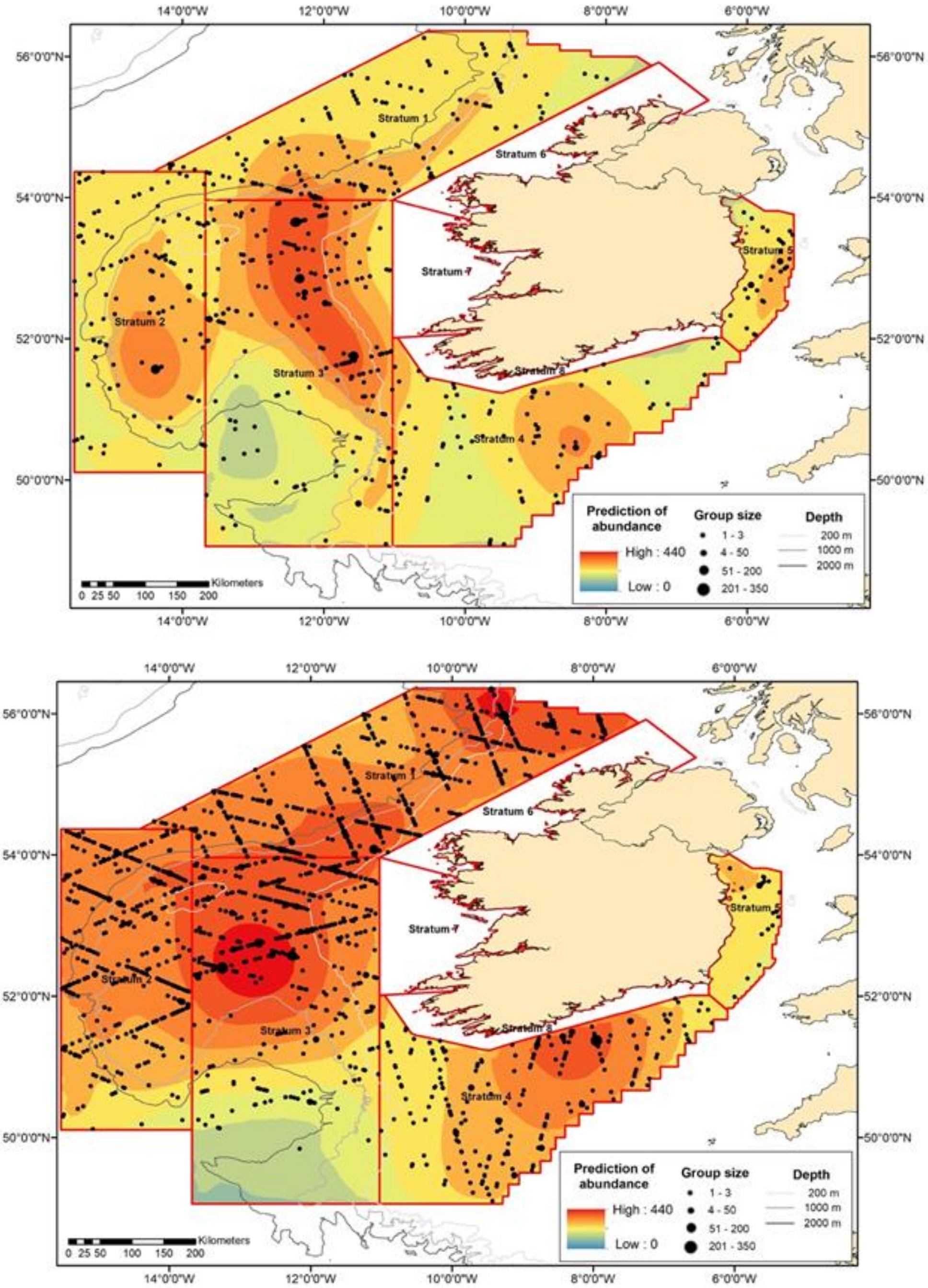


Figure 3. Predicted summer distribution (top), winter distribution (bottom), relative densities and observed group sizes of Fulmar in Irish waters, modelled from aerial survey data gathered in 2015 and 2016 (from Ireland's ObSERVE Programme; Rogan et al., 2018).

Northern gannet

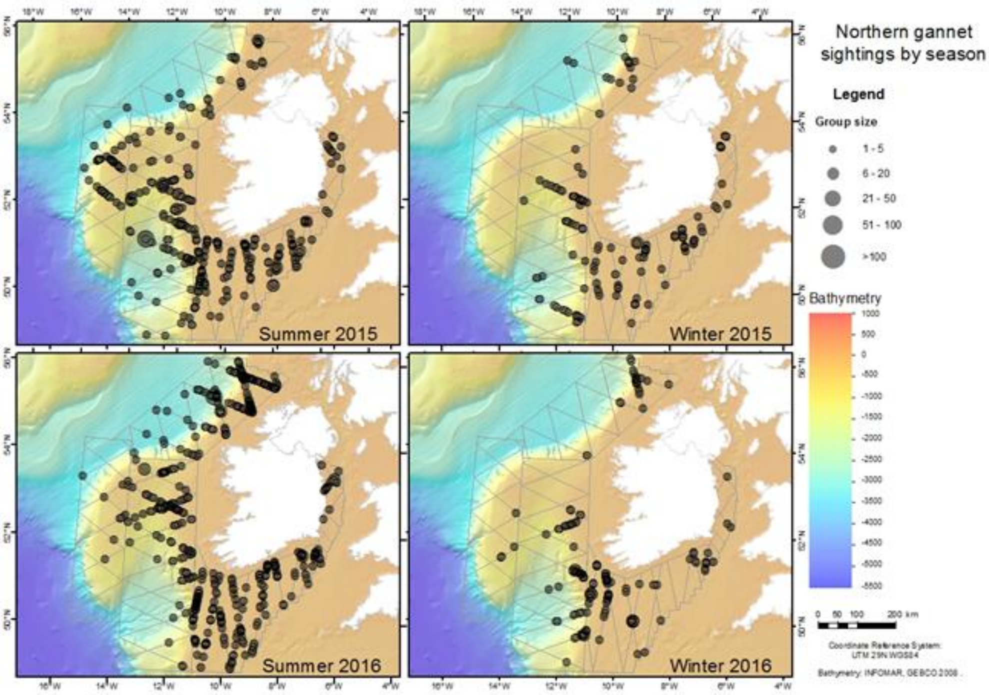


Figure 4. Distribution of Gannet sightings (black circles) from aerial surveys carried out in the summer (left) and winter seasons (right), 2015 & 2016. Grey lines indicate the survey track-lines. Circles are proportional to the number of birds recorded in each sighting (from Ireland's ObSERVE Programme; Rogan et al., 2018).

Marine mammals

Bottlenose dolphin

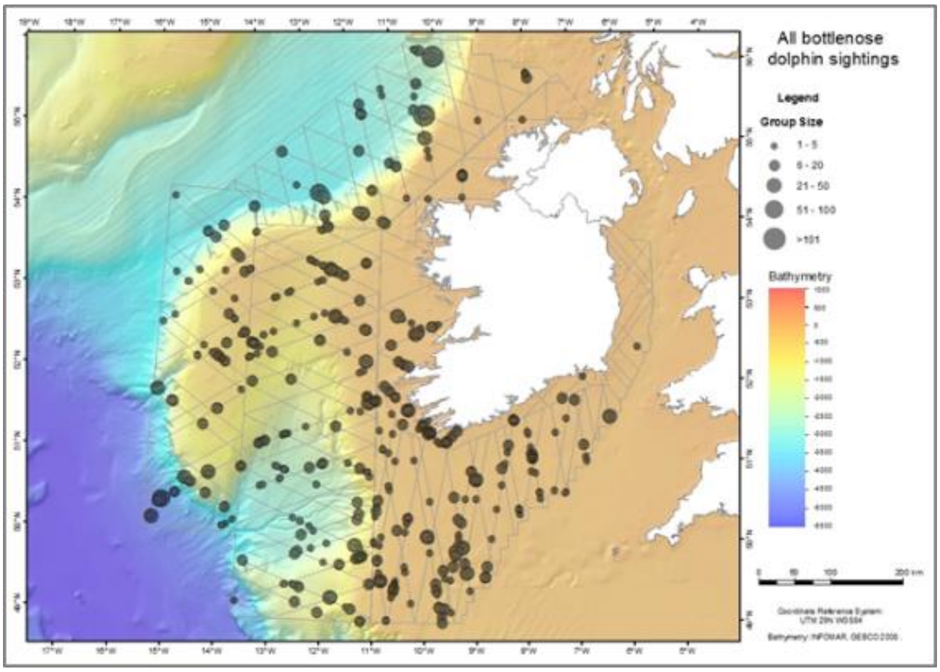


Figure 5. Observed coastal and marine Distribution and Range and group sizes of Bottlenose dolphin within Ireland's EEZ, covering 482 aerial sighting records from May 2015 to March 2017 (summer and

winter only) (from Ireland's ObSERVE Programme; Rogan et al., 2018).

Harbour porpoise

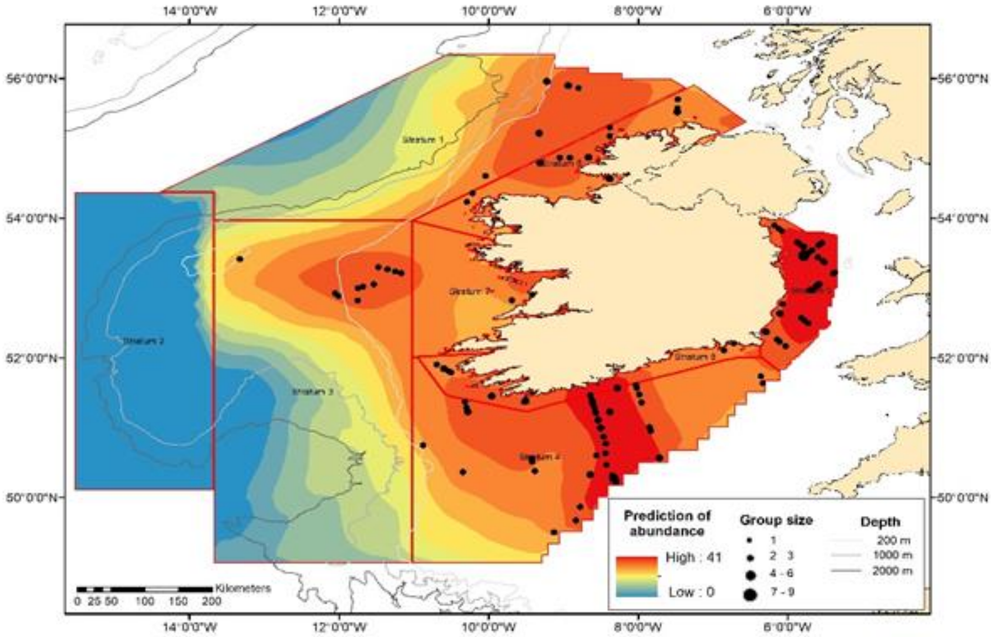


Figure 6. Predicted summer distribution and relative density of Harbour porpoises in Irish waters in the summer of 2016, modelled from high quality aerial survey data (from Ireland's ObSERVE Programme; Rogan et al., 2018).

Grey seal & Harbour seal

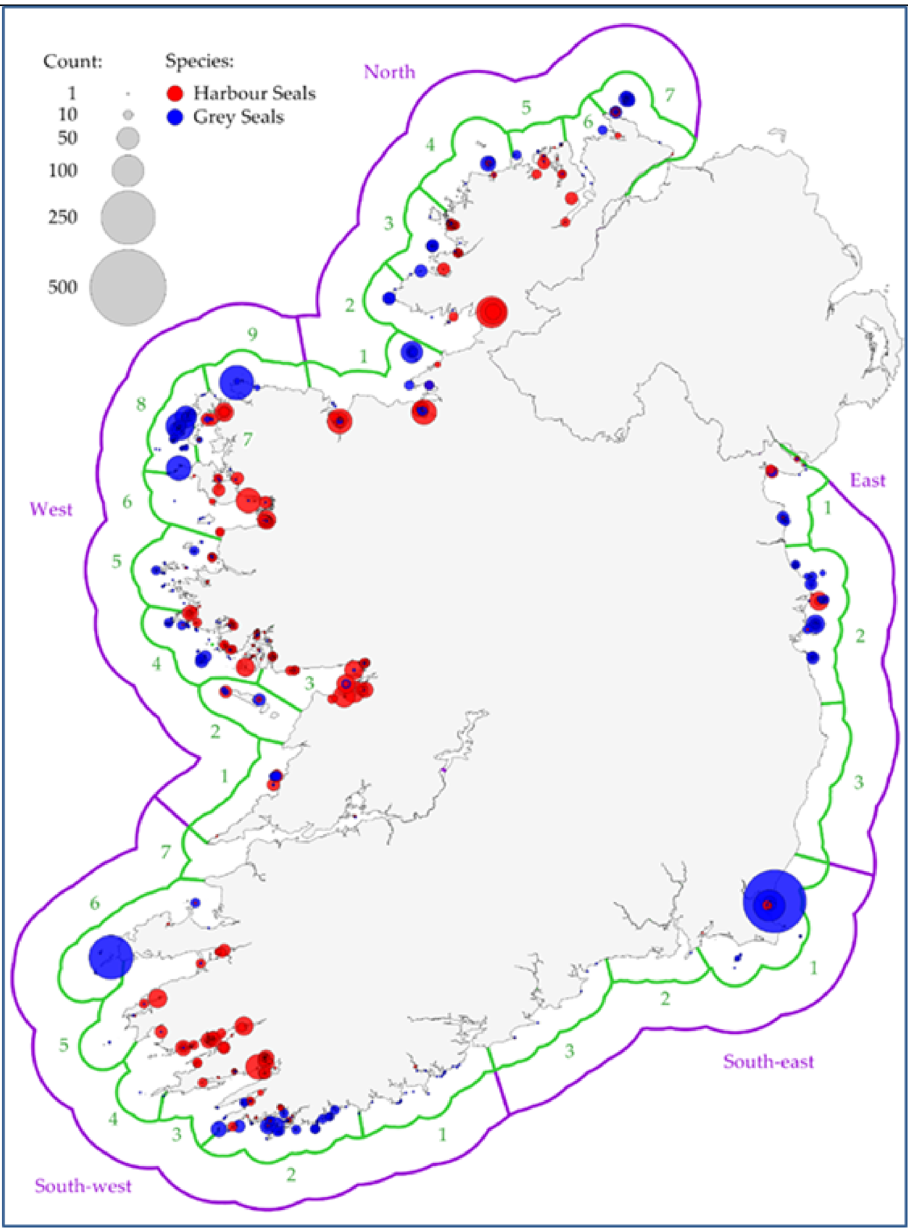
<table>
<tr><td></td><td>

Figure 7. Numbers and distribution of Grey seals (blue circles) and Harbour seals (red circles) recorded within labelled sub-regions in Ireland in August 2017 & August 2018. The displayed symbol size represents the recorded group size with count guides given in the Legend (top left) (NPWS; Morris & Duck, 2019).</td></tr>
<tr><td>Knowledge gaps</td><td>Targeted and collaborative international research is required on (a) the population ecology of Leatherback turtles in the North Atlantic and (b) the extent, severity and risk of impact from human activities on populations of this species.
The population dynamics of Black-legged kittiwake in the North-East Atlantic and the extent, severity and risk of impact from human activities on its populations, should be investigated further.</td></tr>
</table>

	• An improvement in the understanding of Harbour seal seasonal distribution and range at sea around Ireland is required in order to better inform the evaluation and assessment of this species' range and the risk to its population(s) from a range of environmental and industrial pressures.
	Assessment Data
Data Sources	Cummins, S., Lauder, C., Lauder, A. & Tierney, T. D. (2019) The Status of Ireland's Breeding Seabirds: Birds Directive Article 12 Reporting 2013 – 2018. Irish Wildlife Manuals, No. 114. National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht, Ireland. 89pp. Doyle, T. K. (2007) Leatherback Sea Turtles (Dermochelys coriacea) in Irish waters. Irish Wildlife Manuals No. 32. National Parks and Wildlife Service, Department of the Environment, Heritage and Local Government, Dublin, Ireland. Doyle, T., Houghton, J.D.R., Ó Súilleabháin, P.F., Hobson, V., Marnell, F., Davenport, J. & Hays, G.C. (2008) Leatherback turtles satellite-tagged in European waters. Endangered Species Research 4:23-31. Morris, C.D. & Duck, C.D. (2019) Aerial thermal imaging survey of seals in Ireland, 2017-2018. Report (unpublished) for the National Parks and Wildlife Service of the Department of Culture, Heritage and the Gaeltacht, Dublin. NPWS. (2019) The Status of EU Protected Habitats and Species in Ireland. Volume 1: Summary Overview. Unpublished NPWS report. Edited by: Deirdre Lynn and Fionnuala O'Neill. 99pp. Rogan, E., Breen, P., Mackey, M., Cañadas, A., Scheidat, M., Geelhoed, S. & Jessopp, M. (2018) Aerial surveys of cetaceans and seabirds in Irish waters: Occurrence, distribution and abundance in 2015-2017. Department of Communications, Climate Action & Environment and National Parks and Wildlife Service (NPWS), Department of Culture, Heritage and the Gaeltacht, Dublin, Ireland. 297pp. Walsh, P.M., Halley, D.J., Harris, M.P., del Nevo, A., Sim, I.M.W. & Tasker, M.L. (1995) Seabird monitoring handbook for Britain and

	Ireland: a compilation of methods for survey and monitoring of breeding seabirds. Peterborough, JNCC/RSPB/ITE/Seabird Group.			
Data Locations (URL)	https://www.npws.ie/maps-and-data https://www.npws.ie/publications https://www.npws.ie/marine/marine-reports https://www.dccae.gov.ie/observe			
Data Time Line	Start Date:	2009	Start Date:	2018
Point of Contact	Oliver Ó Cadhla, Marine Environment section, DHPLG			
Email	oliver.ocadhla@housing.gov.ie			

D1 C5

Descriptor 1 Biodiversity	**Assessment Sheet: Reptiles, birds and mammals** **Criterion D1C5** **Habitat extent and condition for the species**
Key message	Since 2009 populations of Irish-breeding marine vertebrate species have been monitored relatively consistently using standard international practice. In some cases, (e.g. certain marine birds, small cetaceans and seals) this monitoring followed earlier comprehensive baseline research and surveillance. Key evidence on populations' habitat use to 2018 across a range of eight representative species supports the finding that the majority are maintaining a favourable conservation condition and are therefore achieving Good Environmental Status (GES). This result is informed by Birds Directive and Habitats Directive assessments undertaken and reported by Ireland in 2019. Overall for this criterion GES is being achieved for a total of six ecosystem elements. However, the environmental status of Leatherback turtle, which does not breed in Ireland, and of Black-legged kittiwake are currently unknown. For some species, threshold values for the habitat extent & condition criterion have been considered and are proposed for operation at a subdivision (i.e. national) level. [Note: While three key, comparatively well-studied species of marine bird and four species of marine mammal have been included in this assessment to represent important "Criteria elements" of marine biological diversity, there are of course many more species within each group occurring and/or breeding in Ireland's marine area. In time additional representative species may be added to future assessments of biological diversity as the scientific knowledge base, data quality and understanding of their ecology and role in our marine ecosystems improves.]
Background	Ireland competed an Initial Assessment of its maritime area under the MSFD in October 2013. At the time, the assessment under biologically-orientated descriptors was largely restricted to (a) fisheries–related data for species and (b) broad-scale mapping data for habitats. In relation to biological diversity and associated environmental targets and indicators under Descriptor 1 the 2013 assessment concluded that more work was required to develop and coordinate parameters,

	elements and methods that would contribute to a more effective evaluation of Ireland's marine environmental status. Since then Ireland's approach, data collection and methods of assessment for this Descriptor under MSFD Articles 8, 9 and 10 have progressed considerably. This updated assessment considers elements of marine fauna that represent essential features and characteristics of biological diversity in Ireland's marine environment. It summarises (i) current knowledge of their environmental status, (ii)environmental targets for each faunal element that Ireland has established in order to achieve/maintain Good Environmental Status (GES) and, where possible, (iii) environmental threshold values per element that are proposed in order to secure and support the maintenance of GES in the long term. With regard to the assessment of habitat extent and condition for the species (Criterion D1C5), this work was conducted using "Criteria elements", i.e. a set of species considered to be representative of elements of the marine ecosystem, and for which national monitoring/assessment programmes have been established, namely: **a) Marine reptiles:** Leatherback turtle *Dermochelys coriacea* The most frequently recorded turtle species in Irish waters and the only turtle considered to use Irish waters as part of its natural range, mainly occurring in summer-autumn. Listed in Annex IV of the EC Habitats Directive (Directive 1992/EEC) as a species in need of strict protection; **b) Marine birds:** Black-legged kittiwake *Rissa tridactyla*, Northern fulmar *Fulmarus glacialis*, Northern gannet *Morus bassanus* Protected under the Birds Directive (Directive 2009/147/EC), all three are fully marine species that nest and breed in Ireland on islands and cliff-bound terrain that is less vulnerable to human interference and mammalian predators than the breeding habitat of other seabird species. **c) Marine mammals:** Bottlenose dolphin *Tursiops truncatus*, Harbour porpoise *Phocoena phocoena*, Grey seal *Halichoerus grypus*, Harbour seal *Phoca vitulina* All four species occur in coastal and offshore waters of Ireland's maritime area and are listed in Annex II of the Habitats Directive as species whose conservation requires the designation of special areas of conservation. Both cetacean species are also listed in Annex IV.

Objective	The overriding objective is that Ireland's newly established environmental targets for MSFD Descriptor 1 (Biological diversity) are achieved. With regard to habitat extent and condition for vertebrate species (excluding non-commercial fish species) the applicable target is: **Environmental Target D1T5: The habitat for the species has the necessary extent and condition to support the different stages in the life history of the species.**
Drivers (Activities)	Populations of larger marine vertebrate species, such as reptiles, birds and mammals, may be subject to adverse impacts arising from local and/or regional anthropogenic drivers (activities) throughout their North Atlantic range and in Irish coastal/offshore waters. The main human activities believed to be interacting as pressure mediators on the natural habitat of Ireland's marine vertebrate populations involve commercial vessel-based or shipping-based activities that occur primarily on a local or regional scale and/or on a persistent or intermittent basis (e.g., commercial fisheries or geophysical seismic exploration). Foremost of these anthropogenic drivers in an Irish context is commercial fishing at sea by Irish-registered vessels and other European/international fleets operating within Ireland's Exclusive Economic Zone (EEZ), both through the removal of food biomass and potential prey resources from the marine environment and also through incidental captures (by-catch) or injurious entanglement of individual animals in a range of fishing gear types. In relation to seal by-catch the most significant fishing métiers involved in Ireland and the UK appear to be static nets (i.e., gill nets, tangle nets or trammel nets) targeting demersal fish and larger crustaceans, while for cetaceans and marine birds, pelagic trawlers and demersal trawlers may also be involved in this interaction. Less persistent but nevertheless periodically intensive geophysical surveying of the seafloor and underlying structure (e.g., for oil/gas deposits) may also introduce a significant environmental pressure on the natural habitat of mammal populations at local and/or regional scales, mainly through potential acoustic injury or disturbance, spatial and/or temporal displacement or potential impacts on the natural availability of prey, for example.

	Coastal tourism and other recreational/industrial activities around breeding or resting sites (e.g., shellfish gathering, intertidal aquaculture, coastal walking, wildlife watching) may also introduce environmental pressures, such as disturbance, for marine birds and mammals. According to current evidence on a national scale in Ireland these drivers may not be reducing overall habitat extent and condition for populations of representative vertebrate elements of the ecosystem. They may however act to impair natural habitat use in the absence of potential stressors, and further scientific investigation or improved management of such activities may be necessary via a risk-based prioritisation approach.
Pressures	The predominant pressures identified in Commission Directive 2017/845 that are currently of known and/or potential significance to the extent and condition of natural habitats of vertebrate species in Ireland's MSFD area, are considered to be: • Loss of, or change to, natural biological communities due to cultivation of animal or plant species • Disturbance of species due to human presence • Extraction of, or mortality/injury to, wild species (by commercial fishing, and/or recreational fishing and/or other activities) • Physical disturbance to the seabed (temporary or reversible) • Input of nutrients (diffuse and/or point sources, atmospheric deposition) • Input of organic matter (diffuse sources and/or point sources) • Input of other substances (e.g. synthetic/non-synthetic substances, diffuse and/or point sources, acute events) • Input of litter (solid waste matter, including micro-sized litter) • Input of anthropogenic sound (impulsive, continuous) Among the items listed above the most significant anthropogenic pressure on the natural habitats of vertebrate populations in Ireland's maritime area is the extraction of fish and shellfish biomass (both

	commercial and non-commercial species) and associated disturbance introduced by human fishing activity. This occurs in the water column (e.g. pelagic trawling) and also close to or on the sea-floor (e.g. demersal trawling or set-nets, benthic dredging). It is prevalent all year round and in much of Ireland's EEZ, and is driven by a wide range of international, European Union and national fishing fleets that use diverse gear types, from jigging and long-lining to mobile nets and stationary pots. Fishing-derived pressure is, to a large extent, measurable and it is therefore supported by scientific evidence, monitoring and assessment, as well as EU and international regulation and management (e.g. through the EU Common Fisheries Policy). There are also significant human pressures that can carry with them significant adverse impacts on populations of particular species and/or their habitats, e.g. through the disturbance or deterioration of species' breeding or foraging habitats. Some of these pressures relate to land-based human activities and industries, and are covered by other policy and legal provisions designed to protect the environment, for which there are assessment and reporting obligations (e.g. Water Framework Directive, Nitrates Directive, Common Agricultural Policy). For the natural habitats of larger marine vertebrate species, along with the potential pressures introduced by biomass removal, biological competition for prey resources and incidental mortality, the introduction of anthropogenic sound, disturbance of species and input of litter and other pollutants are considered to present the greatest secondary pressures after commercial fisheries extraction.
State	**Marine reptiles** Leatherback turtle With regard to the primary criteria and established Environmental Targets under Descriptor 1, there are currently significant limitations associated with assessing and reporting on the status of this 'sea turtle' species. Little is known about the habitat requirements of the Leatherback turtle in North Atlantic waters. It is clear that Leatherbacks migrate through Irish waters each year and while most records are from strandings or sightings near to the coast, they are also encountered off-shore. The purpose of this migration appears to be solely related to food availability. It is likely that some offshore areas are more important than others; that some areas are important foraging grounds at certain times with significant concentrations of jellyfish whereas other areas are not. These areas are also likely to vary

	between years. However, it is not possible to identify or characterise these areas at this time. While some recent progress has been made in data acquisition from Ireland and adjacent waters, the species' population ecology, range, habitat use and characteristics, and the pressures/impacts it faces in Irish waters and the wider North-East Atlantic, are not well understood. The overall environmental status of this species in Irish waters, and in relation to its habitat extent and condition, is assessed as Unknown. **Marine birds** Black-legged kittiwake Kittiwake breeding distribution around Ireland has been shown to be increasing significantly both in the short-term and long-term, and the at-sea distribution of this species is extensive throughout Irish waters and in the MSFD assessment area. Yet significant questions remain concerning the extent and quality of the species' natural habitat, among other ecological parameters. There is evidence of significant population declines at a range of breeding colonies (Cummins et al., 2019), partly driven by acute short-term population declines at some of Ireland's most important colonies. Thus an underlying question also remains concerning Kittiwake productivity and reproductive success. While causes of the declines are unclear at present, some examples of potential factors involved are changes in food availability or prey distribution, or climate-related influences. In consideration of the Environmental Target described above, given the available scientific evidence from Ireland and uncertainty as to the causes of declining breeding population numbers, it is concluded that the environmental status of habitat extent and condition for this species is currently Unknown. Northern fulmar This distinctive large petrel species is a common sight around the Irish coast, particularly in the northwest, west and south of the country where it nests on steep vertical slopes and broad ledges near the top of vegetated cliffs. Fulmar breeding distribution was once mainly restricted to the Arctic but since the 1700s its range has expanded southwards from Iceland to the coasts of Britain, Ireland and France. During the breeding season nesting Fulmars are widely dispersed along our coasts as illustrated by the most recent national seabird census (2015 – 2018) which recorded the species breeding at over 120 sites across Ireland. This distribution of Fulmars around the coast has

	been shown to be increasing at a modest rate both in the short-term and long-term. The at-sea distribution of this species is also extensive throughout Irish waters and in the MSFD assessment area. In consideration of the Environmental Target described above, given that the available scientific evidence from Ireland shows an increasing breeding distribution, an extensive distributional range at sea and stable population figures nationally, it is concluded that GES has been achieved for the habitat extent and condition for this species. Northern gannet Gannets breed on isolated sea stacks, small uninhabited islands and on occasion, inaccessible cliffs on large islands (often inhabited) with nests usually on ledges of cliffs above the splash zone and sometimes on flat tops or on shallow soil. Gannets are site faithful with most colonies occupied for decades or longer. Outside of the breeding season they spend most of their lives in the open sea. The Irish population of this species has increased by an estimated 33% over a 10-year period to reach 47,946 pairs in 2014, and its breeding distribution has expended accordingly (up 20% since 2004, up 50% since 1984/85). Regional populations at the traditional colonies have increased across the board such that, in historical terms, the population has increased by 121% since Operation Seafarer in 1969-70. In consideration of the Environmental Target described above, given that the available scientific evidence from Ireland shows an increasing breeding distribution, an extensive distributional range at sea and increasing population figures nationally, it is concluded that GES has been achieved for the habitat extent and condition for this species. **Marine mammals** Bottlenose dolphin Use of the HD Range descriptor and Range surface area calculation as proxies for habitat and habitat area are judged appropriate for this wide-ranging coastal and offshore species. The distribution and natural range of Bottlenose dolphins in Irish waters, and marine waters covered by the Directive, is a small component of the species' wider North Atlantic range, while ongoing evidence from repeated high quality surveys continues to confirm the species' occurrence in Irish waters in all seasons. Sighting records from ongoing dedicated surveillance effort in Irish waters provide no evidence of a decline in distribution/range in the recent past. Therefore, the short-term trend for Range is considered to

	be stable. The long-term trend over the period 1994-2018 is considered to be uncertain for this species (NPWS, 2019) due to limited data availability prior to 1999-2000. Since there is no evidence of a decline in distributional range since the Directive came into force the current range (i.e. 620,000km^2) is set as the Favourable Reference Range (NPWS, 2019). Accordingly, in HD terms the short-term trend for Habitat and Range, as a proxy for habitat, is considered to be stable. All indications are that sufficient high quality habitat is available to support the maintenance and/or expansion of the species in Ireland into the future. In consideration of the Environmental Target described above, given that the available scientific evidence from Ireland shows a widespread distribution and no evidence of a decline in range or distribution nationally, it is concluded that GES has been achieved for the habitat extent and condition for this species. Harbour porpoise Use of the HD Range descriptor and Range surface area calculation as proxies for habitat and habitat area are judged appropriate for this wide-ranging coastal and offshore species. The distribution and natural range of Harbour porpoises in Irish waters, and marine waters covered by the Directive, is a small component of the species' wider North Atlantic range, while ongoing evidence from repeated high quality surveys continues to confirm the species' occurrence in Irish waters in all seasons. Sighting records from ongoing dedicated surveillance effort in Irish waters provide no evidence of a decline in distribution/range in the recent past. Therefore, the short-term trend for Range is considered to be stable. The long-term trend over the period 1994-2018 is considered to be uncertain for this species (NPWS, 2019) due to limited data availability prior to 1999-2000. Since there is no evidence of a decline in distributional range since the Directive came into force the current range (i.e. 400,000km^2) is set as the Favourable Reference Range (NPWS, 2019). Accordingly, in HD terms the short-term trend for Habitat and Range, as a proxy for habitat, is considered to be stable. All indications are that sufficient high quality habitat is available to support the maintenance and/or expansion of the species in Ireland into the future.

	In consideration of the Environmental Target described above, given that the available scientific evidence from Ireland shows a widespread distribution and no evidence of a decline in range or distribution nationally, it is concluded that GES has been achieved for the habitat extent and condition for this species. Grey seal Use of the HD Range descriptor and Range surface area calculation as proxies for habitat and habitat area are judged appropriate for this wide-ranging coastal and offshore species. As a proxy for its Habitat, the species' Range map provided in the recent NPWS HD assessment (NPWS, 2019) covers a surface area measuring 264,900km^2 that is distributed in Irish coastal and marine waters up to 1,000m deep including shallow coastal bays and estuaries and excluding the eastern margin of the Rockall Bank. Over the last two decades records of the occurrence of this species around Ireland have increased considerably in parallel with more active surveillance and assessment and continued seal population monitoring since 2005-06. Knowledge of current Grey seal habitat in Ireland is somewhat concentrated on records gathered at haul-out sites since the mid-1990s including during the annual moult, breeding and summer seasons. This key information, along with inshore/offshore range data for Ireland, indicate that a decline in Grey seal habitat within Irish waters is unlikely to have occurred in the recent past; therefore, accordingly in HD terms the short-term trend for Habitat and Range, as a proxy for habitat, is considered to be stable. All indications are that sufficient high quality habitat is available to support the maintenance and/or expansion of the species in Ireland into the future. In consideration of the Environmental Target described above, given that the available scientific evidence from Ireland shows an increased distribution and increasing population figures nationally, it is concluded that GES has been achieved for the habitat extent and condition for this species. Harbour seal Use of the HD Range descriptor and Range surface area calculation as proxies for habitat and habitat area are judged appropriate for this wide-ranging coastal and offshore species. As a proxy for its habitat, the species' Range map provided in the recent NPWS HD assessment (NPWS, 2019) covers a surface area measuring 176,300km^2 that is distributed in Irish coastal and marine waters up to 200m deep,

	including shallow coastal bays and estuaries and excluding the offshore Porcupine Bank. Prior to the early 2000s there was limited information available concerning the population status, distribution and habitat use of Harbour seals around Ireland and the extent to which these animals travelled within Irish and neighbouring waters. From 2004 the results of research and monitoring involving key Irish breeding and non-breeding haul-out sites began to emerge. Increased emphasis was placed on completion of (i) a national evaluation of Harbour seal distribution and population size, and (ii) the first in-depth regional studies of Harbour seal ecology and movement within Irish waters. Consequently, with regard to this species and its Habitat parameter under the HD it is considered that the years 2007-2018 represent an appropriate period for the evaluation of short-term trends. Current information broadly indicates that Harbour seals of all ages may move freely about their diverse aquatic and intertidal habitat and, based on the species' population size and distribution data available and knowledge of its population ecology, all indications are that sufficient high quality habitat is available to support the maintenance and/or expansion of the species in Ireland into the future. In consideration of the Environmental Target described above, given that the available scientific evidence from Ireland shows an increased distribution and stable or increasing population figures nationally, it is concluded that GES has been achieved for the habitat extent and condition for this species.
Impact	The parameters and characteristics specified in Commission Directive 2017/845 that are likely to be impacted upon by loss of biological diversity can be divided in to species impacts, habitat impacts and ecosystem/food-web impacts. The species impacts are considered to operate via changes to: distribution and/or biomass; size, age and sex structure, reproductive potential, survival and mortality/injury; behaviour including movement and migration; habitat for the species (extent, suitability); and species composition within groups of species. The main habitat impacts are considered to operate via changes to: species composition, abundance and/ or biomass (spatial and temporal variation); size and age structure of species; and physical, hydrological and chemical characteristics. The main ecosystem impacts are considered to operate via changes

	to: links between habitats and species of marine birds, mammals, reptiles, fish and cephalopods; pelagic-benthic community structure; and productivity. The effects and consequences of the predominant pressures on biological diversity during the overall assessment period (2013-2018) and prior to that, if relevant, have been considered in the current assessment. For the marine vertebrates outlined above that have been included as criteria elements (i.e. eight reptile, bird and mammal species) this is primarily informed by Ireland's surveillance, assessments and reporting undertaken to meet requirements under the EU Habitats Directive and Birds Directive. In relation to the predominant pressures identified as known and/or of potential significance in Ireland's marine area, based on scientific evidence and knowledge of current human activity there are few such pressures that are considered to operate with potential population-level effects or consequences for the habitat extent and condition for species' populations in Ireland. Among them, however, are: • Disturbance of species due to human presence Certain species that avoid interaction with humans or animal predators may be highly vulnerable to human disturbance during times of the year that are critical for their populations and for survival (e.g. during migration, foraging, nesting, breeding or resting phases). Human presence may also mediate additional impacts that cause disturbance to the species' natural history, such as the introduction of problematic predators (e.g. mink at seabird breeding sites), disease or invasive species. • Extraction of, or mortality/injury to, wild species (by commercial fishing, and/or recreational fishing and/or other activities) In addition to the loss of potentially significant food biomass from the marine environment through human extraction, this pressure can also have direct population-level consequences (e.g. regional habitat changes, population displacement) if the level of mortality or injury to wild species is not compensated for by natural factors such as productivity or immigration. • Physical disturbance to the seabed (temporary or reversible) The effect of this pressure, if it acts at a population-relevant scale, may be to deter or displace animals from their natural habitat or reduce foraging opportunities, for example, thereby influencing habitat extent or condition or patterns in the populations' use of such habitat.

	• Input of litter (solid waste matter, including micro-sized litter) A number of vertebrate species appear to be vulnerable to ingestion of plastic and other litter in the marine environment. While active research into the effects of water-borne litter and its ingestion is ongoing, for species such as Leatherback turtle and other surface-feeding vertebrates, the input of litter could result in a substantial deterioration in habitat condition. • Input of anthropogenic sound (impulsive, continuous) Individual species (e.g. some marine mammals) and their populations may also be sensitive to certain types of underwater sound transmitted by human practices in the sea and ocean environment. This is an area under active research in relation to several anthropogenic sound sources and the individual or population-level consequences of disturbance or acoustically-driven injury. Examples of potential impacts include spatial and/or temporal changes in habitat extent or quality, and changes in movement patterns or range driven by displacement due to underwater noise. **Marine reptiles** Leatherback turtle Leatherback turtles that migrate through Irish waters mate and breed in the tropics. The most significant threats and pressures acting on the habitat extent and condition of the North Atlantic population, while at sea, are not well understood but are thought to include incidental capture (i.e. bycatch) in commercial fisheries, anthropogenic noise, marine litter and, potentially, pressures arising as a result of climate change (e.g. changes in sea temperature or ocean circulation systems). However, the degree of impact arising from such pressures is poorly known since the understanding of the population ecology, distribution, migration patterns and habitat use of the species in the North-East Atlantic is very limited. Active international, multi-disciplinary research is required to address such important knowledge gaps. **Marine birds** Black-legged kittiwake Despite some evidence of breeding distribution expansion in Ireland this species' population abundance is shown to be declining and there are some indications that this may be environmental and/or human pressure-related. There are insufficient data at present to determine which pressures are critical in this regard and what the effects and

	consequences for Kittiwake habitats might be. Further active research is required nationally and internationally to improve this picture and to determine the impacts of environmental and/or human pressures on the species' natural habitat and its condition. Northern fulmar Based on the stable population abundance and distribution expansion of Fulmars in Ireland and other monitoring data, there is currently no evidence that any pressures and their effect on this criteria element are causing changes to the extent and condition of Fulmar habitat. With implementation of the landing obligation under the reformed Common Fisheries Policy there might be future repercussions in terms of food availability for Ireland's Fulmar population or some component of it and continued monitoring of this species' population and its distribution and ecology will be necessary in this regard. Northern gannet Based on the increasing population abundance and distribution expansion of Gannets in Ireland and other monitoring data, there is currently no evidence that any pressures and their effect on this criteria element are causing changes to the extent and condition of Gannet habitat. With implementation of the landing obligation under the reformed Common Fisheries Policy there might be future repercussions in terms of food availability for Ireland's Gannet population or some component of it and continued monitoring of this species' population and its distribution and ecology will be necessary in this regard. **Marine mammals** Bottlenose dolphin The habitat of Bottlenose dolphin may be subject to a number of local and/or regional environmental pressures and threats, including in Irish coastal/offshore waters. The main pressures thought to be acting on this species' habitat in Ireland are considered to involve commercial shipping-based or vessel-based activities that occur primarily on a local or regional scale and/or on a temporary or intermittent basis (e.g., impacts arising from geophysical seismic exploration; impacts from local/regional prey removal by fisheries; impacts from local seasonal marine tourism). Some are likely to continue to act as pressures into the future, thereby constituting a potential threat. However, in most cases in Ireland there is little evidence that existing pressures on this species are acting on its habitat at a population level.

	An exception might occur in the case of the resident population of Bottlenose dolphins inhabiting the Shannon Estuary, which is genetically distinct and appears to be ecologically adapted to living in this comparatively discrete coastal region. In this context the monitoring of local dolphin-watching tourism has been an important method of surveillance for significant impacts on the resident population, while regular scientific surveys indicate that the habitat extent and condition within the Shannon Estuary has been relatively stable over the last two decades. While the wider impacts of human activities on Bottlenose dolphin in Irish waters are not well understood, partly due to the species' extensive range and continuing uncertainty regarding population trends and ecology within Ireland's marine area, none of the associated pressures are considered to be of sufficient magnitude to be causing an adverse impact on the habitat extent or condition for its populations in Irish waters. In parallel with continued surveillance and monitoring of this protected species, ongoing pressures and threats to its populations have been and continue to be identified and managed appropriately, thus the status of and prospects for the habitat of this species into the future are favourable. Harbour porpoise The habitat of Harbour porpoise may be subject to a number of local and/or regional environmental pressures and threats, including in Irish coastal/offshore waters. The main pressures thought to be acting on this species' habitat in Ireland are considered to involve commercial shipping-based or vessel-based activities that occur primarily on a local or regional scale and/or on a temporary or intermittent basis (e.g., impacts arising from geophysical seismic exploration; impacts from local/regional prey removal by fisheries; impacts from local maritime development). Some are likely to continue to act as pressures into the future, thereby constituting a potential threat. While the effect of these pressures may act on a temporary and/or regional scale and some (e.g. disturbance or displacement due to anthropogenic noise) are likely to continue to act as pressures into the future, none is considered to be of sufficient magnitude to be causing an adverse impact on the habitat extent and condition for its populations in Irish waters. There is no evidence to suggest a change in the main pressures thought to be acting on this species' habitat in the near future.

	However, surveillance of the species and the pressures potentially acting upon it will continue, while the application of strong management measures (e.g., via the statutory/regulatory process) to avoid potentially significant impacts is also expected to continue; thus the status of and prospects for the habitat of this species into the future are favourable. Grey seal The habitat of Ireland's Grey seal population may be subject to a number of local and/or regional environmental pressures and threats on land in coastal areas, and in coastal and offshore waters. The main pressures thought to be acting on this species' habitat extent and condition around Ireland are considered to involve commercial vessel-based or shipping-based activities that occur primarily on a local or regional scale and/or on a persistent or intermittent basis (e.g. impacts from local/regional prey removal by fisheries; impacts arising from geophysical seismic exploration). Some are likely to continue to act as pressures into the future, thereby constituting a potential threat. While the effect of these pressures may act on a temporary and/or regional scale, based on current information none is considered to be of sufficient magnitude to be causing an adverse impact on the habitat of Grey seal in Ireland. The available evidence, as supported by ongoing robust surveillance, indicates continued growth in the species' breeding population size around the coastline. There is no evidence to suggest a change in the main pressures thought to be acting on this species' habitat in the near future. However, surveillance of the species and the pressures potentially acting upon it will continue, while the application of strong management measures (e.g., via the statutory/regulatory process) to avoid potentially significant impacts is also expected to continue; thus the status of and prospects for the habitat of Ireland's Grey seal population into the future are favourable. Harbour seal The habitat of Ireland's Harbour seal population may be subject to a number of local and/or regional environmental pressures and threats on land in coastal areas, and in coastal and offshore waters. The main pressures thought to be acting on this species' habitat extent and condition around Ireland are considered to involve commercial vessel-based or shipping-based activities that occur primarily on a local or regional scale and/or on a persistent or intermittent basis (e.g. impacts from local/regional prey removal by fisheries; impacts arising from

	geophysical seismic exploration). Other possible impacts may occur from coastal tourism and localised human disturbance at haul-out sites, though further research into this aspect is currently required to assess the degree and nature of such potential impacts around the Irish coast. Some are likely to continue to act as pressures into the future, thereby constituting a potential threat. While the effect of these pressures may act on a temporary and/or regional scale, based on current information none is considered to be of sufficient magnitude to be causing an adverse impact on the habitat of Harbour seal in Ireland. The available evidence, as supported by ongoing surveillance, indicates continued relative stability in the species' population size around the coastline. There is no evidence to suggest a change in the main pressures thought to be acting on this species' habitat in the near future. However surveillance of the species and the pressures potentially acting upon it will continue, while the application of strong management measures (e.g., via the statutory/regulatory process) to avoid potentially significant impacts is also expected to continue; thus the status of and prospects for the habitat of Ireland's Harbour seal population into the future are favourable.
Assessment Method	**Marine reptiles** Leatherback turtle The method of assessment of habitat extent for this species is reliant on information on its natural range and distribution, collected via surveillance programmes. The Leatherback turtle is the most widely distributed living reptile species, being found in all oceans except the Southern Ocean. Within the North Atlantic its range extends from the tropics to the high latitudes of Newfoundland right across to Europe's north-westerly fringe. It is a widely roaming species, with individuals making extensive pan-oceanic movements. Breeding is confined to warm tropical regions because of thermal constraints on egg incubation, but the species has many unique anatomical and physiological adaptations that permit it, unlike other marine turtles, to forage seasonally into cooler temperate waters. Consequently, Leatherback populations have a very dynamic range. During the summer months their range is at its greatest extent with individuals located throughout the North Atlantic, whereas during the winter months their range is restricted to areas where the sea surface temperature is >15 °C.

	Recent studies have shown that after nesting in the tropics the majority of North Atlantic Leatherbacks head north towards cooler temperate waters. Some of these individuals head north towards the north-east Atlantic and Irish waters where they forage on jellyfish for the summer months before turning south again in the autumn as water temperatures decline. The TURTLE database is used to collate all Leatherback records from Ireland and the UK. It is clear that Leatherbacks migrate through Irish waters each year (with 198 records since 2000) and while most records are from sightings near to the coast, or strandings, they can also be encountered off-shore. For the 2013 Habitats Directive assessment, it was assumed that the entire extent of Ireland's EEZ could constitute the range of the Leatherback turtle. However, the results from the extensive ObSERVE aerial survey project in 2015-2016 may indicate a more restricted range than previously thought. That project was aimed at off-shore cetaceans but also recorded other megafauna and resulted in over 600,000 km^2 of sea being surveyed, but only recorded three turtles, all from the Celtic shelf. Consequently, pending further survey work, the range of this species is taken as the area incorporating the distribution records for 2000-2018. **Marine birds** The method of assessment of habitat extent for this species is reliant on information on its natural range and distribution, collected via surveillance programmes. The majority of surveys conducted as part of the national seabird monitoring programme followed guidance on sampling and census methods for seabirds as well as species-specific methodology detailed in the Seabird Monitoring Handbook for Britain and Ireland (Walsh et al., 1995). This facilitated the assessment of population distribution, colony sizes and to estimate the changes in numbers since the last national census carried out in Seabird 2000. A summary of the methods employed and recommended timings of surveys are set out in Cummins et al. (2019). These Census Instructions are based on Walsh et al. (1995)'s handbook and are the recommended methods for the Seabirds Count census work across Ireland, Northern Ireland and Britain. Black-legged kittiwake Approximately 90% of the total contemporary population estimate is derived from single visit surveys undertaken across Ireland in 2015. Over 80% of the counts were undertaken during the period mid-May – June with the remaining sites covered in July. There is high confidence

	in both contemporary population and distribution estimates. The confidence in short-term estimates of change is medium, based on greater recent coverage and more targeted timing of surveys compared to Seabird 2000. The long-term estimates of change in abundance are also qualified as medium. Northern fulmar Over 70% of counts were conducted in June, which is the noted ideal month for surveying this species and greater than the 64% figure for Seabird 2000. Approximately 66% of the total contemporary population estimate is derived from single visit surveys undertaken in 2015. NPWS confidence in both the contemporary national population estimate and the breeding range is at least a medium. The confidence in short-term estimates of change is medium based on greater coverage in this round compared to Seabird 2000. The estimated long-term population change is also qualified as medium, as coverage was not as comprehensive in the Seabird Colony Register even though some corrections for surveyed colonies were made. Northern gannet The results of the census of Irish Gannet colonies (gannetries) were largely derived from aerial photographs taken in 2013 and 2014 and supplemented by additional land-based vantage point counts at the smaller colonies, i.e. Clare Island, Ireland's Eye and Lambay Island. The count unit for aerial surveys is the Apparently Occupied Site (AOS) as usually it is not possible to see whether one or two birds are present on the site. For the three largest colonies (Little Skellig, Bull Rock and Great Saltee), estimates were derived by taking the mean (or average) of three independent observer counts of the aerial imagery following published guidance. The contemporary population estimate and distribution for this species is high due to the conspicuous nature of Gannet colonies and that the survey data came from a single species national survey of the seven known colonies, conducted during 2013 – 2014. Both the short- and long-term comparisons are against high quality counts; therefore, confidence in these estimates is also high. Due to the limited number of Gannet colonies in Ireland, confidence in the estimated change in distribution is also high.

	Marine mammals Bottlenose dolphin Use of the range descriptor and range surface area calculation as proxies for habitat extent are judged appropriate for this wide-ranging pelagic and oceanic species. The species' natural range and thus habitat in Irish waters is a small component of its wider North Atlantic range. The quality of habitat for Bottlenose dolphin (i.e. habitat condition) was determined by NPWS (2019) giving due consideration to the relevant direct and indirect pressures thought to be acting on the species and/or its functional group, and on its habitat within its natural environment. These pressures were evaluated in development of the 2009 Conservation Plan for Cetaceans in Irish waters and informed by more recent scientific surveillance (see NPWS, 2019), including Ireland's ObSERVE Programme and using available data concerning, inter alia, habitat use, population size, distribution and ecology, and threats to the species' protection (e.g., via natural/biological sources, human sectoral activities, management gaps, etc.). Harbour porpoise Use of the range descriptor and range surface area calculation as proxies for habitat extent are judged appropriate for this wide-ranging coastal and offshore species. The species' natural range and thus habitat in Irish waters is a small component of its wider North Atlantic range. The quality of habitat for Harbour porpoise (i.e. habitat condition) was determined by NPWS (2019) giving due consideration to the relevant direct and indirect pressures thought to be acting on the species and/or its functional group, and on its habitat within its natural environment. These pressures were evaluated in development of the 2009 Conservation Plan for Cetaceans in Irish waters and informed by more recent scientific surveillance (see NPWS, 2019), including Ireland's ObSERVE Programme and using available data concerning, inter alia, habitat use, population size, distribution and ecology, and threats to the species' protection (e.g., via natural/biological sources, human sectoral activities, management gaps, etc.). Grey seal Use of the range descriptor and range surface area calculation as proxies for habitat extent are judged appropriate for this wide-ranging coastal and offshore species.

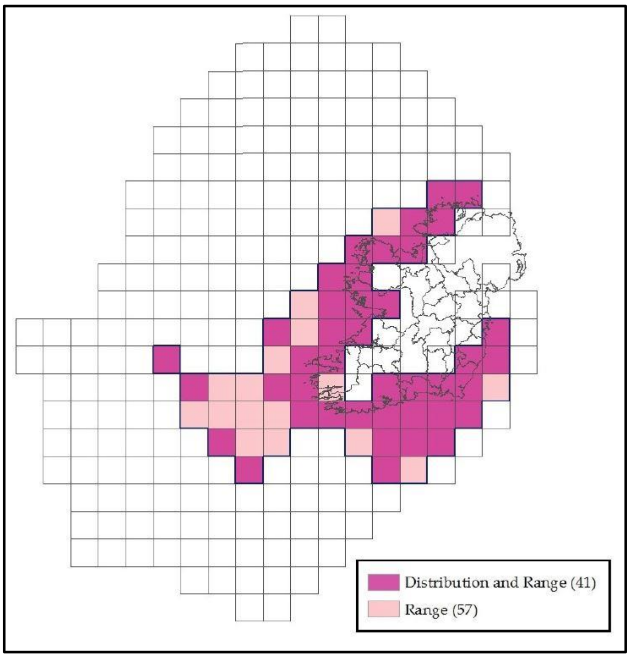
	The habitat used by Grey seals in Ireland is diverse and dynamic, from coastal and estuarine waters close to human activity and undisturbed offshore islands, to deeper Atlantic shelf waters and shallow seas shared with adjacent member states. The quality of habitat for Grey seal (i.e. habitat condition) was determined by NPWS (2019) giving due consideration to the relevant direct and indirect pressures thought to be acting on the species, and on its habitat within its natural environment. These pressures were informed by more recent scientific surveillance (see NPWS, 2019), including using available data concerning, inter alia, habitat use, population size, distribution and ecology, and threats to the species' protection (e.g., via natural/biological sources, human sectoral activities, management gaps, etc.). Harbour seal Use of the range descriptor and range surface area calculation as proxies for habitat extent are judged appropriate for this wide-ranging coastal and offshore species. The habitat used by Harbour seals in Ireland is diverse and dynamic, from coastal and estuarine waters close to human activity and undisturbed offshore islands, to continental shelf waters and the comparatively shallow Irish Sea. The quality of habitat for Harbour seal (i.e. habitat condition) was determined by NPWS (2019) giving due consideration to the relevant direct and indirect pressures thought to be acting on the species, and on its habitat within its natural environment. These pressures were informed by more recent scientific surveillance (see NPWS, 2019), including using available data concerning, inter alia, habitat use, population size, distribution and ecology, and threats to the species' protection (e.g., via natural/biological sources, human sectoral activities, management gaps, etc.).
Assessment Result	**Marine reptiles** Leatherback turtle The full extent and condition of Leatherback turtle habitat in Irish waters is assessed as Unknown and can only be inferred via existing limited range and distribution records. Records of the Leatherback turtle are sporadic and scattered around Irish waters; there is no information available to allow us to calculate changes in the habitat extent or quality of this species and no trends can be estimated. We still have much to learn about the migration patterns and seasonal behaviour of Leatherbacks in the Northeast Atlantic. For now, a

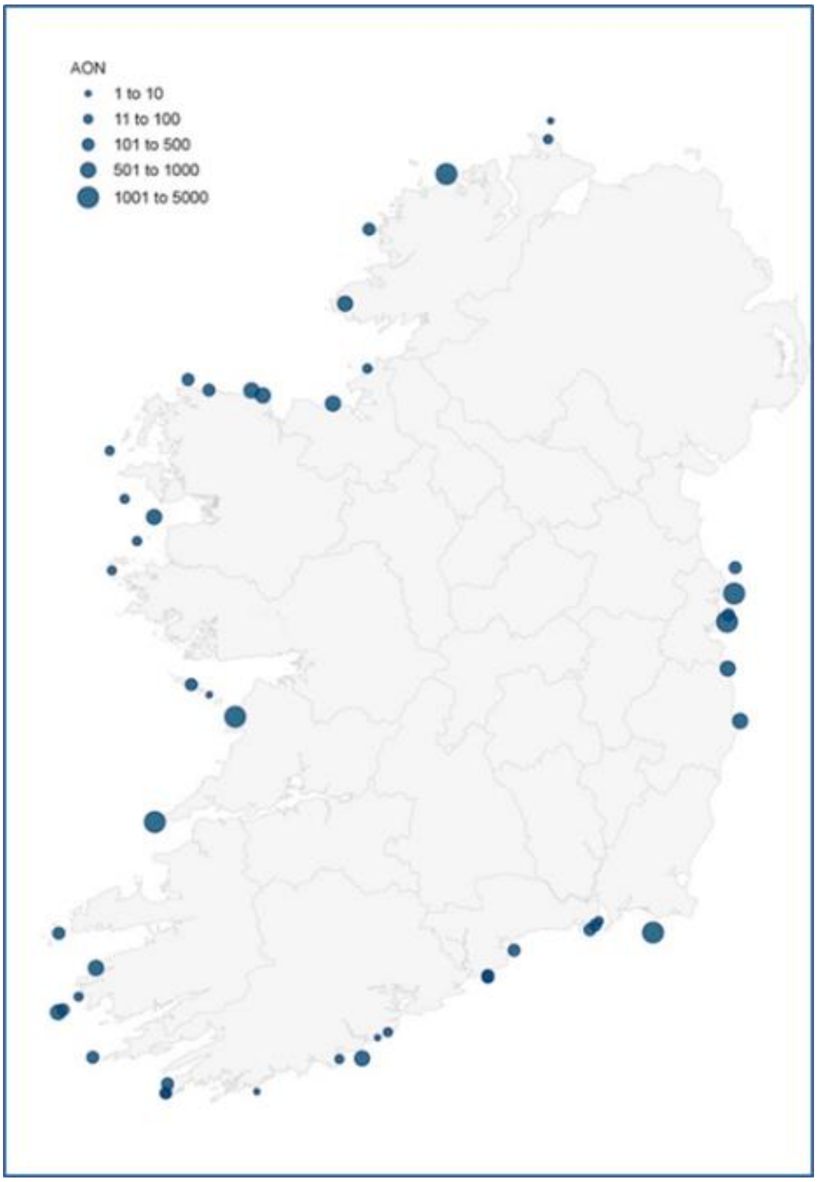
	definitive statement cannot be made on the sufficiency of area or quality of Leatherback turtle habitat in Ireland. **Marine birds** Black-legged kittiwake Kittiwake breeding distribution around Ireland has been shown to be increasing significantly both in the short-term and long-term. The at-sea distribution of this species is extensive throughout Irish waters and in the MSFD assessment area. However, there is evidence of significant population declines at a range of breeding colonies in Ireland (Cummins et al., 2019). This is in part driven by acute (circa 50%) short-term population declines at some of our most important colonies, i.e. Horn Head, Co. Donegal, Cliffs of Moher, Co. Clare and Great Saltee, Co. Wexford. A near 20% decline was recorded at Lambay Island which, owing to its relative colony size, also influences the estimated national population decline. An underlying question remains concerning Kittiwake reproductive success and the condition of its natural habitats, given the observed breeding population decline. Causes of the decline are unclear at present and some examples of potential factors involved are changes in food availability or prey distribution, or climate-related influences. Consequently (i) the species' population dynamics in the North-East Atlantic and (ii) the extent, severity and risk of impact from human activities on its populations, should be investigated further. Northern fulmar Breeding distribution of Fulmars around Ireland has been shown to be increasing at a modest rate both in the short-term and long-term. The at-sea distribution of this species is extensive throughout Irish waters and in the MSFD assessment area. With regard to the habitat extent and condition for this species, overall these can be described as in a good state. The contrasting fortunes of some of the larger traditional Fulmar colonies across Ireland indicate that the relationship between factors influencing the recorded colony abundances in Ireland may be a complex one. Although further analysis is needed it could be that increased survey effort may be masking a short-term decline in the actual breeding population. Ongoing monitoring of this species' abundance, distribution and its habitat condition will be necessary to investigate the nature, causes and significance of local declines within Ireland.

	Northern gannet While the number of Gannet colonies is comparatively small relative to other cliff-nesting or island-nesting marine birds, the breeding distribution around Ireland has been shown to be increasing significantly both in the short-term and long-term. The at-sea distribution of this species is also extensive throughout Irish waters and in the MSFD assessment area. These features, along with increasing population numbers in the short-term and long-term indicate that the habitat extent and condition for this large marine bird species are in a good state. **Marine mammals** Bottlenose dolphin The most recent estimate of Range (as a proxy for habitat extent) for this toothed cetacean species is as follows, drawn from the latest HD assessment (NPWS, 2019): 620,000km^2 Bottlenose dolphins may be subject to a number of local and/or regional environmental pressures throughout their range in Irish waters (NPWS, 2019). However, based on current spatial and temporal data none are considered to be of sufficient impact on the species to be causing a significant deterioration in overall habitat condition in Ireland from a status that is sufficient for long-term survival. Long-term trends in habitat for Bottlenose dolphin remain uncertain due to insufficient accurate data for this species prior to 1999-2000. However, with improved surveillance and numerous ongoing records of Bottlenose dolphins in the last 18-20 years, the short-term trend indicates the continued existence of sufficient good quality habitat for the species. The range value referred to above is considered to be a revised baseline for this species and has been set as the Favourable Reference Range under the Habitats Directive. This surface area calculation is slightly greater than that reported by NPWS in 2013. Against this background and with regard to the species' habitat extent, Ireland's **threshold value for Good Environmental Status** under this criterion is proposed as follows: Equivalent to the current Favourable Reference Range

	Harbour porpoise The most recent estimate of Range (as a proxy for habitat extent) for this small toothed cetacean species is as follows, drawn from the latest HD assessment (NPWS, 2019): 400,000km^2 Harbour porpoises may be subject to a number of local and/or regional environmental pressures throughout their range in Irish waters (NPWS, 2019). However, based on current spatial and temporal data none are considered to be of sufficient impact on the species to be causing a significant deterioration in overall habitat condition in Ireland from a status that is sufficient for long-term survival. Long-term trends in habitat for Harbour porpoise remain uncertain due to insufficient accurate data for this species prior to 1999-2000. However, with improved surveillance and numerous ongoing records of Harbour porpoises in the last 18-20 years, the short-term trend indicates the continued existence of sufficient good quality habitat for the species. The range value referred to above is considered to be a revised baseline for this species and has been set as the Favourable Reference Range under the Habitats Directive. This surface area calculation is slightly greater than that reported by NPWS in 2013. Against this background and with regard to the species' habitat extent, Ireland's **threshold value for Good Environmental Status** under this criterion is proposed as follows: Equivalent to the current Favourable Reference Range Grey seal The most recent estimate of Range (as a proxy for habitat extent) for this seal species is as follows, drawn from the latest HD assessment (NPWS, 2019): 264,900km^2 Current information broadly indicates that Grey seals of all ages move freely about this diverse habitat and, based on the population size and distribution data available and knowledge of its population ecology, all indications are that sufficient high quality habitat is available to support the maintenance and/or expansion of the species in Ireland into the future. Consequently, the habitat condition is considered good. Long-term trends in habitat for Grey seal remain uncertain due to insufficient accurate data for this species throughout its range in Ireland prior to 2000. However, with improved surveillance and numerous

	ongoing records of Grey seals in the last 18-20 years, the short-term trend indicates (a) the continued existence of sufficient good quality habitat for the species and (b) an expansion in haul-out distribution around the island of Ireland, based on comparison with previous nationwide assessments and the results of repeated aerial surveillance (Morris & Duck, 2019). The range value referred to above is considered to be a revised baseline for this species and has been set as the Favourable Reference Range under the Habitats Directive. This surface area calculation is slightly lower than that reported by NPWS in 2013. Against this background and with regard to the species' habitat extent, Ireland's **threshold value for Good Environmental Status** under this criterion is proposed as follows: Equivalent to the current Favourable Reference Range Harbour seal The most recent estimate of Range (as a proxy for habitat extent) for this seal species is as follows, drawn from the latest HD assessment (NPWS, 2019): 176,300km^2. Current information broadly indicates that Harbour seals of all ages may move freely about this diverse habitat and, based on the population size and distribution data available and knowledge of its population ecology, all indications are that sufficient high quality habitat is available to support the maintenance and/or expansion of the species in Ireland into the future. Consequently, the habitat condition is considered good. Long-term trends in habitat for Harbour seal remain uncertain due to insufficient accurate data for this species throughout its range in Ireland prior to 2003. However, with improved surveillance and numerous ongoing records of Harbour seals in the last 15-16 years, the short-term trend indicates the continued existence of sufficient good quality habitat for the species, based on comparison with previous nationwide assessments and the results of repeated aerial surveillance (Morris & Duck, 2019). The range value referred to above is considered to be a revised baseline for this species and has been set as the Favourable Reference Range under the Habitats Directive. This surface area calculation is slightly lower than that reported by NPWS in 2013.

	Against this background and with regard to the species' habitat extent, Ireland's **threshold value for Good Environmental Status** under this criterion is proposed as follows: Equivalent to the current Favourable Reference Range
Results (figures & tables)	**Marine reptiles** Leatherback turtle  **Figure 1.** Observed coastal and marine Distribution and Range of Leatherback turtle in Ireland's MSFD and Habitats Directive assessment area. The map covers all known records from 2000 to 2018 (n=198) collectively displayed as coloured 50km grid cells (NPWS, 2019).

	Marine birds Black-legged kittiwake  **Figure 2.** Breeding Kittiwake abundance and distribution for the period 2015–2018. Figures are based on apparently occupied nests (AONs) (NPWS; Cummins et al., 2019).

	Northern fulmar

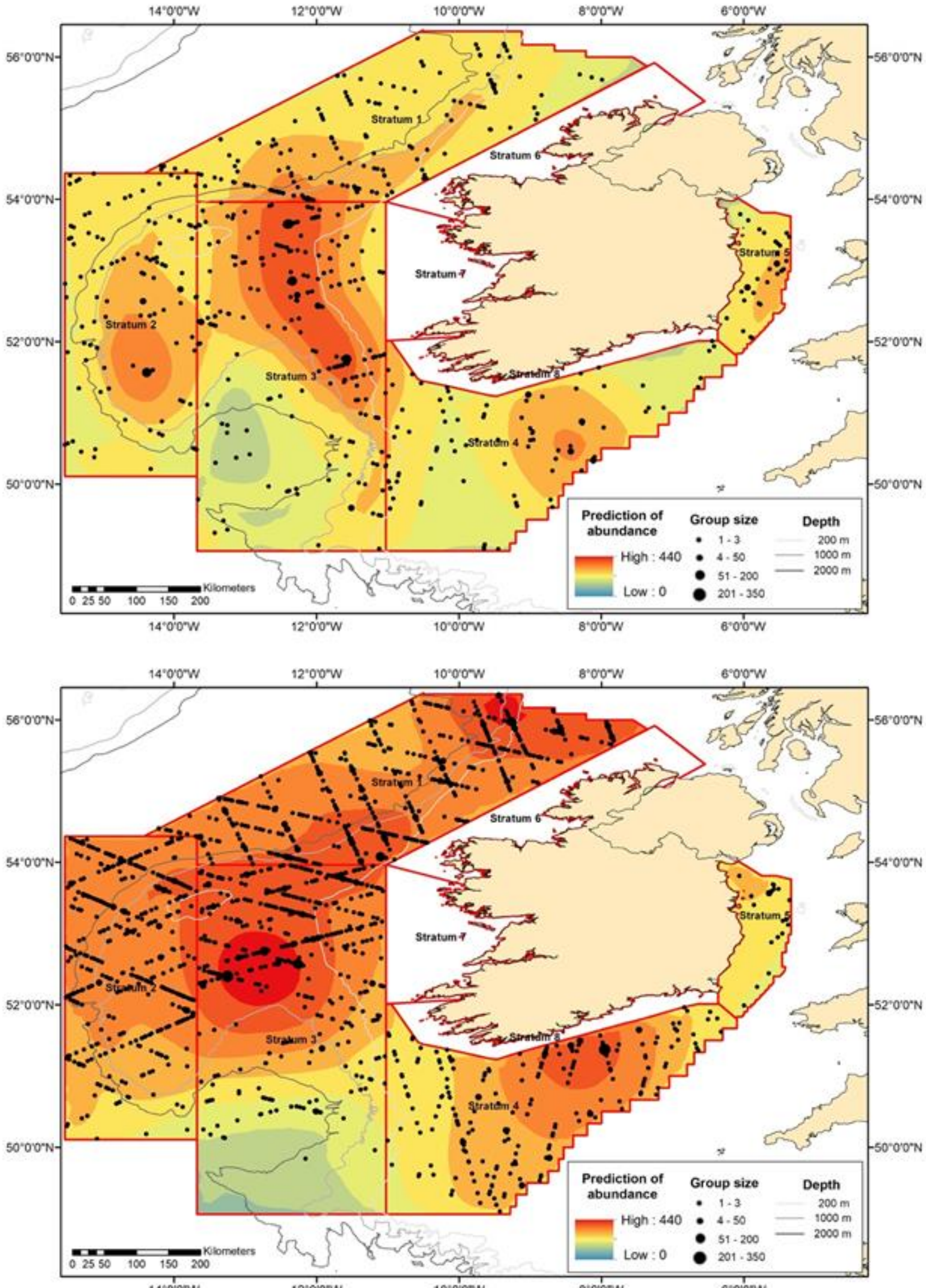


Figure 3. Predicted summer distribution (top), winter distribution (bottom), relative densities and observed group sizes of Fulmar in Irish waters, modelled from aerial survey data gathered in 2015 and 2016 (from Ireland's ObSERVE Programme; Rogan et al., 2018).

Northern gannet

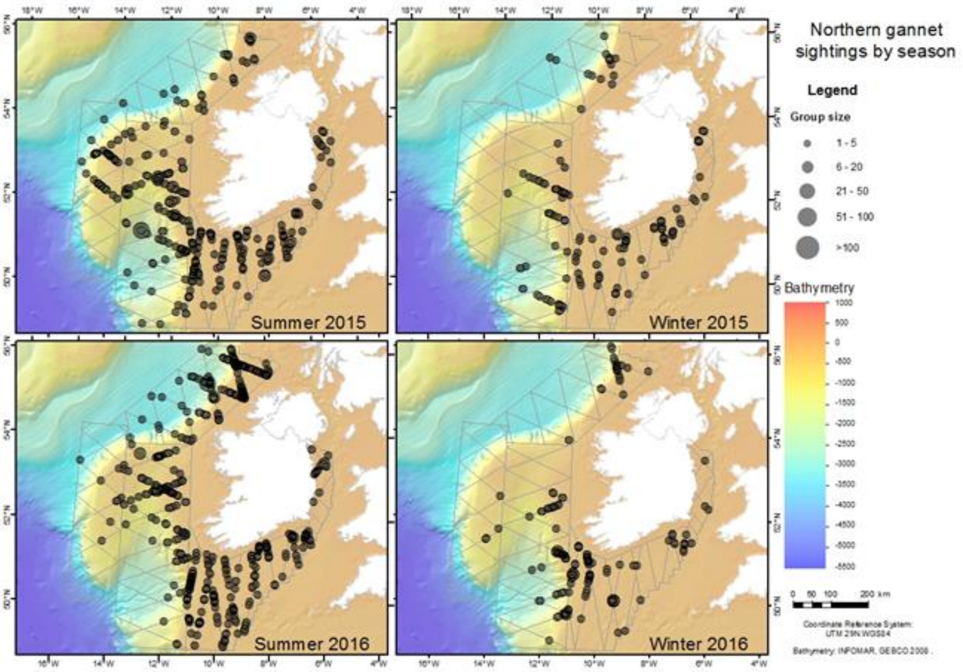


Figure 4. Distribution of Gannet sightings (black circles) from aerial surveys carried out in the summer (left) and winter seasons (right), 2015 & 2016. Grey lines indicate the survey track-lines. Circles are proportional to the number of birds recorded in each sighting (from Ireland's ObSERVE Programme; Rogan et al., 2018).

Marine mammals

Bottlenose dolphin

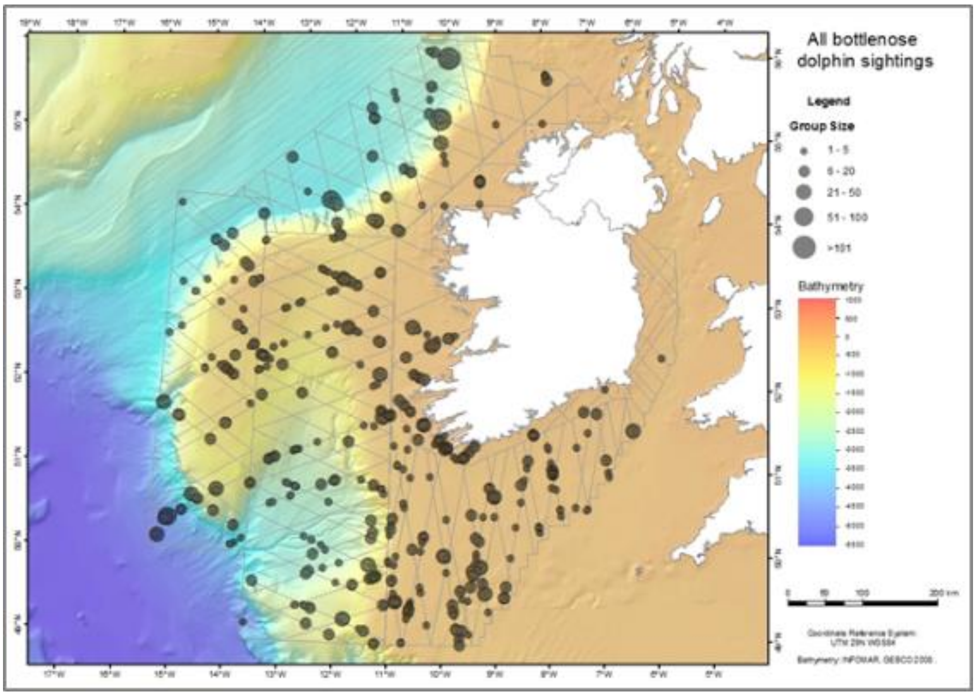


Figure 5. Observed coastal and marine Distribution and Range and group sizes of Bottlenose dolphin within Ireland's EEZ, covering 482

aerial sighting records from May 2015 to March 2017 (summer and winter only) (from Ireland's ObSERVE Programme; Rogan et al., 2018).

Harbour porpoise

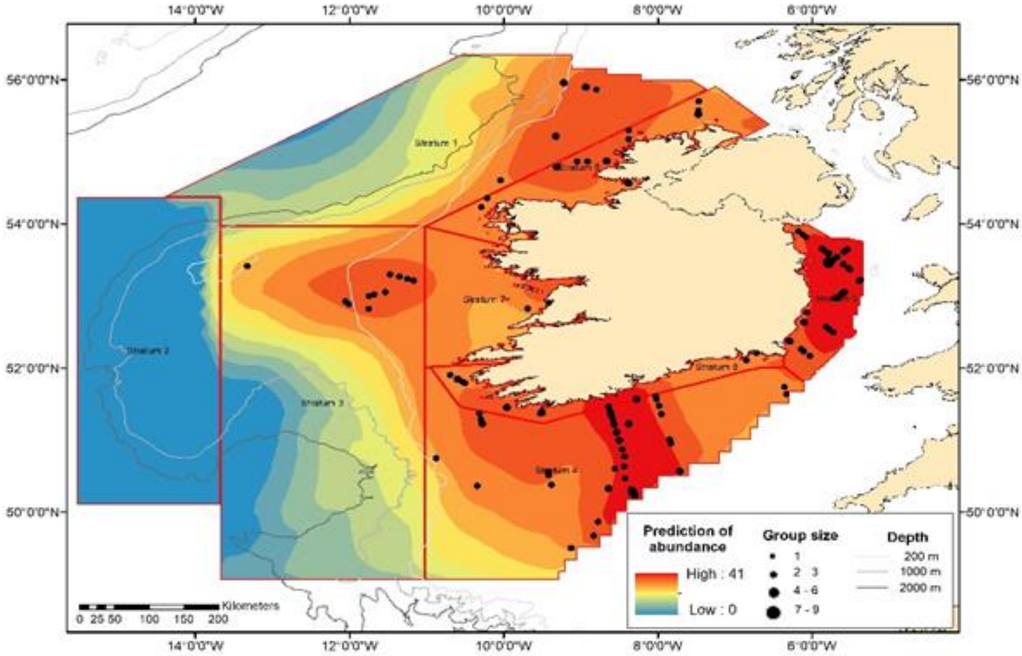


Figure 6. Predicted summer distribution and relative density of Harbour porpoises in Irish waters in the summer of 2016, modelled from high quality aerial survey data (from Ireland's ObSERVE Programme; Rogan et al., 2018).

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Grey seal & Harbour seal

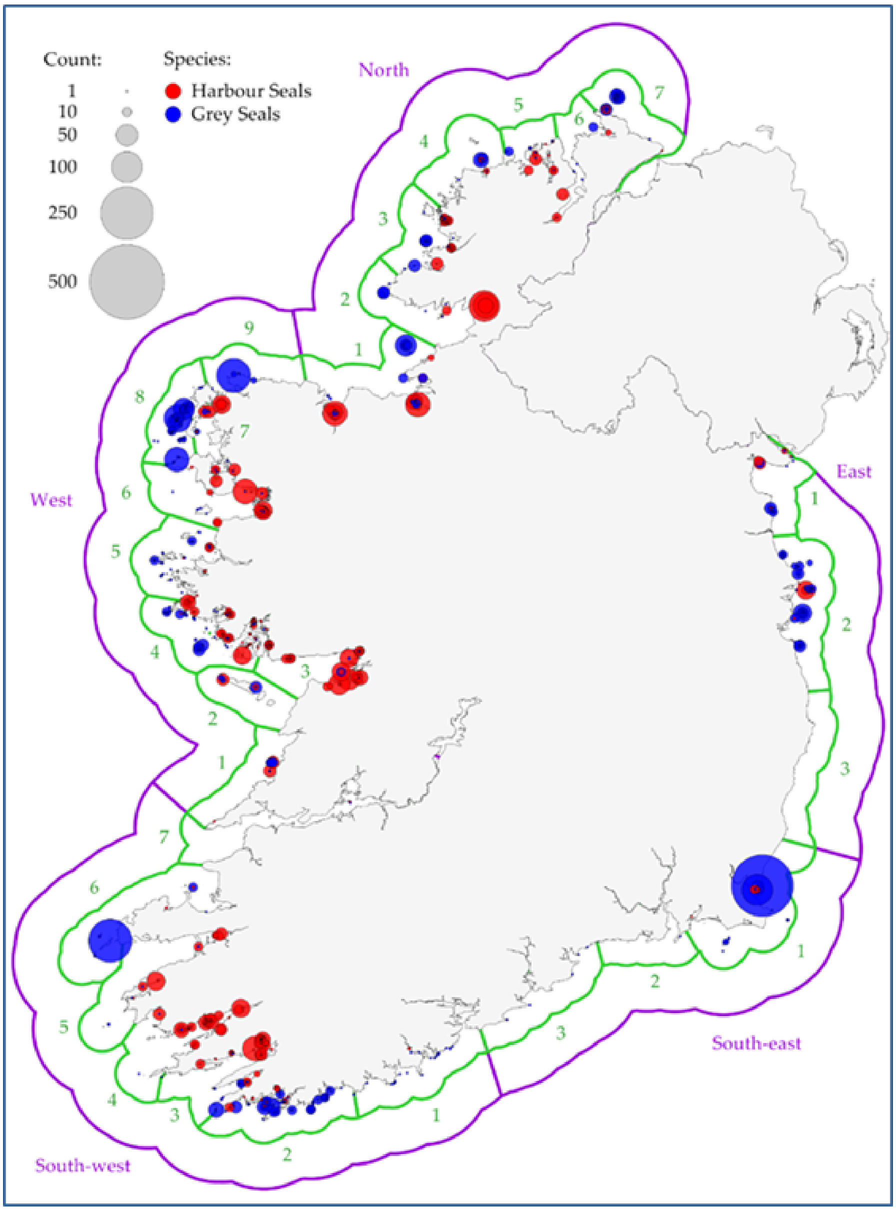

Figure 7. Numbers and distribution of Grey seals (blue circles) and Harbour seals (red circles) recorded within labelled sub-regions in Ireland in August 2017 & August 2018. The displayed symbol size represents the recorded group size with count guides given in the Legend (top left) (NPWS; Morris & Duck, 2019).
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<td>Knowledge gaps</td>
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Targeted and collaborative international research is required on (a) the population ecology of Leatherback turtles in the North Atlantic and (b) the extent, severity and risk of impact from human activities on populations of this species.
The population dynamics of Black-legged kittiwake in the North-East Atlantic and the extent, severity and risk of impact from human activities on its populations, should be investigated further.

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	• Coordinated efforts should be made to scientifically evaluate and test methodologies for the assessment of habitat condition across a range of habitat types, such that the condition of natural habitats for key criteria elements can be analysed and inform future assessments of environmental status.
	Assessment Data
Data Sources	Cummins, S., Lauder, C., Lauder, A. & Tierney, T. D. (2019) The Status of Ireland's Breeding Seabirds: Birds Directive Article 12 Reporting 2013 – 2018. Irish Wildlife Manuals, No. 114. National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht, Ireland. 89pp. Doyle, T. K. (2007) Leatherback Sea Turtles (Dermochelys coriacea) in Irish waters. Irish Wildlife Manuals No. 32. National Parks and Wildlife Service, Department of the Environment, Heritage and Local Government, Dublin, Ireland. Doyle, T., Houghton, J.D.R., Ó Súilleabháin, P.F., Hobson, V., Marnell, F., Davenport, J. & Hays, G.C. (2008) Leatherback turtles satellite-tagged in European waters. Endangered Species Research 4:23-31. Morris, C.D. & Duck, C.D. (2019) Aerial thermal imaging survey of seals in Ireland, 2017-2018. Report (unpublished) for the National Parks and Wildlife Service of the Department of Culture, Heritage and the Gaeltacht, Dublin. NPWS. (2019) The Status of EU Protected Habitats and Species in Ireland. Volume 1: Summary Overview. Unpublished NPWS report. Edited by: Deirdre Lynn and Fionnuala O'Neill. 99pp. Rogan, E., Garagouni, M., Nykänen, M., Whitaker, A. & Ingram, S. (2018) Bottlenose dolphin survey in the Lower River Shannon SAC, 2018. Report to the National Parks and Wildlife Service, Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs. University College Cork. 19pp. Walsh, P.M., Halley, D.J., Harris, M.P., del Nevo, A., Sim, I.M.W. & Tasker, M.L. (1995) Seabird monitoring handbook for Britain and Ireland: a compilation of methods for survey and monitoring of breeding seabirds. Peterborough, JNCC/RSPB/ITE/Seabird Group.

Data Locations (URL)	https://www.npws.ie/maps-and-data https://www.npws.ie/publications https://www.npws.ie/marine/marine-reports https://www.dccae.gov.ie/observe			
Data Time Line	Start Date:	2009	Start Date:	2018
Point of Contact	Oliver Ó Cadhla, Marine Environment section, DHPLG			
Email	oliver.ocadhla@housing.gov.ie			

Descriptor 2 – Non-indigenous species (NIS)

D2 C1

Ref D2C1Rev6	**Assessment Sheet: Criteria D2C1** **The number of non-indigenous species which are newly introduced via human activity into the wild, per assessment period (6 years)**
Key message	In the assessment period 2013 to 2018 three number non-indigenous species are considered to be newly introduced since: • *Undaria pinnatifida, Wakame or Asian kelp* • *Schizoporella japonica, a bryozioan* • *Perphora japonica, a colonial sea squirt* Significant progress has been made in implementing management processes aimed at minimising new introductions.
Background	Non-Indigenous Species (NIS) are defined as species that are deliberately or unintentionally introduced by human activities outside of their natural range (Olenin et al., 2010)[1]. Invasive NIS are a subset of established NIS which have spread, are spreading or have demonstrated their potential to spread elsewhere, and have an adverse effect on biological diversity, ecosystem functioning, socio- economic values and/or human health in invaded regions (OSPAR, 2018)[2]. **MSFD Initial Assessment reporting 2013** In 2013, through MSFD Initial Assessment reporting, Ireland adopted the following targets for NIS: Target 1: Effect a reduction in the risk of introduction and spread of non-native species through the prioritisation of species and improved management of high risk pathways and vectors. Target 2: The development of action plans for key high-risk marine non indigenous species by 2020. The Initial Assessment stated that "The number of NIS currently recognised in Irish waters at present is 79, although this is likely to be an underestimation of the true number present in Irish waters. There are various reasons for this including identification uncertainty that surround some poorly-studied taxonomic groups, small size,

	occurrence in habitats that are difficult to study, or because of a similarity with other recognised species. As a result, there is a high degree of uncertainty around abundance estimates and associated trends which is further exacerbated by the disparate data sources" and that "The determination of trends is further complicated by conflicting views on what constitutes a cosmopolitan, cryptogenic or a NIS. In many cases there is also a high degree of uncertainty on how a NIS arrived in Irish waters and their subsequent dispersal once established." It was also reported, that "It is not possible to assess the current pressure and impact of NIS at this time. Work is ongoing on how best to improve our understanding of the presence, distribution, trends and impacts of NIS in the Irish Assessment Area". These uncertainties have led to current work in the area of marine NIS – see section Research Projects and National Initiatives on page 6 of this document. **MSFD Article 11 Monitoring Programme reporting 2015** In the 2015 Article 11 Monitoring Programme Ireland detailed how no active monitoring of NIS is carried out. And it stated that Ireland "will carry out risk assessments to identify sites and activities for future monitoring and will draw on the monitoring approach to be developed under the OSPAR CEMP Guidelines, Common Indicator: Changes to non-indigenous species communities (NIS3) and under AIS Regulations". **MSFD Revised Commission Decision 2017** In May 2017 the Revised Commission Decision set out one primary and secondary criteria for NIS. The primary criteria D2C1: The number of non-indigenous species which are newly introduced via human activity into the wild, per assessment period (6 years), measured from the reference year as reported for the initial assessment under Article 8(1) of Directive 2008/56/EC, is minimised and where possible reduced to zero. Member States shall establish the threshold value for the number of new introductions of non-indigenous species, through regional or subregional co-operation.

	Evaluation of this primary criteria is the focus of this assessment and this will form the basis for the MSFD Article 17 update on Article 8, 9 & 10 for Descriptor 2
Objective	The objective of this assessment is to evaluate the number of non-indigenous species which are newly introduced via human activity into the wild, per a 6-year assessment period. The time period for this assessment is the years 2013 to 2018 inclusive. The ultimate aim of MSFD is to minimise and where possible reduce to zero the number of NIS introduced in an assessment period. The threshold value for the number of new introductions of non-indigenous species, through regional or sub regional cooperation shall be established by Member States though regional and sub-regional cooperation. No threshold values have been determined to date. This will be done through participation in the OSPAR NIS assessment; Ireland participated in the most recent (2017) assessment.
Drivers	The drivers for the introduction of NIS in Irish marine waters, as per the Directive, are: • Shipping, • Tourism & Leisure and • The Fish & Shellfish Harvesting & Processing Industries **Shipping** Marine non-indigenous species can be introduced either through ballast water or from biofouling. Studies have shown that the greatest numbers of known NIS occur in marinas with fully marine conditions; but there is much variation between different marina sites. More marinas occur on the east coast of Ireland and this is the coast where the greatest range for NIS will have been found. This may be due to the levels of activity associated with the greater number of berths present (Minchin, 2014 A2.12)[3]. The harbours of particular susceptibility to new introductions of NIS are Cork Harbour and Belfast Lough (Awad et al. 2014)[4].

	Fish and Shellfish Harvesting and Processing Aquaculture has long been recognised as an important vector for introductions of NIS, both deliberate and accidental. Aquaculture is a particularly important industry for the Irish rural economy. The Irish coastline has a caged salmon industry extending from the areas on the southwest coast to the north Irish coast, situated mainly within sheltered bays; but with new engineered structures there are possibilities for the industry to venture into more exposed conditions. The shellfish industry mainly consists of an intensive cultivation of Pacific oysters confined within bags on trestles, rope grown culture of mussels and broadcast management of mussels within sheltered bays (Minchin, 2014 A2.9). Examples of efforts to reduce impacts of non-indigenous species can be found as early as 1930s, whereby limitations on shellfish imports to France were imposed to counter the introduction of non-indigenous species associated with cultured organism (Ojaveer et al. 2018)[5]. Acknowledging that practices involving the culture of aquatic organisms can operate as important pathways and vectors for IAS, Regulation EC 708/2007 concerning use of alien and locally absent species in aquaculture was adopted in 2007. The growth of the aquaculture industry is dependent on increased production, development of new sites and transhipments of live animals within and between states and the regulation is intended to address the potential effects of these activities on biodiversity. **Tourism and leisure** Studies have shown that the greatest numbers of known NIS occur in marinas with fully marine conditions; but there is much variation between different marina sites. More marinas occur on the east coast of Ireland and this is the coast where the greatest range for NIS has been found. This may be due to the levels of activity associated with the greater number of berths present. **Climate Change** Climate change effects may also drive NIS introductions. However, there is currently not enough known as to the extent to which climate change will drive NIS introductions. **Summary** In summary the major driving forces for the introduction of non-indigenous species in Ireland are the transporting goods and people,

	the demand for food, and the tourism and recreation sector. There are several mechanisms involved including (but not limited to) shipping, fish and Shellfish Harvesting and Processing and tourism and leisure.
Pressures	The pressures as per the Directive are: • The Input or spread of non-indigenous species, • the input of genetically modified species and translocation of native species, • the loss of or change to natural biological communities due to cultivation of animal or plant species and • the disturbance of species (e.g. where they breed, rest and feed) due to human presence.
State	The number of Non-Indigenous Species (NIS) currently recognised in Irish marine waters is 135. The Initial Assessment 2013 identified 79 species, the 2014 Marine NIS Risk Assessment carried out by Dan Minchin, identified 32 high impact target species and the most recent GMIT report, carried out in 2019, identified 122 marine NIS. An examination of these species lists was carried out and the current number of NIS in Irish marine waters is determined to be 135. Of these 3 no. species are considered to be newly introduced since 2013; these species are: • *Undaria pinnatifida*, Wakame or Asian kelp • *Schizoporella japonica*, a bryozioan • *Perphora japonica*, a colonial sea squirt Appropriate measures have been taken to control the vector risks and pathways described in the Initial Assessment (2013), including the development of a comprehensive Alien Species work programme focused on the aquaculture sector and research projects focusing on quantifying NIS in Irish marine waters. The Ballast Water Convention has entered into force internationally however; the direct legal provision is not yet in-force in Ireland.

	Internationally ships are required to comply with its provisions and do so when entering Irish ports. The OSPAR Intermediate Assessment 2017 [6] outlines the numbers of new NIS recorded in OSPAR by region. This assessment highlights that for the 6-year period 2009 to 2014 the mean member of new NIS recorder per region was as follows: • Greater North Sea (Region II) 7.67 • Celtic Seas (Regions III) 2.83 • Bay of Biscay & Iberian Coast (Region IV) 3.67 The 3 NIS newly recorded in the Irish MSFD area for the 6-year period 2013-2018 compares favourably with the OS assessment figure for Region III (Celtic Seas).
Impact	The impacts demonstrated from NIS can include: • Loss of native biodiversity • Loss of recreational value • Loss of ecosystem services: Some ecosystems services (particularly mariculture) have been impacted, e.g., increased time taken to clean mussel lines of Didemnum and indirectly, through the loss of potential seed sources with the banning of importing seed mussels from high risk areas. • Transfer of diseases: Including the impacts of diseases in mariculture where there is the potential for the loss to both farmed and wild stock. The impacts of NIS in Irish marine waters have not been assess in detail to date, however work is ongoing - see section Research Projects and National Initiatives on page 6 of this document.
Response	The response to NIS and the management of pathways and risk is being undertaken by a number of national Agencies and Departments: **Marine Fisheries Board (Bord Iascaigh Mhara, BIM) response to NIS** BIM have developed a comprehensive Alien Species work programme focused on the aquaculture sector. This work programme

	includes convening an interdepartmental and inter agency working group whose work is continuing. Through the group the development of an aquaculture licence protocol for Risk Assessment and Biosecurity Planning is on-going. Other actions being undertaken by BIM are: • The retention of an expert advisor whose duties include the collection of baseline data. • BIM are providing support to the aquaculture sector in the development of Risk Assessment and Biosecurity Plans. • BIM staff training on NIS was completed in March 2019 and aquaculture industry training is on-going. • An aquaculture sector focused smartphone App was developed in the 3rd quarter of 2019. • Inventories of species found in shellfish aquaculture areas are being completed by BIM, with several bays being selected for full IAS assessment. Data arising from this programme will be logged with the National Biodiversity Data centre. **Enactment of the Ballast Water Convention** The Department of Transport, Tourism and Sport are in the process of enacting the Ballast Water Convention which will apply IMO and OSPAR Guidelines for the control and management of ship's ballast water to minimise the transfer of harmful aquatic organisms and pathogens. Provisions were made for the incorporation of the Convention into Irish law in the Sea Pollution Act 2006. The Convention came into force internationally in 2017. Secondary legislation has been drafted to commence the 2006 Act and to allow Ireland to ratify the Convention. It is expected that this legislation will be enacted shortly. **Research Projects and National Initiatives** Recent research projects and National Initiatives focusing on numbers of marine NIS and spatial distribution have been carried out, including: 1. The 2019 review of available information on Non-Indigenous Species in Irish marine waters: This paper identifies 122 NIS in Irish marine waters (including transitional brackish waters). Of

	these 122, 66% are animal species, 18% plants and 13% chromista. The paper also categorises species into impact status i.e. 20 species are high-impact, 25 species are moderate-impact, 6 species are low-impact and 70 species are not assessable or assessed. The review found that within the animal kingdom arthropods and molluscs appear as the dominant marine NIS taxa in Ireland. 2. Galway Mayo Institute of Technology are currently carrying out a largescale assessment on NIS surveillance methods, entitled the 'Development and application of traditional and molecular marine invasive species surveillance methods to facilitate their spatial mapping in Irish nearshore and foreshore waters and benthic habitats'. This project commenced in March 2019 and will run for 2 years. 3. University College Dublin are currently undertaking an assessment on modelling and mapping of NIS in Irish marine waters, entitled 'Modelling and Mapping Ireland's Invasive Marine Species Spread and Impact Potential. This project commenced in June 2019 and will also run for 2 years. 4. The Horizon scanning workshop[7], held at the Institute of Technology Sligo, 19th and 20th of April 2017 produced a summary list of 40 Invasive Alien Species on the Island of Ireland which included eight potential marine species as follows: 1. *Caulacanthus okamurae*, pom-pom weed 2. *Hesperibalanus fallax*, a warm-water barnacle 3. *Ensis directus*, American razor-clam 4. *Mnemiopsis leidyi*, Warty comb-jelly 5. *Hemigrapsus takanoi*, Brush-clawed shore crab 6. *Celtodoryx ciocalyptoides*, a sponge 7. *Hemigrapsus sanguineus*, Asian shore crab 8. *Rangia cuneate*, a bivalve clam The two-day workshop was co-funded by the EPA and the National Parks and Wildlife Service (NPWS). It was co-organised by the project team and the National Biodiversity Data Centre (NBDC). 5. The 2014 Marine NIS Risk Assessment carried out by Dan Minchin:

	A comprehensive Risk assessment of non-indigenous marine species in Ireland (including those expected in inland waters) was carried out by Dan Minchin in 2014. This risk assessment identified 32 no. high impact target species, including those expected to arrive based on high impacting species identified i.e. this list includes species established and species of concern which are not yet established: 1. Alexandrium catenella (Whedon and Kofoid) Balech [DAISIE] 2. Alexandrium tamarense (Lebour) Balech [GISP] 3. Bonamia ostreae (Pichot, Comps, Tíge, Grizel & Rabouin, 1980). Bonamiosis [OIE] 4. Corbicula fluminalis (O.F. Müller, 1774), Asian clam 5. Corbicula fluninea (O.F. Müller, 1774). Asian clam [DAISIE; GISP] 6. Corella eumyota Traustedt, 1882. Orange tipped sea squirt 7. Crassostrea gigas (Thunberg, 1793). Pacific oyster [DAISIE, GISP, NOBANIS] 8. Crepidula fornicata (Linneaus, 1758). Slipper limpet [DAISIE; GISP; NOBANIS] 9. Didemnum vexillum (Kott, 2002). Carpet sea-squirt {GISP] 10. Dikerogammarus haemobaphes (Eichwald, 1841). The demon shrimp 11. Dikerogammarus villosus (Sowinsky, 1894). Killer shrimp [DAISIE] 12. Dreissena bugensis (Andrusov, 1897). Quagga mussel [GISP] 13. Ensis directus (Conrad, 1843). American razor, jack-knife clam [DAISIE; NOBANIS] 14. Epizootic Haematopoietic necrosis virus (EHVN) [OIE] 15. Eriocheir sinensis (H. Milne Edwards, 1853). Chinese mitten crab [DAISIE; GISP; NOBANIS] 16. Gyrodactylus salaris (von Nordmann, 1832). Gyrodactylosis [DAISIE; NOBANIS; OIE] 17. Hemigrapsus sanguineus (De Haan, 1835). Asian shore crab [GISP] 18. Hemigrapsus takanoi (Asakura & Watanabe, 2005). Hairy-clawed shore crab 19. Heterosigma akashiwo (Y. Hada) Y. Hada ex Y. Hara & M. Chihara 20. Infectious haematopoietic necrosis virus (IHN) [OIE] 21. Infectious salmon anaemia virus (ISA) [OIE] 22. Marenzellaria viridis (Verrill, 1873). Red-gilled mud-worm

	23. Marteilia refringens (Grizel, Bonami, Cousserans, Duthoit & Le Pennec, 1974). Aber disease [OIE] 24. Mnemiopsis leidyi (A. Agassiz, 1865). American comb jelly [DAISIE; GISP; NOBANIS] 25. Neogobius melanostomus (Pallas, 1814). round goby [DAISIE; GISP; NOBANIS] 26. Ocenebra inornata (Récluz, 1851). Japanese oyster drill [GISP] 27. Ostreid herpesvirus 1-microvariant (OsHV-1 µvar), causing summer mortality syndrome in Pacific oysters [OIE] 28. Pseudorasbora parva, top-mouthed gudgeon, stone morocco, false harlequin [DAISIE; NOBANIS] 29. Sphaerothecum destruens. (Arkush, Mendoza, Adkison, & Hedrick, 2003). Rosette agent 30. Styela clava. (Herdman, 1881). club tunicate [DAISIE; GISP; NOBANIS] 31. Undaria pinnatifida (Harvey Suringar, 1873). Japanese kelp, wakame [DAISIE; GISP] 32. Vibrio cholorae. (Pacini 1854). **Notes:** DAISIE: Delivering Alien Invasive Species Inventories for Europe, 2009 GISP: Global Invasive Species Programme NOBANIS: The European Network on Invasive Alien Species 6. National Parks and Wildlife Service (NPWS) Invasive species Ireland list of established marine NIS and species with the potential to become established: **Established species:** Didemnum vexillum, Slipper Limpet (Crepidula fornicata), Smooth cordgrass (Spartina anglica), Wakame (Undaria pinnatifida), Wire weed (Sargassum muticum). **Potential Species:** Asian rapa whelk (Rapana venosa), Oyster drill (Ceratostoma inornatum and Urosalpinx cinerea), Red King Crab (Paralithodes camtschaticus). 7. Delivering Alien Invasive Species Inventories for Europe, 2009 Of the thirty-five most significant marine NIS identified by DAISIE (Delivering Alien Invasive Species Inventories for Europe, 2009), eight have been recorded in Ireland:

	The nematode parasite *Anguillicola crassus,* the barnacle *Amphibalanus improvisus,* the marine algae *Bonnemaisonia hamifera* and *Codium fragile,* the phytoplankton *Coscinodiscus wailesii,* the Pacific oyster *Crassostrea gigas,* the tube worm *Ficopomatus enigmaticus* and the sea squirt *Styela clava*
Assessment Method	The Approach taken for this assessment directly followed the requirements for the primary criteria D2D1; the number of newly introduced NIS, via human activity into the wild, from 2013. Species lists from the 2013 Initial Assessment, the 2014 NIS Risk Assessment and the GMIT 2019 report were examined and three newly introduced species identified. The current number of NIS in Irish marine waters was also determined i.e. 135. This number was determined following a thorough assessment of published NIS data, carried out in close collaboration with the Marine Institute, NPWS, GMIT, the National Biodiversity Centre, the EPA, the Department of Transport, Tourism and Sport and BIM.
Assessment Result	3 no. species are newly introduced since 2013: • *Undaria pinnatifida*, Wakame or Asian kelp • *Schizoporella japonica*, a bryozioan • *Perphora japonica*, a colonial sea squirt
Conclusion	Following a thorough assessment of published NIS data, carried out in close collaboration with the Marine Institute, NPWS, GMIT, the National Biodiversity Centre, the EPA, the Department of Transport, Tourism and Sport and BIM 3 no. newly introduced species have been identified in Irish Marine waters. • *Undaria pinnatifida*, Wakame or Asian kelp • *Schizoporella japonica*, a bryozioan • *Perphora japonica*, a colonial sea squirt Significant progress has been made in implementing management processes aimed at minimising new introductions.
Knowledge gaps	The recently published European Commission's Joint Research Centre's paper on MSFD D2[8] highlights the need for harmonization

	and coherent implementation of European Marine NIS; mostly in relation to NIS reference points, monitoring, and thresholds. The development of indicators at regional and subregional scale is needed and associated monitoring and surveillance in key areas is required. The Irish 2013 NIS assessment is now considered incomplete; confidence in the assessment of the number of new introductions since 2013 is therefore considered moderate. Research is ongoing, through the projects outlined on page 6 of this document, which will help us evaluate monitoring, modelling and mapping techniques.
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	6. The OSPAR Intermediate Assessment 2017, https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/ 7. The Horizon scanning workshop, https://www.itsligo.ie/2017/04/13/aliens-on-the-horizon-at-it-sligo/ 8. European Commission's Joint Research Centre's paper on MSFD D2, Tsiamis, Konstantinos et al, 2019, Non-indigenous species refined national baseline inventories: A synthesis in the context of the European Union's Marine Strategy Framework Directive. Marine Pollution Bulletin. 145. 429-435.			
	Assessment Data			
Data Sources	Interim Report of the Working Group on Introductions and Transfers of Marine Organisms (WGITMO), 7–9 March 2018, Madeira, Portugal. ICES CM 2018/HAPISG:11. 179 pp. https://www.researchgate.net/publication/328402634_WGITMO			
Data Locations (URL)	https://invasivespeciesireland.com/species-accounts/established/marine https://invasivespeciesireland.com/species-accounts/potential/marine http://www.biodiversityireland.ie/projects/invasive-species/union-concern-ias/ https://species.biodiversityireland.ie/			
Data Time Line	Start Date:	2013	End Date:	2018
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Descriptor 3 – Commercial fish and shellfish

Descriptor 3 Commercial fish and shellfish	**Assessment Sheet: Commercially-exploited fish and shellfish** **Criteria D3C1, D3C2 & D3C3** **Extraction of, or mortality/injury to, wild species including target and non-target species**
Key message	In 2013, Ireland completed an Initial Assessment of its maritime area, under the 2008 Marine Strategy Framework Directive (MSFD; Directive 2008/56/EC). An updated assessment has now been carried out with respect to the original Directive and newly established criteria, elements and methodological standards as set out in Commission Decision (EU) 2017/848 and amending Commission Directive (EU) 2017/845. In relation to populations of all commercially-exploited fish and shellfish species, the status of 177 stocks within Ireland's designated MSFD area was assessed. A key finding is that there has been a substantial improvement in fishing mortality, assessed under Criterion D3C1 set out in Commission Decision 2017/848. Of the commercially-exploited stocks that were assessed in both cycles, there was an 80% improvement in the fishing mortality criterion. It is concluded that a total of 34 stocks have achieved GES, while the environmental status of 99 stocks is currently unknown. In the case of 44 other stocks, GES is not being achieved.
Background	Fisheries that occur in Ireland's maritime area are managed both under the EU's Common Fisheries Policy (CFP) and nationally for stocks not subject to the EU quota regime. This assessment covers all criteria elements under MSFD D3. The assessment covers both stocks managed under the CFP and those managed nationally, which are fished in Irish MSFD waters. Many of these stocks straddle the boundary between Ireland and other jurisdictions, while some are exploited in Irish waters, but not by Irish vessels. The relevant criteria for inclusion of stocks in the assessment is based on Commission Decision 848/2017, as follows: (a) all stocks that are managed under Regulation (EU) No 1380/2013; (b) the species for which fishing opportunities (total allowable catches and quotas) are set by Council under Article 43(3) of the Treaty on the Functioning of the European Union;

	(c) the species under multiannual plans according to Article 9 of Regulation (EU) No 1380/2013; (d) the species under national management plans according to Article 19 of Regulation (EC) No 1967/2006; (e) any important species on a regional or national scale for small-scale/local coastal fisheries.
Objective	Irelands Initial Assessment (2013) described the characteristic of Good Environmental Status (GES) for populations of commercial fish and shellfish as follows: Populations of commercially exploited fish and shellfish are within safe biological limits. Stocks of commercially exploited fish and shellfish species are exploited at levels which ensure long term sustainability and maintenance of sufficient reproductive capacity. Populations exhibit a healthy composition with regard to age and size distribution. Consistency to be maintained in accordance with the progressing reform of the EU Common Fisheries Policy, The associated targets outlined in the Initial Assessment (2013) were as follows: • Target fishing mortality to be at levels which aim to restore and maintain populations of harvested species at least at levels which can produce the maximum sustainable yield (MSY), by 2015, where possible. Where stocks are managed within an agreed management plan, which is consistent with MSY in the long term, target fishing mortality as specified by the management plan should be adhered to; • Target fishing mortality to be at levels which aim to restore and maintain populations of harvested species at least at levels which can produce the maximum sustainable yield, by 2020, for all stocks. Where stocks are managed within an agreed management plan, which is consistent with MSY in the long term, target fishing mortality as specified by the management plan should be adhered to; • Spawning Stock Biomass (SSB) should be within the range of biomasses which would be expected under fishing mortality equal to or below FMSY in the medium to long term and incorporate scientific uncertainty and natural variability;

	• Size and age structure as measured by selected indicators reflect populations which are sustainably fished in the medium to long term and incorporate scientific uncertainty and natural variability. The environmental targets from the Initial Assessment (2013) have now been updated in light of the Commission Decision (EU) 2017/848 amending Commission Directive (EU) 2017/845. Ireland has now established the following environmental targets, based on the revised Common Fisheries Policy, Regulation (EU) 1380/2013, which stipulates that “in order to reach the objective of progressively restoring and maintaining populations of fish stocks above biomass levels capable of producing maximum sustainable yield, the maximum sustainable yield exploitation rate shall be achieved by 2015 where possible and, on a progressive, incremental basis at the latest by 2020 for all stocks.” Therefore, Ireland’s environmental targets under Descriptor 3 are: **Environmental Target D3T1: The Fishing mortality rate of populations of commercially-exploited species is at or below levels which can produce the maximum sustainable yield (MSY).** **Environmental Target D3T2: The Spawning Stock Biomass of populations of commercially-exploited species are above biomass levels capable of producing maximum sustainable yield (MSY).** The threshold value for the proportion of stocks required to be achieving GES is 100%, following Common Fisheries Policy Regulation (EU) 1380/2013, which stipulates that “in order to reach the objective of progressively restoring and maintaining populations of fish stocks above biomass levels capable of producing maximum sustainable yield, the maximum sustainable yield exploitation rate shall be achieved by 2015 where possible and, on a progressive, incremental basis at the latest by 2020 for all stocks.”
Drivers (Activities)	Irish waters are a subset of the Celtic Seas ecoregion – as defined by ICES - and share the general characteristics of that ecoregion. The Celtic Seas ecoregion supports some of the most productive fishing grounds in Europe. At least 8 major fishing nations currently have fisheries targeting the many marine stocks within this area. The greatest volume of landings is by Norway, UK, Ireland, the

	Netherlands, and France. Lesser amounts are landed by Germany, Spain and Belgium. These fisheries target a large number of stocks. The pelagic fisheries, which account for the largest catches (by weight) in the region are the mid-water trawl fisheries for blue whiting, mackerel, horse mackerel, herring, boarfish, and sprat. The largest demersal fishery targets hake along the shelf edge using gillnets and longlines. There are also large mixed bottom-trawl fisheries targeting benthic species, *Nephrops*, and gadoids. The species composition of these mixed fisheries tends to vary, depending on the area and the countries involved in the fishery. In addition, there are many inshore fisheries which take place, inside 6-12 miles and mostly use static fishing gears. Landings from nations such as Ireland, Norway, the Netherlands, Germany and Denmark are dominated by pelagic species. Other nations within the EU target a combination of pelagic, demersal (including *Nephrops*), deep-water, and shellfish species. France has the highest reported effort. Effort levels for most countries show declining trends, with the most pronounced decline seen in Spanish effort. The catches of pelagic species vary both spatially and temporally. Mackerel and blue whiting are caught mainly on their southward migrations along the shelf edge to spawning grounds in spring. The main international blue whiting fishery is around the Porcupine Bank. Mackerel and horse mackerel are caught throughout the ecoregion and catches are highest west of Ireland. Herring catches are concentrated in the Celtic Sea, and on the Donegal coast. The highest boarfish catches are in the western Celtic Sea. The albacore tuna fishery occurs in the southwestern part of Irish waters late in the season when effort extends north from the Bay of Biscay. Hake are caught in deeper waters (> 70 m), along the continental shelf edge where the directed gillnet and longline fisheries occur. Anglerfish are also common throughout, with the highest catches on the shelf in the Celtic Sea. The highest megrim catches are in the western Celtic Sea. Whiting catches are highest in the Celtic Sea south of Ireland where there are also significant catches of haddock and cod. Pollack are mainly caught in inshore areas off Cornwall and along the southern coast of Ireland. The main *Nephrops* catches are in the western Irish Sea, the Aran Islands Ground, the Celtic Sea, and

	on the Porcupine Bank. Brown crab catches mainly occur off northwest Ireland. Otter trawl is the main gear by effort used in demersal fisheries in the Celtic Sea ecoregion. The species caught depends on the area, depth-range habitat, and season fished, as well as on the cod-end mesh size, but in all cases the catches consist of a mixture of different species. *Nephrops* is an important target species for otter trawls on discrete muddy grounds within the ecoregion. Vessels typically, although not exclusively, use twin- or quad-rig trawls with 80 mm cod-ends. A small wanted bycatch of fish species includes cod, haddock, plaice, anglerfish, and to a lesser extent sole. The use of selective gears (grids, square mesh, and separator panels) to reduce unwanted fish bycatch has increased over time. Mixed fisheries target both *Nephrops* and fin-fish in the Celtic Sea using a larger mesh size (100 mm or more). Fin-fish are targeted with both small (80–99 mm) and larger (> 99 mm) mesh sizes in different parts of the ecoregion, depending on regulation and target assemblage. Smaller mesh otter trawls and seiners are typically used to target a broad mixture of species, including gadoids, flatfish, and other benthic species. These fisheries primarily occur within the Celtic Sea, along the slope west of Ireland and Scotland, and in the western English Channel. Large-mesh otter trawlers (typically 100 mm or 120 mm) tend to target gadoids, anglerfish, or rays. Deep-water trawl fisheries are conducted in ICES subareas 6 and 7, principally by France, with some other participation, mainly Spanish. Trawling in waters deeper than 800 m, and gillnetting in waters deeper than 600m is prohibited by Regulation EC41/2007. This mixed deep-water trawl fishery mainly targets roundnose grenadier, black scabbardfish, and blue ling, with a bycatch mainly of smoothheads and deep-water sharks on the continental slope and offshore banks of subareas 6 and 7. Beam trawlers operate on sandy grounds in the Irish and Celtic seas. The majority of the vessels use meshes in the range of 80–89 mm, and come from Belgium, the UK, and Ireland. In the Irish Sea, the vessels primarily target plaice and sole (although the sole fishery has declined significantly in the last decade). There is also a fishery for

	ray species in the southern Irish Sea. In the Celtic Sea, the beam-trawl fishery occurs on grounds where sole, anglerfish, cuttlefish, and megrim are abundant and the seabed is suitable for beam trawling. The fishery has bycatches of anglerfish, cod, haddock, and whiting. The main gillnet fishery, (mainly with 120 mm mesh size) in this ecoregion targets hake along the continental slope. Spanish, French, UK, and Irish vessels are involved in the fishery, which typically operates at depths of 150–600 m. In the shallower Celtic Sea, where mesh sizes used are 120–219 mm, target species include anglerfish, flatfish, and gadoids. A large number of inshore gillnetters (< 12 m) are also active in the Celtic Sea ecoregion. The target species and gears used tend to vary spatially and temporally. In the first quarter, the primary target of inshore gillnetters operating in divisions 7.g and southern 7.a is cod. Fisheries around the Irish coast seasonally target anglerfish, flatfish, pollack, and catsharks. Spanish-, French-, and UK-registered longliners target hake along the continental slope with bycatches of ling, blue ling, and other deep-water species. In addition to the above, inshore fishing takes place inside 12 nm of the Irish coast, while fishing from the baselines to 6nm is limited to Irish and Northern Irish owned and operated vessels only. The Irish fleet is, currently divided into a number of sub-segments. The Polyvalent [Potting] Sub-segment consists of small vessels fishing exclusively by means of pots for crustaceans and whelk. The polyvalent [Scallop] Sub-segment consists of larger vessels target great scallop. The Polyvalent [<18 m vessel length] and [≥18 m vessel length] sub-segments consist of vessels targeting a broad range of species. Some of these vessels target the same stocks as offshore fleets. A new development in recent years has been the targeting of wrasse stocks, using pots, to supply cleaner fish which remove sea-lice from farmed salmon.
Pressures	The predominant pressure exerted by fishing in Irish waters has been identified as extraction of or mortality/injury to wild species by commercial fishing. This is defined as a pressure under the MSFD Commission directive 2017/845. Such extraction of fish from a stock

	through fishing leads to fishing mortality on target and by-catch species. Fishing mortality is measured under criterion D3C1 of the MSFD, whilst by-catch mortality is measured against D1C1 under the D1 biodiversity descriptor of the MSFD. Other pressures from commercial fishing, which have been identified in Irish waters are abrasion, incidental loss of species and litter. No important pressures on the fish resource which do not come from commercial fishing have been identified to date.
State	The state of fish stocks is usually determined from their reproductive capability which is determined by measuring its spawning stock biomass, denoted “SSB”. In some cases, state is determined by total biomass, if SSB cannot be ascertained. For a stock to be consistent with criterion D3C2, SSB must be above levels capable of producing MSY (maximum sustainable yield). If F is too high, SSB may not stabilise around levels that could support MSY.
Impact	Among the parameters and characteristics specified in Commission Directive 2017/845 that are likely to be impacted upon by fisheries are: changes to distribution and/or biomass; size, age and sex structure, fecundity, survival and mortality/injury; behavior including movement and migration; habitat for the species (extent, suitability); and species composition within groups of species. ICES has evaluated the main impacts of fishing on the marine environment as extraction, abrasion and smothering. Extraction of, or mortality/injury to, wild species by fishing and other activities impacts on food webs, benthos, populations of fish, seabirds and mammals. Such extraction of fish from a stock through fishing activities is measured as fishing mortality and is denoted “F”. Fishing mortality should be at or below rates which can produce maximum sustainable yield (MSY) to be consistent with D3C1 of the MSFD. This rate is termed F_{MSY}. For stocks which are either at or at risk of being unable to reproduce themselves, fishing mortality must be reduced to below F_{MSY}, to a rate consistent with recovery. The reproductive capability of a fish stock is measured as its spawning stock biomass, denoted “SSB”. In some cases, state is determined by total biomass, if SSB cannot be ascertained. To be consistent with criterion D3C2, SSB must be above levels capable of producing MSY. If F is too high, SSB may not stabilise around levels that could support MSY.

	Physical disturbance (abrasion and smothering) of the seabed by fishing impacts on marine habitats in general, on benthos and on marine productivity. Abrasion is associated with bottom-contacting mobile and set fishing activities, in particular scallop dredging, beam trawling, and otter trawling but also other activities such as anchoring and hydrodynamic dredging. Smothering refers to activities contributing to change in siltation on the seabed include dredging for shipping, disposal of materials to the seafloor, and commercial fishing. ICES has previously advised zero catches in this ecoregion for stocks of rare or threatened species such as basking shark, porbeagle, angel shark, the common skate complex, white skates, undulate rays, orange roughy, deep-water sharks (kitefin shark, leafscale gulper shark, Portuguese dogfish), and greater silver smelt. These stocks have been either targeted or by-caught in fisheries in the past and are now depleted. Information on these stocks is sparse, but they require special management attention to conserve remaining populations.
Assessment Method	The assessment is based on results of ICES or Marine Institute advice/additional assessments for individual stocks, giving results in terms of F (D3C1) and SSB (D3C2). All stocks which have a landings value recorded in the FAO FISHSTAT database were included, if the stock occurs the Irish MSFD area. In a few cases additional analyses were conducted to evaluate the status of stocks which have not previously been advised upon by either the MI or ICES. However, no additional assessments were performed for any stock which was already assessed by ICES, even if ICES classified the stock as unknown. ICES provides advice on fishing mortality and SSB reference points F_{MSY} and MSY $B_{trigger}$. F_{MSY} is estimated as the fishing mortality with a given fishing pattern and current environmental conditions that gives the long-term maximum yield. MSY $B_{trigger}$ is the lower bound of spawning–stock biomass fluctuation when fished at $F_{MSY.}$ The approach does not use a B_{MSY} estimate. B_{MSY} is a notional value around which stock size fluctuates when fishing at F_{MSY}. Determination of MSY $B_{trigger}$ requires contemporary data with fishing at FMSY to identify the normal range of fluctuations in biomass when stocks are fished at this fishing mortality rate. When sufficient observations of SSB fluctuations associated with fishing around FMSY are available, the MSY $B_{trigger}$ should be re-estimated to

	correspond to the lower bound of the range of stock sizes associated with MSY. For all shellfish stocks other than *Nephrops* stocks the Marine Institute analyses were used to populate this assessment. These analyses are presented in the Review of Shellfish Stocks 2018. Two methods are used to establish F in relation to F_{MSY}, spawning potential ratio (SPR) or harvest ratio (HR). SPR defines the ratio of spawning under current (likely) fishing mortality rate to that of an unexploited stock (Bo). Limit and target reference points for SPR are generally accepted to be 0.1 and 0.35 respectively based on meta-analysis of fish stocks response to exploitation. Hence 0.35*SPRBo corresponds to B_{MSY}. Where the SPR is not defined analytically it can be described by the relationship between size at maturity and size at first capture (Minimum Landing Size or Minimum Conservation Reference Size, MCRS) especially where discard mortality is negligible as is the case for most shellfish. All shellfish have an MCRS which is designed to enable some spawning escapement and which provides for a given SPR. HR or catch biomass ratio, is the proportion of the biomass, removed annually. HR corresponding to F_{MSY} will vary between stocks i.e. some species can sustain higher levels of F or HR than others. For stocks where reference points are unavailable the sustainable HR is unknown. In these cases, the response of the stock to the HRs, and which are controlled by TAC, are monitored over time and adapted. For non-ICES shellfish stocks, stock biomass can be described directly from surveys, where such surveys provide estimates of absolute biomass, and by proxies such as biomass indicators from surveys or catch per unit effort (CPUE) from commercial data. The stock status relative to B_{MSY} is not generally known but proxies could include trends in surveys or CPUE and comparison of current or recent position against long term trends. This should, however, be qualified given that the historic trend is likely to already represent an exploited stock time series and true Bo (unexploited) or B_{MSY} remains unknown. These time series can also be analysed using various stock assessment procedures and may provide estimates of B_{MSY}. For a small number of stocks not assessed by either ICES or the MI through its shellfish assessments, survey trend analyses were performed. The reference point used in these analyses was the relationship between survey abundance over time versus the long term average, following Commission Decision 2017/848 concerning

	the determination of GES. Those stocks above the average were considered to be have achieved GES. The assessment was carried out for 177 stocks/species of fish, crustaceans and shellfish. Of the stocks in Irish waters, 18% were found to have achieved GES while the environmental status of 59% of stocks is unknown. A further 22% of stocks were found not to have achieved GES. ICES advises that the data currently collected on fish length for stock assessment purposes is suitable to assess the size distribution of a stock (D3C3) but that until the proof of concept has been validated, D3C3 is not operational for MSFD assessment purposes.
Assessment Result	The assessment of Good Environmental Status (GES) of commercial fish stocks is based on whether stocks are fished at or below a rate consistent with maximum sustainable yield (MSY) and whether their SSB is above the level that can produce MSY. For pelagic fish, 3 stocks were found to have achieved GES, 5 stocks have not achieved GES and the environmental status of 6 stocks is currently unknown. Among the pelagic stocks that have achieved GES are albacore tuna, swordfish and Irish Sea herring. Among the stocks not achieving GES are mackerel, blue whiting and western horse mackerel. Horse mackerel met criterion D3C1 ($F \leq F_{MSY}$) but not D3C2 ($SSB > MSY\ B_{trigger}$). In contrast, mackerel and blue whiting met criterion D3C2 but not D3C1. Some stocks not meeting criterion D3C2 were experiencing recruitment impairment (e.g. herring in ICES Sub-area 6a and herring in the Celtic Sea). Bluefin tuna met D3C1 but was unknown in relation to D3C2 and hence unknown in relation to the achievement of GES. Others stocks were unknown under either criterion; these include sprat, pilchard and boarfish. For demersal fish, 10 stocks were found to have achieved GES, 18 stocks have not achieved GES and the environmental status of 18 stocks is currently unknown. Among those stocks that have achieved GES are northern hake, saithe in ICES Sub-areas 4, 6 and 3a and megrim in ICES Sub-areas 4 and 6a. Of the stocks not achieving GES, whiting in the Irish Sea, cod and sole in the Celtic Sea and plaice off southwest Ireland did not meet either assessment criterion. Stocks not meeting criterion D3C1 included haddock off NW Ireland, megrim in the Celtic Sea and Biscay, whiting and haddock in the Celtic Sea. Stocks not meeting criterion D3C2 included sea bass in

	ICES Sub-area 4bc, 7a, and 7d-h, cod and sole in the Irish Sea. Among the stocks of unknown environmental status were plaice, sea bass and sole off the northwest of Ireland. Anglerfish in the Celtic Sea and Biscay met criterion D3C1, but was unknown in relation to D3C2. Of demersal shellfish stocks, 10 were found to have achieved GES, 4 stocks have not achieved GES and the environmental status of 8 stocks is currently unknown. GES was achieved for most *Nephrops* stocks with the exception of the Aran grounds stock, whilst the environmental status of *Nephrops* on the Porcupine grounds is currently unknown overall but it did not meet D3C1. Edible crab stocks met criterion D3C1, but were unknown for D3C2. Most king scallop stocks were found have achieved GES overall. For coastal shellfish stocks, 9 stocks were found to have achieved GES, 15 stocks have not achieved GES and the environmental status of 23 stocks is currently unknown. Most razor clam stocks have achieved GES, though most lobster and native oyster stocks have not done so. Many lobster stocks met criterion D3C2 but not D3C1. In contrast most native oyster stocks met D3C1 but not D3C2. Of the elasmobranch stocks being commercially exploited, the environmental status of most stocks (n=16) was found to be currently unknown. One stock (i.e. blue shark) was found to have achieved GES, while shortfin mako shark and spurdog have not achieved GES. Spurdog met criterion D3C1, unlike the others. Among the remaining commercially-exploited stocks in Irish waters, the environmental status of all cephalopod stocks and coastal fish is found to be currently unknown. This will require more work, particularly for the coastal fish species. This work would involve biological studies and catch data collection schemes.

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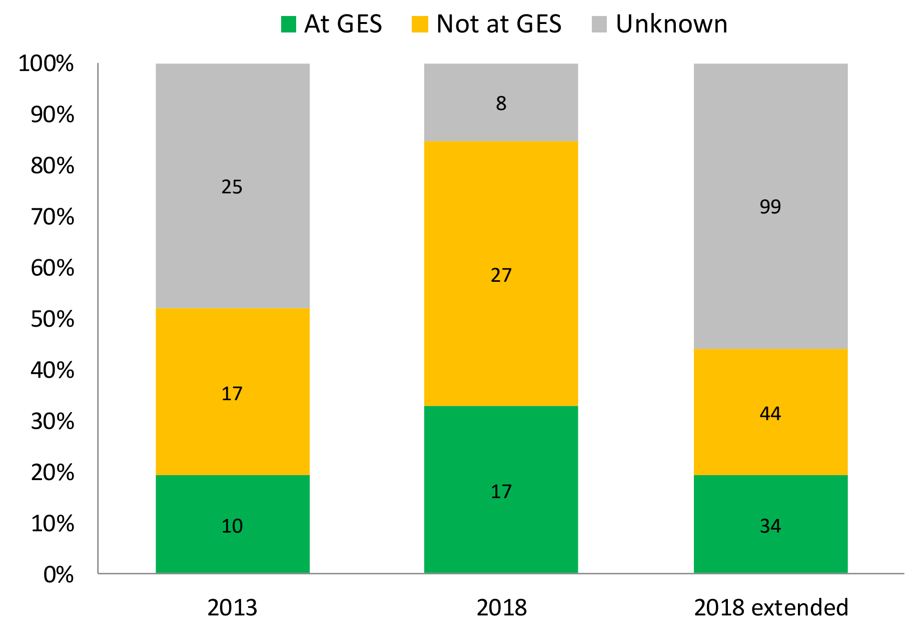

Figure 1. Percentage and number of stocks achieving GES in 2012 (first MSFD cycle) and 2018 (second MSFD cycle) for the same set of stocks, and also in 2018 for all stocks in Irish waters. Stocks included in this assessment include those managed with TACs and also those not managed with TACs.

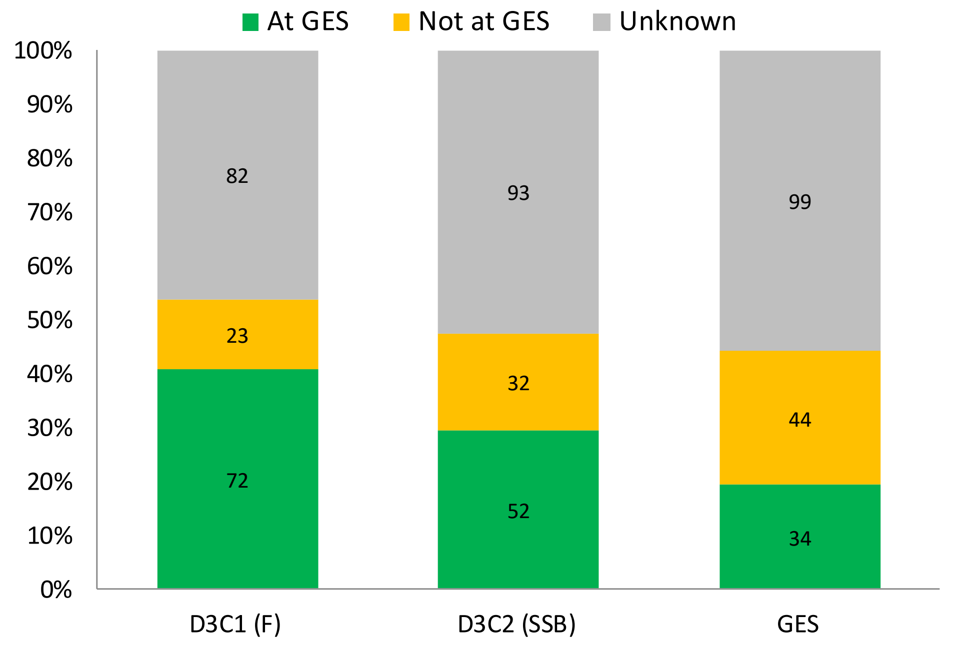

Figure 2. Percentage and number of stocks conforming to D3C1 (F at or below F_{MSY}), to D3C2 (SSB above MSY $B_{trigger}$) and achieving GES overall in 2018. Stocks included in this assessment include those managed with TACs and also those not managed with TACs.
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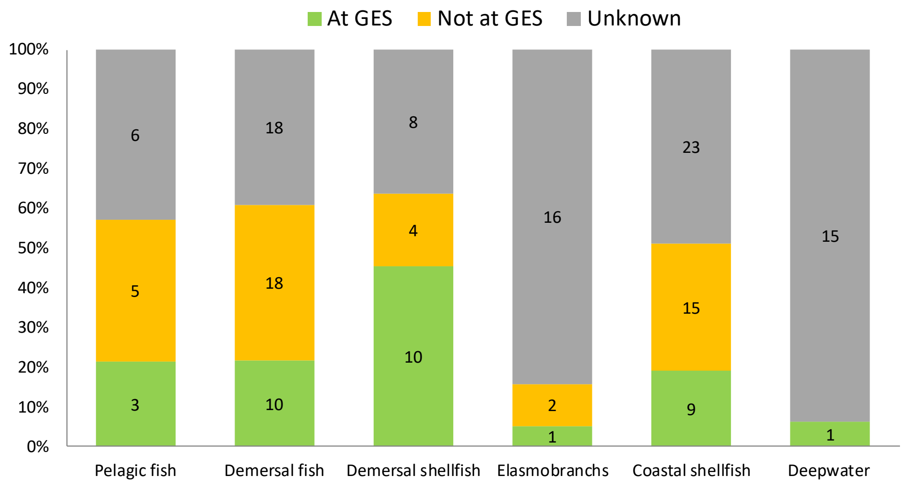
	 **Figure 3.** Percentage and number of selected stock groups in relation to the achievement of GES in 2018. The environmental status of all stocks in the categories Coastal fish and Cephalopods (not shown) is unknown. Stocks included in this assessment include those managed with TACs and also those not managed with TACs.
Conclusion	GES has been achieved for many but not for all commercially-exploited fish and shellfish stocks in Ireland's waters. The environmental status of many assessed stocks (n=99) is currently unknown. This is the case for stocks assessed by ICES and those assessed nationally. An estimated 25% of commercial stocks have not achieved GES. There was a substantial improvement in the metric for commercial fisheries Criterion D3C1, fishing mortality. Of the stocks assessed in both MSFD cycles so far, there was an 80% improvement in stocks meeting the requirements under Criterion D3C1. Though the proportion of all assessed stocks achieving GES is unchanged from 2013 there was a 25% improvement in the number of stocks that were originally found not to have achieved GES in 2013. A direct comparison with the initial assessment in 2013 (i.e. the same 52 stocks) shows a 70% improvement in the number of stocks that have achieved GES, with an almost 70% reduction in the number of such stocks for which the environmental status is unknown. Nevertheless, almost 60% more stocks were found not to have achieved GES.
Knowledge gaps	It is not currently possible to determine whether some stocks are within safe biological limits because because information is inadequate to assess both pressure and state. In the case of some stocks or species, it may never be possible to assess their

	environmental status in relation to GES. This is particularly challenging for cephalopod stocks, which are not easily assessed because they are so short-lived and are subject to fluctuations driven by environmental changes. Further work is also required to assess the status of some coastal fish (e.g. wrasse), which are currently unassessed. Apart from coastal stocks, almost all stocks in this assessment are exploited by more than one country. In order to assess progress towards achievement or maintenance of GES for these shared stocks, the assessments need to be undertaken in an international forum such as ICES. For the coastal stocks, work is ongoing at a national level on determining their life history parameters, quantification of catch and assessment of sustainable exploitation rates. More work and international cooperation is required to analyse if age and size distribution metrics available for populations of commercially-exploited species are indicative of healthy populations (i.e. Criterion D3C3).			
	Assessment Data			
Data Sources	Marine Institute and Bord Iascaigh Mhara. 2018. Shellfish Stocks and Fisheries Review. Galway. Marine Institute and Bord Iascaigh Mhara. 70 pp. Inshore stockbook 2018. Marine Institute 2018. The Stockbook, Annual Review of Fish Stocks in 2018 with Management Advice for 2019. 521 pp. Palma, S., Clarke, M. and Stokes, D. in prep. Status of non-assessed commercial and non-commercial fish in Irish waters. Irish Fisheries Bulletin. Marine Institute, Galway. ICES. 2017. EU request to provide guidance on operational methods for the evaluation of the MSFD criterion D3C3 (second stage 2017). Accessed on 12th September 2019 from https://www.ices.dk/sites/pub/Publication%20Reports/Advice/2017/Special_requests/eu.2017.07.pdf			
Data Locations (URL)	www.marine.ie			
Data Time Line	Start Date:	2013	End Date:	2018
Point of Contact	Maurice Clarke, Marine Institute FEAS, Rinville, Oranmore, Co. Galway			
Email	maurice.clarke@marine.ie			

Appendix: Assessment results for individual commercially-exploited fish and shellfish stocks.

Type	Stock	D3C1	D3C2	GES stock
Pelagic	Albacore Tuna North Atlantic	1	1	1
Pelagic	Bigeye tuna N. Atl.	-	-	?
Pelagic	Blue whiting Northeast Atlantic	0	1	0
Pelagic	Bluefin Tuna East Atlantic & Mediterranean	1	-	?
Pelagic	Boarfish 6, 7, 8	-	-	?
Pelagic	Herring 6aN, 7aS and 7bc	1	0	0
Pelagic	Herring 7aN	1	1	1
Pelagic	Herring 7aS 7g,j	0	0	0
Pelagic	NEA mackerel Northeast Atlantic	0	1	0
Pelagic	Pilchard Sub-area 7 (Southern Celtic Seas, and the English Cha	-	-	?
Pelagic	Pouting(=Bib) Sub-area 6 and 7	-	-	?
Pelagic	Sprat 6 and 7 (excl. 7d and 7e)	-	-	?
Pelagic	Swordfish North Atlantic	1	1	1
Pelagic	Western Horse mackerel 2a 4a 6 7a-c,e-k 8	1	0	0
Elasmobranch	Blonde ray 7a,f,g	-	-	?
Elasmobranch	Blue shark North Atlantic	1	1	1
Elasmobranch	Common stingray 6 and 7	-	-	?
Elasmobranch	Cuckoo ray 6, 7, and 8a,b,d	-	-	?
Elasmobranch	Lesser spotted catshark 6 and divisions 7.a–c and 7.e–j	-	-	?
Elasmobranch	Other skates 6 and 7	-	-	?
Elasmobranch	Painted ray 7f,g	-	-	?
Elasmobranch	Sandy ray 6 and 7	-	-	?
Elasmobranch	Shagreen ray 6and 7	-	-	?
Elasmobranch	Shortfin mako shark North Atlantic	0	0	0
Elasmobranch	Smooth-hounds NEA	-	-	?
Elasmobranch	Spotted ray 6, 7b,j	-	-	?
Elasmobranch	Spotted ray 7a,e,f,g	-	-	?
Elasmobranch	Spurdog Northeast Atlantic	1	0	0
Elasmobranch	Thornback ray 6	-	-	?
Elasmobranch	Thornback ray 7a,f,g	-	-	?
Elasmobranch	Thresher shark N. Atl.	-	-	?
Elasmobranch	Tope shark 6 and 7	-	-	?
Elasmobranch	Undulate ray 7b,j	-	-	?
Demersal fish	Anglerfish 6,2a, 3a, 4	-	-	?
Demersal fish	Anglerfish L. budegassa 7 & 8	1	-	?
Demersal fish	Anglerfish L. piscarorious 7 & 8	1	1	1
Demersal fish	Bass 4bc, 7a, and 7d–h	1	0	0
Demersal fish	Bass 6a, 7b, and7j	-	-	?
Demersal fish	Brill 6 and 7	-	-	?
Demersal fish	Cod 6a	0	0	0
Demersal fish	Cod 6b	-	-	?
Demersal fish	Cod 7a	1	0	0
Demersal fish	Cod 7e-k	0	0	0
Demersal fish	Common dab 6 and 7	-	-	?
Demersal fish	European conger 6 and 7	-	0	0
Demersal fish	European flounder 6 and 7	-	0	0
Demersal fish	Grey gurnard 6 and 7	-	1	?
Demersal fish	Haddock 4, 3a and 6a	0	1	0
Demersal fish	Haddock 6b	1	1	1

Type	Stock	D3C1	D3C2	GES stock
Demersal fish	Haddock 7a	1	1	1
Demersal fish	Haddock 7bce-k	0	1	0
Demersal fish	Hake 2, 3, 4, 6, 7, 8	1	1	1
Demersal fish	John dory 6 and 7	-	0	0
Demersal fish	Lemon sole 6 and 7	-	1	?
Demersal fish	Megrim 6a and 4	1	1	1
Demersal fish	Megrim 6b	1	1	1
Demersal fish	Megrim 7b-k & 8abde	0	1	0
Demersal fish	Plaice 5b(EU waters), 6, 12, 14	-	-	?
Demersal fish	Plaice 7a	1	1	1
Demersal fish	Plaice 7bc	-	-	?
Demersal fish	Plaice 7fg	1	1	1
Demersal fish	Plaice 7hjk	0	0	0
Demersal fish	Red gurnard 6 and 7	-	0	0
Demersal fish	Red mullet 6 and 7	-	-	?
Demersal fish	Saithe 4, 6 and 3a	1	1	1
Demersal fish	Saithe 7,8,9,10	-	-	?
Demersal fish	Sand sole 6 and 7	-	1	?
Demersal fish	Sole 5b(EU), 6, 12, 14	-	-	?
Demersal fish	Sole 7a	1	0	0
Demersal fish	Sole 7bc	-	-	?
Demersal fish	Sole 7fg	0	0	0
Demersal fish	Sole 7hjk	1	1	1
Demersal fish	Striped red mullet 6 and 7	-	-	?
Demersal fish	Tub Gurnard 6 and 7	-	0	0
Demersal fish	Turbot 6 and 7	-	1	?
Demersal fish	Whiting 6a	1	0	0
Demersal fish	Whiting 7a	0	0	0
Demersal fish	Whiting 7bce-k	0	1	0
Demersal fish	Witch flounder 6 and 7	-	1	?
Demersal shellfish	Edible crab Malin Shelf	1	-	?
Demersal shellfish	Edible crab North Irish Sea	1	-	?
Demersal shellfish	Edible crab South East	1	-	?
Demersal shellfish	Edible crab South West	1	-	?
Demersal shellfish	King scallop Celtic Sea	1	0	0
Demersal shellfish	King scallop NE Irish Sea	1	1	1
Demersal shellfish	King scallop NW Irish Sea	1	1	1
Demersal shellfish	King scallop SW Ireland	1	1	1
Demersal shellfish	King scallop SW Irish Sea	1	1	1
Demersal shellfish	Nephrops norvegicus 6 rectangles outside FUs	-	-	?
Demersal shellfish	Nephrops norvegicus FU11	1	1	1
Demersal shellfish	Nephrops norvegicus FU12	1	1	1
Demersal shellfish	Nephrops norvegicus FU14	1	1	1
Demersal shellfish	Nephrops norvegicus FU15	1	1	1
Demersal shellfish	Nephrops norvegicus FU16	0	-	0
Demersal shellfish	Nephrops norvegicus FU17	1	0	0
Demersal shellfish	Nephrops norvegicus FU18 & other rectangles	-	-	?
Demersal shellfish	Nephrops norvegicus FU19	1	1	1
Demersal shellfish	Nephrops norvegicus FU20-21	1	-	?

Type	Stock	D3C1	D3C2	GES stock
Demersal shellfish	Nephrops norvegicus FU22	1	1	1
Demersal shellfish	Queen scallop Inishowen	-	-	?
Demersal shellfish	Queen scallop North Irish Sea	0	0	0
Demersal cephalopod	Cuttlefish Sepia officionalis 7defgh	-	-	?
Demersal cephalopod	Northern Shortfinned squid Illex coindetii 7	-	-	?
Demersal cephalopod	Squid, European Squid, Various squids Loligo forbesi 6a7b	-	-	?
Demersal cephalopod	Squid, European Squid, Various squids Loligo forbesi 6b	-	-	?
Demersal cephalopod	Squid, European Squid, Various squids Loligo forbesi 7a	-	-	?
Demersal cephalopod	Squid, European Squid, Various squids Loligo forbesi 7jkfgh	-	-	?
Deepwater	Alfonsino 3-10,12,14	-	-	?
Deepwater	Argentine 5b,6a	1	-	?
Deepwater	Argentine 6b,7-10,12	-	-	?
Deepwater	Black scabbard 5,6,7, 12	-	-	?
Deepwater	Blackbelly rosefish 6,7	-	1	?
Deepwater	Blue ling 5b,6,7	1	1	1
Deepwater	Common mora 6 and 7	-	1	?
Deepwater	Deep-sea red crab NEA	-	-	?
Deepwater	Forkbeard 5,6,7	-	-	?
Deepwater	Ling 3a,4a, 6, 7, 8, 9,12, and 14	1	-	?
Deepwater	Longnosed skate NEA	-	-	?
Deepwater	Orange roughy NEA	-	-	?
Deepwater	Red seabream 6,7,8	-	-	?
Deepwater	Roundnose grenadier 5b, 6,7	-	-	?
Deepwater	Tusk 5,6,7	-	-	?
Deepwater	Wolffishes(=Catfishes) nei 6 and 7	-	-	?
Coastal shellfish	Blue mussel Castlemaine Hbr	-	-	?
Coastal shellfish	Blue mussel Irish Sea	-	-	?
Coastal shellfish	Cockle Castlemaine Hbr	-	-	?
Coastal shellfish	Cockle Drumcliffe Bay	-	-	?
Coastal shellfish	Cockle Dundalk Bay	1	1	1
Coastal shellfish	Crawfish South west	1	0	0
Coastal shellfish	Lobster Clare Galway	0	0	0
Coastal shellfish	Lobster Cork	0	1	0
Coastal shellfish	Lobster Kerry	0	1	0
Coastal shellfish	Lobster Mayo Donegal	0	1	0
Coastal shellfish	Lobster North Irish sea	0	1	0
Coastal shellfish	Lobster Waterford Wexford	0	1	0
Coastal shellfish	Native oyster Achill	1	0	0
Coastal shellfish	Native oyster Blacksod Bay	1	0	0
Coastal shellfish	Native oyster Clew Bay	1	0	0
Coastal shellfish	Native oyster Galway Bay	1	0	0
Coastal shellfish	Native oyster Kilkieran Bay	1	0	0
Coastal shellfish	Native oyster Lough Foyle	1	1	1
Coastal shellfish	Native oyster Lough Swilly	1	0	0
Coastal shellfish	Native oyster Tralee Bay	1	1	1
Coastal shellfish	Razor clam Ensis magnus Ballinakill	1	1	1
Coastal shellfish	Razor clam Ensis magnus Clifden Bay	1	1	1
Coastal shellfish	Razor clam Ensis magnus Inisbofin/Killary	1	1	1
Coastal shellfish	Razor clam Ensis magnus Iniskea Is	1	1	1

Type	Stock	D3C1	D3C2	GES stock
Coastal shellfish	Razor clam Ensis siliqua Curracloe	-	-	?
Coastal shellfish	Razor clam Ensis siliqua North Irish Sea	0	0	0
Coastal shellfish	Razor clam Ensis siliqua Rosslare	0	0	0
Coastal shellfish	Razor clam Ensis siliqua Waterford Estuary	1	1	1
Coastal shellfish	Shore crab all areas	-	-	?
Coastal shellfish	Shrimp Palaemon serratus Bantry	1	-	?
Coastal shellfish	Shrimp Palaemon serratus Clew Bay	1	-	?
Coastal shellfish	Shrimp Palaemon serratus Connemara	1	-	?
Coastal shellfish	Shrimp Palaemon serratus Galway Bay	1	-	?
Coastal shellfish	Shrimp Palaemon serratus Kenmare	1	-	?
Coastal shellfish	Shrimp Palaemon serratus North Irish Sea	1	-	?
Coastal shellfish	Shrimp Palaemon serratus Roaringwater	1	-	?
Coastal shellfish	Shrimp Palaemon serratus Shannon	1	-	?
Coastal shellfish	Shrimp Palaemon serratus Tralee	1	-	?
Coastal shellfish	Shrimp Palaemon serratus West Donegal	1	-	?
Coastal shellfish	Shrimp Palaemon serratus Wexford	1	-	?
Coastal shellfish	Spider crab Tralee Bay	1	-	?
Coastal shellfish	Surf clam Clifden Bay	-	-	?
Coastal shellfish	Surf clam Galway Bay	-	-	?
Coastal shellfish	Surf clam Waterford Harbour	1	1	1
Coastal shellfish	Velvet crab all areas	1	-	?
Coastal shellfish	Whelk Inishowen	-	-	?
Coastal shellfish	Whelk South Irish Sea	-	-	?
Coastal fish	Ballan Wrasse all areas	-	-	?
Coastal fish	Corkwing wrasse all areas	-	-	?
Coastal fish	Cuckoo Wrasse all areas	-	-	?
Coastal fish	Goldsinny wrasse all areas	-	-	?
Coastal fish	Pollack 6 and 7	-	-	?
Coastal fish	Rockcook Wrasse all areas	-	-	?
Coastal fish	Thicklip grey mullet all areas	-	-	?

List of abbreviations

B_0 — The biomass of a stock of fish/shellfish that has never been harvested.

B_{MSY} — The Spawning Stock Biomass consistent with delivering maximum sustainable yield.

CFP — Common Fisheries Policy

D3C1 — The Fishing mortality rate of populations of commercially exploited species is at or below levels which can produce the maximum sustainable yield (MSY).

D3C2 — The Spawning Stock Biomass of populations of commercially-exploited species are above biomass levels capable of producing maximum sustainable yield (MSY).

D3C3 — The age and size distribution of individuals in the populations of commercially-exploited species is indicative of a healthy population. This shall include a high proportion of old/large individuals and limited adverse effects of exploitation on genetic diversity.

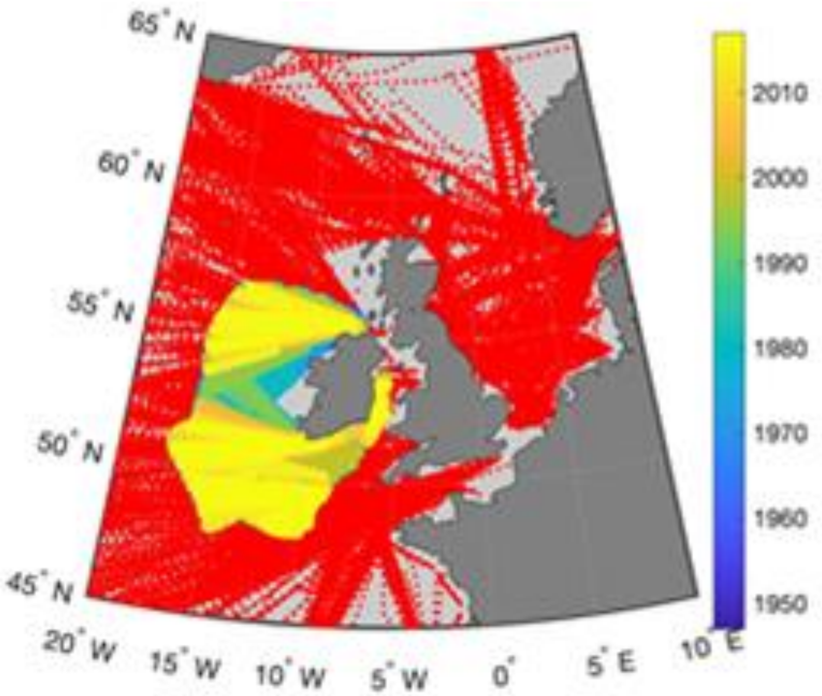
F_{MSY}	Fishing mortality rate that is consistent with achieving maximum sustainable yield
HR	Harvest Ratio, is the proportion of the biomass, removed annually
MCRSEU	Regulation Minimum Conservation Reference Size, below which fish/shellfish cannot be landed and sold for human consumption
MSY	Maximum Sustainable Yield
SPR	The ratio of spawning under current (likely) fishing mortality rate to that of an unexploited stock
SSB	Spawning stock biomass, the weight in tonnes of adults capable of spawning in a population.

Descriptor 4 – Food webs

Descriptor 4 Food webs	**Assessment Sheet: Ecosystems, including food webs Criteria D4C1 & D4C2 Trophic guilds of an ecosystem**
Key message	With regard to all elements of the marine food webs in Irish waters, the environmental status is currently unknown. There is some scientific evidence that components of the marine food webs are changing but it is not clear how they are affecting each other or the extent to which this is due to anthropogenic influence or associated pressures.
Background	Marine food webs are complex and those in Irish waters particularly so. The diverse elements and their relationships within the food web and wider ecosystem collectively represent one of the most difficult MSFD descriptors to assess. There are currently no regional or EU common indicators developed for the food web Primary Criteria D4C1 and D4C2, as defined in Commission Decision 2017/848. Progress towards the achievement of Good Environmental Status (GES) for marine food webs in Irish waters was assessed for phyto-plankton, zoo-plankton and fish. The indicators selected for this assessment comply with Commission Decision 2017/848 and consider at least 3 trophic guilds. However, the assessment does not fully integrate the assessment results across trophic guilds. The two Primary Criteria under MSFD Descriptor 4 are addressed in this assessment as follows: • D4C1: The diversity of the trophic guild is not adversely affected due to anthropogenic pressures. This was assessed for fish. • D4C2: The balance of total abundance between the trophic guilds is not adversely affected due to anthropogenic pressures. This was assessed in combination between phyto-plankton and zoo-plankton. The assessment of food web elements was undertaken for the Celtic Seas ecoregion as a whole. This is considered to be indicative of the Irish maritime area which comprises part of the wider eco-region.
Objective	In the 2013 MSFD Initial Assessment Ireland identified marine food webs as being safeguarded in a manner that would ensure that:

	1. Abundance, distribution, extent and condition of key species is in line with prevailing physiographic, geographic and climate conditions or is indicative of sustainable exploitation; 2. Age and size structure of key species is in line with prevailing physiographic, geographic and climate conditions or is indicative of sustainable exploitation; 3. Vulnerable (long-lived, slowly reproducing) species populations are maintained in line with prevailing physiographic, geographic and climate conditions or are indicative of sustainable exploitation. In broad terms, these objectives remain relevant for this MSFD Descriptor. However, in light of Commission Decision 2017/848, clearer methodological criteria have been given for use in the assessment and determination of Good Environmental Status, and in order to help frame the establishment of stronger environmental targets.
Drivers (Activities)	The predominant activity driving pressures on marine food webs, based on Commission Directive 2017/845, is extraction of living resources (fish and shellfish harvesting). At least 8 major fishing nations currently have fisheries targeting the many marine stocks within this diverse area. Detailed descriptions of this driver are provided in the Commercial Fishes D3 Assessment Sheet. Other relevant activities are cultivation of living resources, by aquaculture, agriculture and forestry; urban and industrial uses, such as waste treatment and disposal.
Pressures	The predominant pressure exerted on marine food webs in Irish waters is the extraction of or mortality/injury to wild species by commercial fishing. This is defined as a pressure under the amending Commission Directive (EU) 2017/845. Other relevant pressures, particularly in coastal waters, include for example the input of nutrients and inputs of organic matter.
State	There has been an increase in phyto-plankton abundance and a decrease in zoo-plankton abundance (particularly the small copepods) in recent years compared with the 1960s. Within the plankton community there have been significant changes in community structure and energy flows. For fish components of food

	webs there are local increases and decreases but for the greater part of Irish waters the situation is currently unclear.
Impact	The parameters and characteristics specified in Commission Directive 2017/845 that are likely to be impacted by anthropogenic pressures on food webs can be divided into species impacts, habitat impacts and ecosystem/food web impacts. The main species impacts are: changes to distribution and/or biomass, behavior including movement and migration, habitat for the species (extent, suitability) and species composition within groups of species. The main habitat impacts are: changes to species composition, abundance and/or biomass (spatial and temporal variation). The main ecosystem impacts can be summarised as: changes to links between habitats and species of marine birds, mammals, reptiles, fish and cephalopods, changes to pelagic-benthic community structure and/or productivity.
Assessment Method	The assessment of plankton communities follows the methodologies of the OSPAR Common Indicators PH1/FW5 and the methods of McQuatters-Gollop *et al*. (2018). The assessment of plankton biomass draws on OSPAR Common Indicator PH2. The indicators use data from the Continuous Plankton Recorder (CPR) transects taking place in Irish waters (Figure 1). The time series spans 1958 to 2014. The fish assessment uses the OSPAR Common Indicator of mean maximum length of fish developed by Lynam *et al.* (2018), which is calculated using catch data from scientific surveys for demersal and pelagic species separately.

	 **Figure 1.** Continuous plankton recorder (CPR) sampling effort in the Irish maritime area (yellow shading), also applicable to MSFD implementation.
Assessment Result	Almost all lifeform pair comparisons displayed moderate though significant change. The strongest change was observed between small and large copepods and between non-carnivorous and carnivorous zoo-plankton (Table 1), indicative of food web structure and energy flow between trophic groups. The holo-plankton and mero-plankton lifeform pair also experienced significant change, suggesting changes in linkage between the benthic and pelagic components of the ecosystem. The only non-significant change was in harmful algal bloom causing diatoms and dinoflagellates, though further work needs to be done to refine this comparison. The plankton biomass assessment identifies changes in plankton communities showing annual deviations from the assumed natural variability (anomalies) of the time series for the period 1958–2014. Such anomalies can be positive or negative with the magnitude of the change being split into three categories (small change, important change or extreme change). In the Celtic Seas as a whole, phytoplankton biomass showed variability across years with an increase since the mid-1980s (Figures 2 and 3). Zoo-plankton biomass has shown an overall decline throughout the time series, but particularly since the late 1980s (Figures 4 and 5). The assessment, though preliminary, shows that changes have occurred, highlighting potential issues for the wider marine ecosystem.

For fish, in most of the Irish sector of the Celtic Seas ecoregion the overall trend is unclear and the time scale short. Demersal fish size decreased along the shelf edge waters to the west and near some coasts, but with increases to the south of Ireland, (Figure 6). For the pelagic fish community there were increases in the central Irish Sea and Celtic Sea.

Results (figures & tables)

Table 1. Results of the assessment of PH1 common indicator for the period 2010-2014 vs. the time series back to 1958, showing the plankton index per life form pair, and significance level (p<0.05*, p<0.01**, NS not significant). A plankton index of 0 denotes complete change, whilst 1.0 denotes no change.

Lifeform Pairs	Indeterminate	Seasonally stratified	Notes
Carniv Zoop vs Non-Carniv Zoop	0.58**	0.52**	Indicator of energy flow and balance between primary consumers and secondary consumers
Diatim vs Auto and mixo dinoflagellates	0.76**	0.60**	Dominance by dinoflagellates may be an indicator of eutrophication or change in water column stability and may result in less desirable food webs.
Diatoms vs dinoflagellates	0.76**	0.61**	
HAB diatoms vs HAB dinos	0.88 NS	0.64**	Shift in algal community towards nuisance and/or toxic species which have the potential to impact other higher trophic level indicators
Holoplankton vs meroplankton	0.63**	0.65**	Indicator of strength of benthic-pelagic coupling and reproductive output of benthic versus pelagic faunas.
Pelagic diatoms vs tychopelagic diatoms	0.83**	0.78**	Indicator of benthic disturbance and frequency of resuspension events.
Phytoplankton vs non-carnivorous zooplankton	0.67**	0.72**	Indicator of energy flow and balance between primary producers and primary consumers
Small copepods vs large copepods	0.53**	0.51**	Size based indicator of food web structure and energy flows.

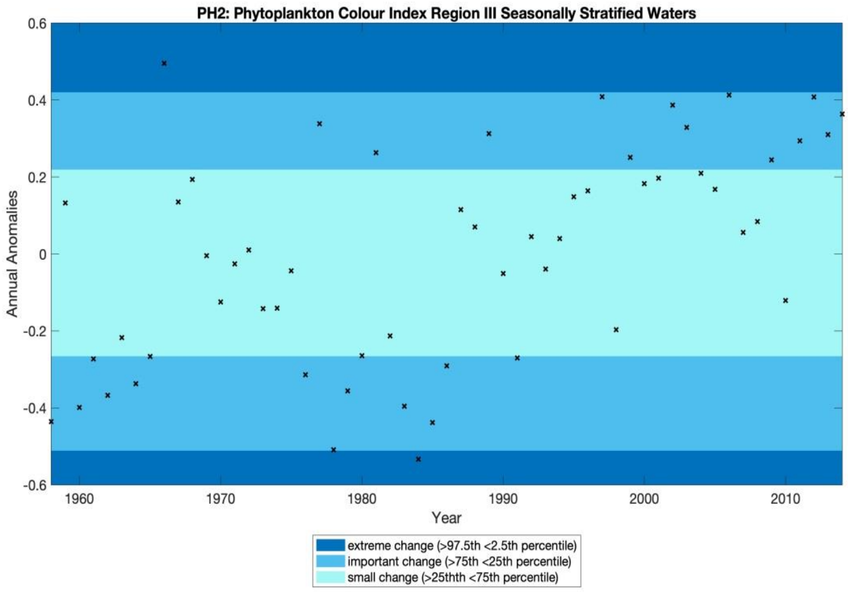


Figure 2. Annual anomalies in the phyto-plankton colour index for the Celtic Seas, for seasonally stratified waters over the period 1958–2017.

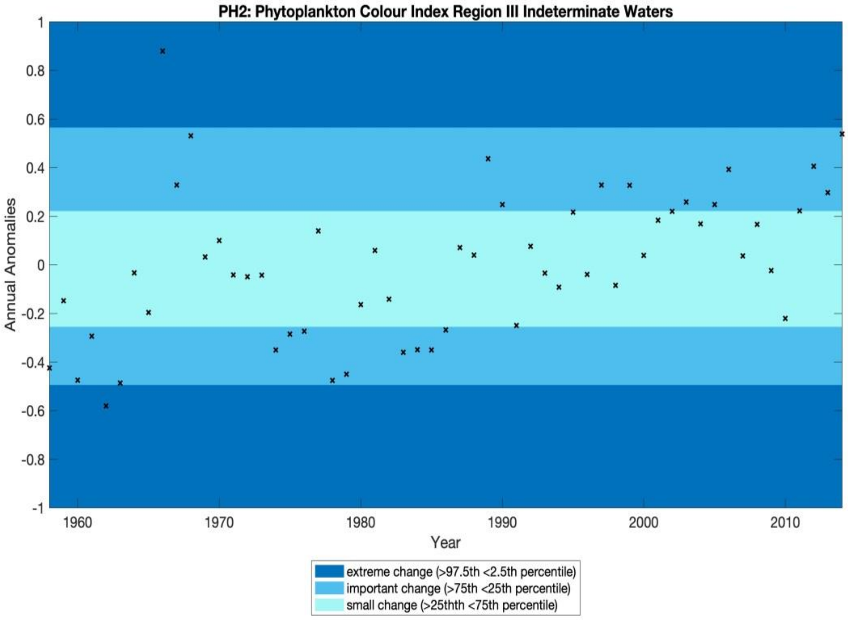


Figure 3. Annual anomalies in the phyto-plankton colour index for the Celtic Seas, for indeterminate waters over the period 1958–2017.

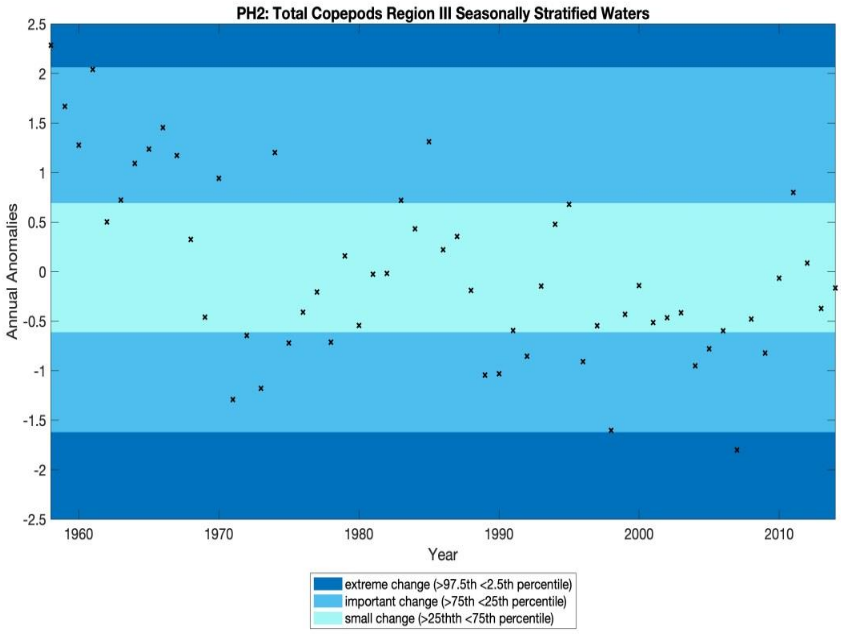


Figure 4. Annual anomalies in zoo-plankton abundance (total copepods) for the Celtic Seas, for seasonally stratified waters over the period 1958–2017.

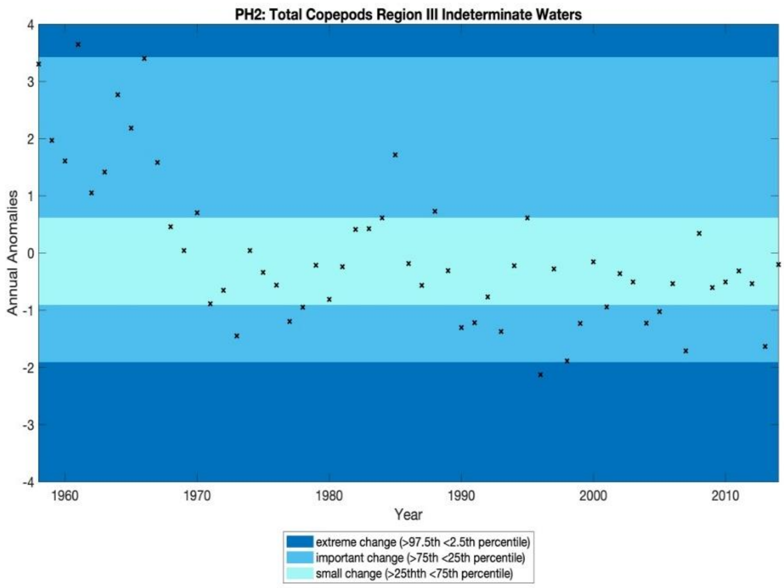


Figure 5. Annual anomalies in zoo-plankton abundance (total copepods) for the Celtic Seas, for indeterminate waters over the period 1958–2017.

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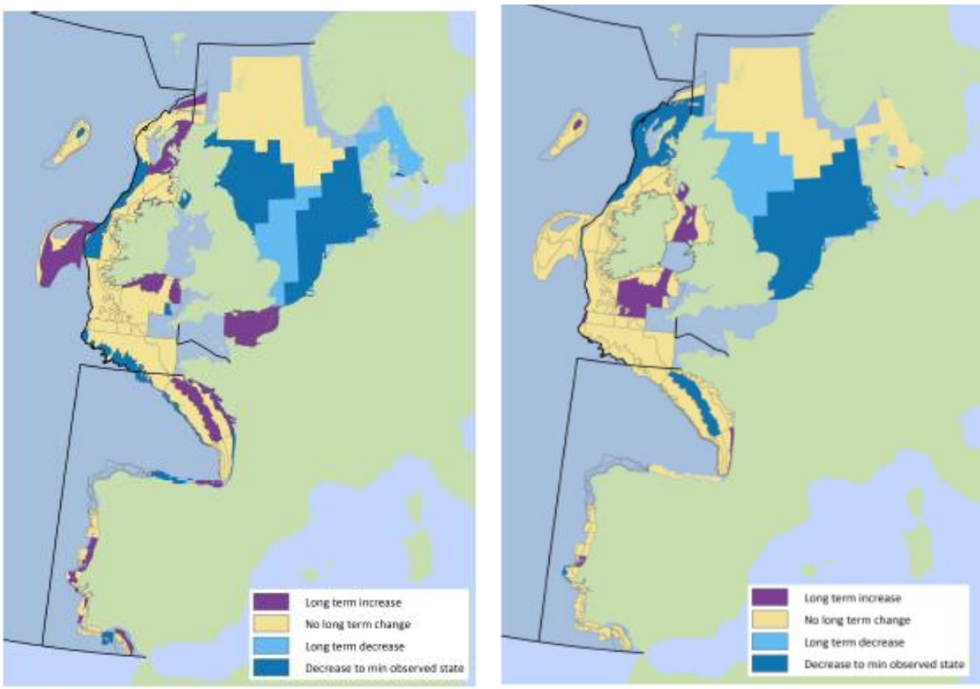
<tr><td></td><td>

Figure 6. Spatial patterns of mean maximum length of fish (left demersal fish, right pelagic fish).</td></tr>
<tr><td>Conclusion</td><td>With regard to all elements of the marine food webs in Ireland’s maritime area, the environmental status is currently unknown. There is some scientific evidence that components of the marine food webs are changing but it is not clear how they are affecting each other or the extent to which this is due to anthropogenic influence or associated pressures.

While the there are changes evident in plankton communities, the pressures driving change in lifeform pairs remain unclear. It would appear that prevailing physiographic conditions are the overall driver of change. For fish, the overall situation is unclear.</td></tr>
<tr><td>Knowledge gaps</td><td>This assessment covered food web elements under Primary Criteria D4C1 (fish trophic guild only) and D4C2 (phyto-plankton and zoo-plankton only). This is because there are currently no regional or EU common indicators covering these Criteria for any trophic guild. Work will be needed in this area in the future.

The assessment does not include top predator species. In addition, the time series for the fish trophic guild assessment is quite short; this is because the survey time-series from Irish waters is comparatively</td></tr>
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<tr><td></td><td colspan="4">recent. Considerable work will be required in the future to develop indicators covering both Primary Criteria for several trophic guilds.</td></tr>
<tr><td></td><td colspan="4">Assessment Data</td></tr>
<tr><td>Data Sources</td><td colspan="4">OSPAR, 2018. OSPAR CEMP Guideline Common indicator: PH1/FW5 Plankton lifeforms. 17 pp.

OSPAR (in prep). Coordinated Environmental Monitoring and Assessment Programme Guidelines for assessing changes in phytoplankton biomass and zooplankton abundance.

Lynam, C.P., Moriarty M., and Greenstreet, S.P.R. 2018. Size composition in fish communities (Typical Length). UK Marine Online Assessment Tool, available at: https://moat.cefas.co.uk/biodiversity-food-webs-and-marine-protected-areas/fish/size-composition/

McQuatters-Gollop, A., Atkinson, A., Aubert, A., Bedford, J., Best, M., Bresnan, E., Cook, K., Devlin, M., Gowen, R., Johns, D.G., Machairopoulou, M., McKinney, A., Mellor, A., Ostle, C., Scherer, C., and Tett, P. 2018. Change in Plankton Communities. UK Marine Online Assessment Tool, available at: https://moat.cefas.co.uk/biodiversity-food-webs-and-marine-protected-areas/pelagic-habitats/plankton-communities/

OSPAR 2018. CEMP Combined guideline for the common indicators FC1, FC2, FC3 and FW3 for fish and food webs (OSPAR Agreement 2018-05)1. Accessed on the 4th October 2019 from: https://www.ospar.org/documents?v=38999</td></tr>
<tr><td>Data Locations (URL)</td><td colspan="4">https://moat.cefas.co.uk/biodiversity-food-webs-and-marine-protected-areas/pelagic-habitats/plankton-communities/
https://moat.cefas.co.uk/biodiversity-food-webs-and-marine-protected-areas/fish/size-composition/
https://www.ospar.org/documents?v=38999</td></tr>
<tr><td>Data Time Line</td><td>Start Date:</td><td>1958</td><td>End Date:</td><td>2017</td></tr>
<tr><td>Point of Contact</td><td colspan="4">Maurice Clarke, Marine Institute FEAS, Rinville, Oranmore, Co. Galway</td></tr>
<tr><td>Email</td><td colspan="4">maurice.clarke@marine.ie</td></tr>
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Descriptor 5 – Eutrophication

D5 C1

Ref D5C1	**Assessment Sheet: Descriptor 5 Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters** D5C1 — Primary: Nutrient concentrations are not at levels that indicate adverse eutrophication effects.
Background	Eutrophication is diagnosed using OSPAR's harmonised criteria of nutrient inputs, concentrations and ratios, chlorophyll-a concentrations, phytoplankton indicator species, macrophytes, dissolved oxygen levels, incidence of fish kills and changes in zoobenthos (OSPAR Agreement 2010-3). As there is no single indicator of disturbance caused by marine eutrophication, OSPAR applies a multi-step method using the harmonised criteria. Eutrophication is considered to have occurred if there is evidence for all of the stages shown in **Figure 1** and of causal links between them (ECJ, 2009).

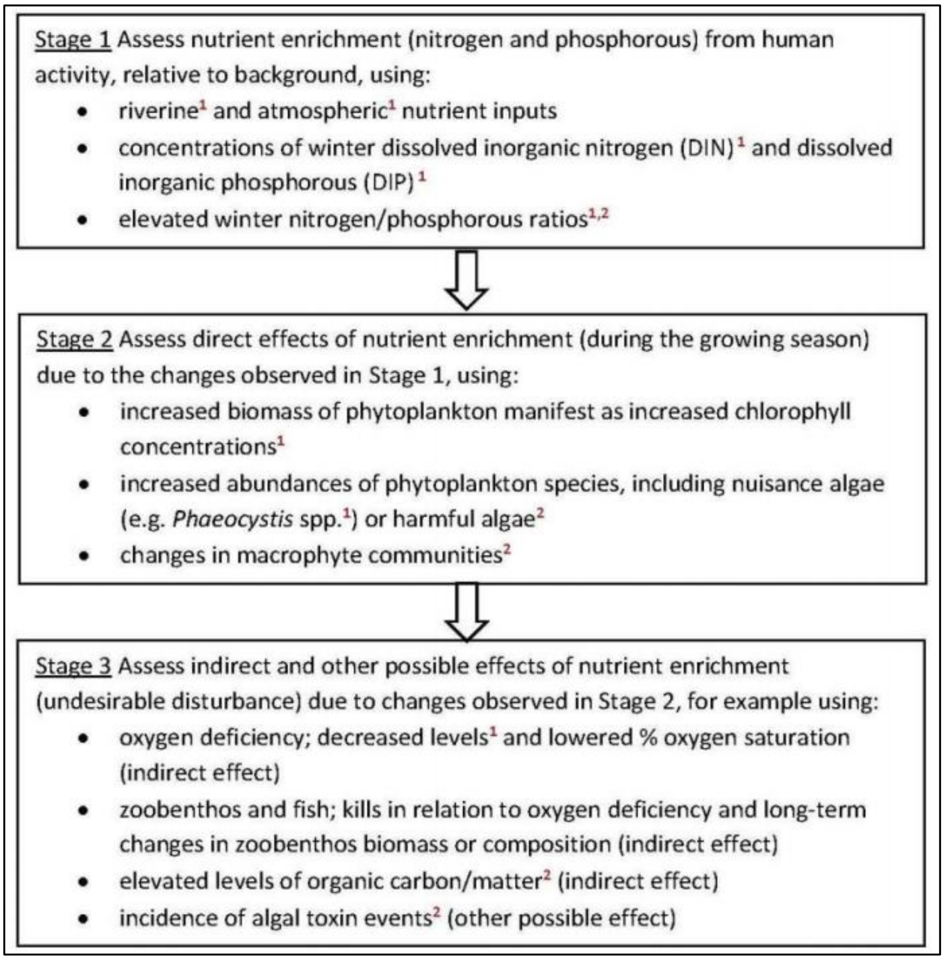

	Figure 1: Three stages in the identification of eutrophication. The criteria marked [1] are common indicators for the OSPAR Intermediate Assessment 2017. The criteria marked [2] are not relevant in all Contracting Parties' waters. Elevated nutrient concentrations promote the growth of phytoplankton and other plant life. Long-term winter dissolved inorganic nutrient concentrations and ratios, namely of nitrogen and phosphorus, act as indicators for quantifying the pressures of human activities and for evaluating the success of measures taken. For the interpretation of winter inorganic nutrient concentration gradients, sources and sinks, influx of nutrients from long distance transport and local upwelling events are important. Nutrient concentrations in coastal waters are mainly determined by riverine nutrient inputs and the mixing of these inputs with seawater. Riverine inputs are reflected by higher nutrient concentrations in coastal areas with lower salinity, decreasing seaward with lower concentrations in the open sea with deeper and more saline offshore waters (i.e. exhibiting nutrient gradients). The effect of these mixing processes on the assessment of nutrient concentrations needs to be taken into account. This is achieved by assessing nutrient concentrations within defined salinity bands.
Objective	D5C1 — Primary: Nutrient concentrations are not at levels that indicate adverse eutrophication effects.
Drivers (Activities) **Pressures**	Nutrients such as nitrogen, phosphorus and silicate enter the marine environment from the atmosphere, rivers, land runoff, or by direct discharges into the sea. Human activities can result in large quantities of nutrients entering the sea from sources that include agriculture, combustion processes (road traffic, shipping, power plants), municipal and industrial waste water treatment and aquaculture. Such nutrient discharges can lead to elevated nutrient concentrations in the marine environment, of which dissolved inorganic winter nutrient concentrations are a good indicator. Dissolved inorganic nitrogen, phosphorus and silicate concentrations are measured in winter when biological activity and uptake of nutrients by phytoplankton is low. Eutrophication is the result of excessive enrichment of water with nutrients. This may cause accelerated growth of algae and / or higher forms of plant life. This may result in an undesirable disturbance to the balance of organisms present and thus to the overall water quality.

	Undesirable disturbances can include shifts in the composition and extent of flora and fauna and the depletion of oxygen due to decomposition of accumulated biomass. Such disturbances then have other effects, such as changes in habitats and biodiversity, blooms of nuisance algae or macroalgae, decrease in water clarity and behavioural changes or even death of fish and other species. Identifying causal links between these disturbances and nutrient enrichment can be complicated by other pressures. Cumulative effects, including climate change, may have similar effects on biological communities and dissolved oxygen, further complicating efforts to demonstrate causal links. **Nutrient Inputs to the Marine Environment** As part of the Oslo Paris Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR), monitoring of nutrient inputs from 19 major Irish rivers to estuarine and coastal waters has been ongoing since 1990. Measuring these inputs provides a useful indicator of trends in the transfer of nutrients from land-based sources. The inputs are calculated based on nutrient concentrations, which are measured 12-times a year, and river flow, which is measured continuously. Nutrient inputs from Irish rivers have varied over the 29 years since monitoring began (Figure 2). Loads of total nitrogen were highest in the 1990s, then decreased until 2013. The reductions indicated the success of national measures aimed at reducing the loss of nutrients from terrestrial sources to surface waters. Since 2014 however, the trend has reversed and we are now seeing an increase in nutrient inputs to the marine environment. In recent years average total nitrogen in 2016–2018 has increased by 8,806 tonnes (16%) since 2012–2014. Average total phosphorus rose by 329 tonnes (31%) over the same period undoing the gains made over previous years.

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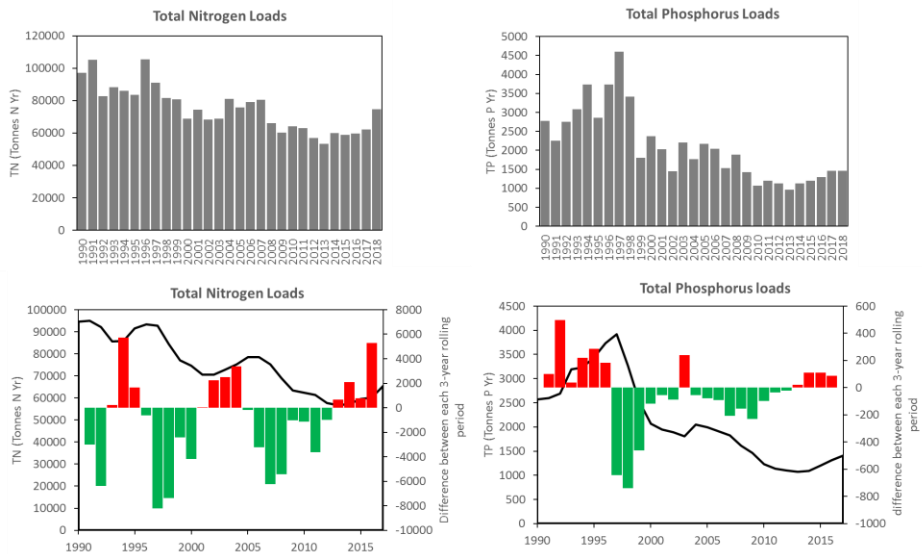

Figure 2: Loads of total nitrogen and total phosphorus (tonnes per year) between 1990 and 2018 for all monitored rivers combined. Areas under the black line (bottom graphs) indicate loads when averaged over three-year rolling periods. Green bars indicate a reduction from one three-year rolling period to the next; red bars indicate an increase.

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Estuarine and nearshore coastal waters
Winter Dissolved Inorganic Nitrogen (DIN) and Dissolved Inorganic Phosphorous (DIP) Concentrations

Nitrogen is considered the primary limiting nutrient in coastal systems while phosphorus or nitrogen can control the growth of phytoplankton and macroalgae in estuarine systems. In winter, the concentrations of both nutrients are expected to be at their highest due to the absence of any significant plant or algal growth. Salinity related thresholds have been defined for nitrogen and phosphorus and median nutrient concentrations above the thresholds indicates the presence of increased levels from pollution sources.

The level of exceedance above, or compliance below an assessment parameter, is presented as a percentage deviation from the respective assessment level (based on salinity related thresholds detailed in table 1).

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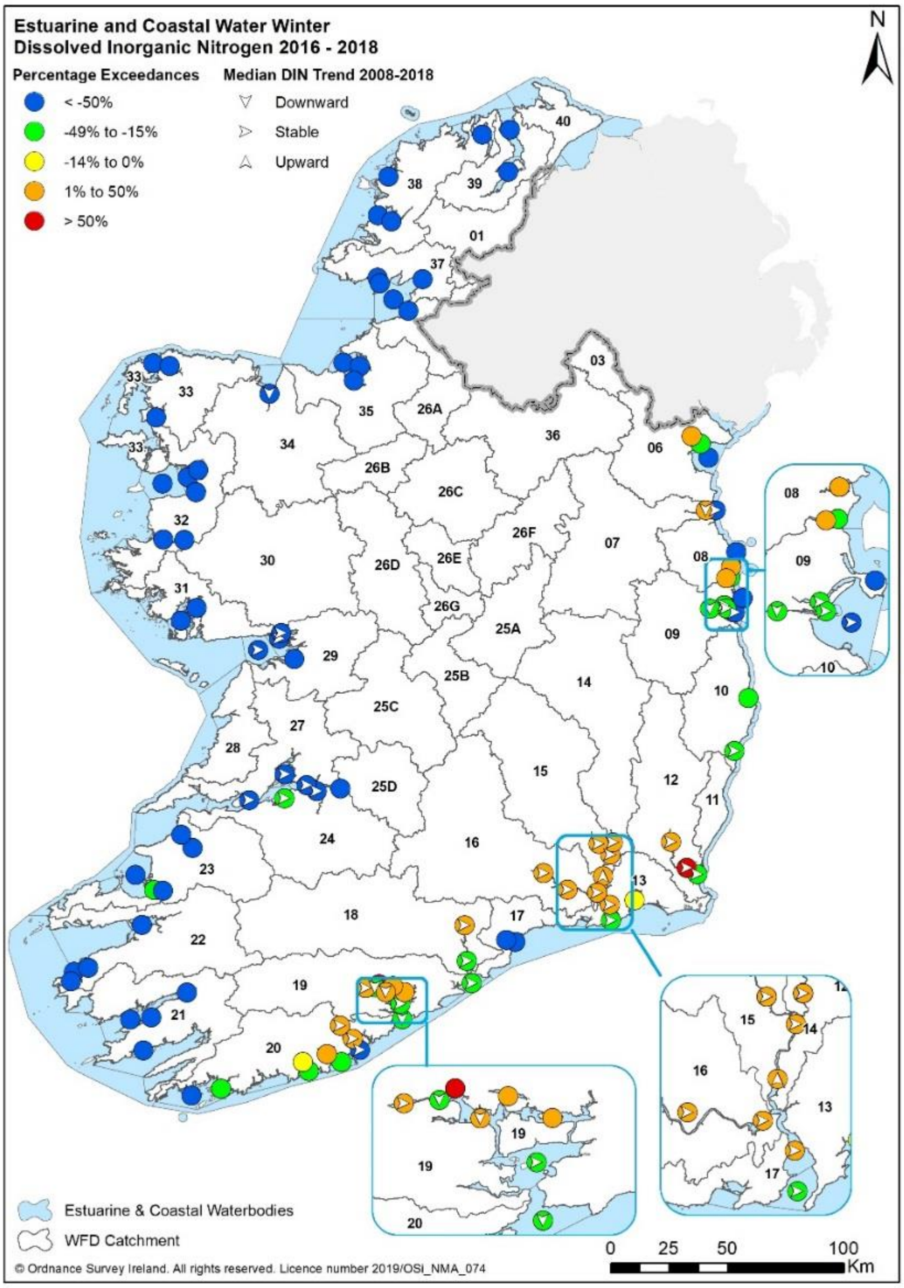
Parameter	Numeric Criterion	Statistic	Period to which Criterion Applies
Category A (Nutrient Enrichment)			
Dissolved Inorganic Nitrogen	mg/l (≈ µM)		
Tidal Fresh Waters (0 psu)	>2.6 (185)	Median	Winter or Summer
Intermediate Waters (1- 17)	>1.4 (100)	Median	Winter or Summer
Full salinity Water (>34.5)	>0.25 (18)	Median	Winter or Summer
Ortho-phosphate (MRP)	µg/l (≈ µM)		
Tidal Fresh Waters (0 psu)	>60 (2.0)	Median	Winter or Summer
Intermediate Waters (1- 17)	>60 (2.0)	Median	Winter or Summer
Full salinity Water (>34.5)	>40 (1.25)	Median	Winter or Summer
Category B (Accelerated growth)			
Chlorophyll	(µg/l)		
Tidal Fresh Waters (0 psu)	>15 (median) or >30 (90 percentile)		Summer
Intermediate Waters (1- 17)	>15 (median) or >30 (90 percentile)		Summer
Full salinity Water (>34.5)	>10 (median) or >20 (90 percentile)		Summer
Category C (Undesirable disturbance)			
Tidal Fresh Waters (0 psu)	<70 (5 percentile) or >130 (95 percentile)		Summer
Intermediate Waters (1- 17)	<70 (5 percentile) or >130 (95 percentile)		Summer
Full salinity Water (>34.5)	<80 (5 percentile) or >120 (95 percentile)		Summer

Table 1: Parameters and assessment levels for Irish estuaries, bays and nearshore coastal waters used in the Trophic Status Assessment Scheme (TSAS) scheme (Toner et al. 2005). Assessment criteria are adjusted on a sliding scale from 0-34.5 psu (practical salinity units).

For the last OSPAR assessment an analysis was undertaken on data up to 2014. More recent data has been assessed for the Water Quality in Ireland report 2013-2018 (EPA, 2019).

Twenty-five of the 102 estuarine and coastal water bodies assessed were above the salinity-related nitrogen criteria (Figure 3). All exceedances in this period were in transitional waters. Only two of the 102 water bodies assessed for phosphorus exceeded the relevant salinity-related winter phosphorus thresholds (Figure 4), the Maigue estuary and the Deel estuary in Co. Limerick. No coastal waters exceeded the thresholds.

A trend analysis was undertaken of winter median nitrogen concentrations (as dissolved inorganic nitrogen) in estuarine and coastal water bodies in 17 catchments from 2008 to 2018. Of the 39 water bodies included in the analysis, one water body showed a significant upward trend (New Ross Port). Trend analysis was also carried out in the same 17 catchments for winter median phosphorus concentrations (as molybdate reactive phosphorus). Of the 39 water

	bodies included in the analysis, one water body showed an upward trend (upper Shannon estuary).  **Figure 3:** Nitrogen winter exceedances above the salinity related assessment thresholds

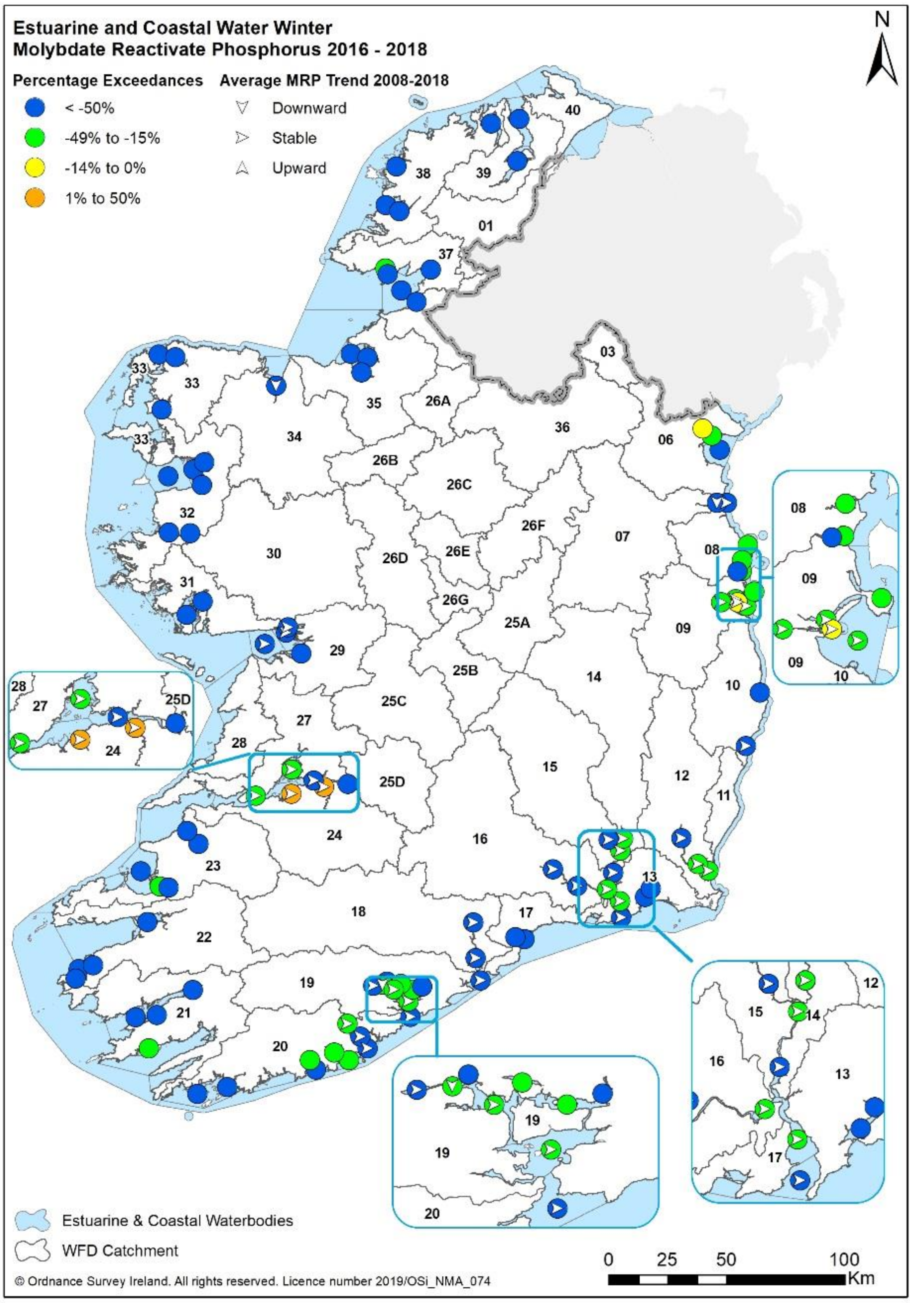


Figure 4: Phosphorus winter exceedances above the salinity related assessment thresholds

Coastal and offshore waters: Winter nutrients assessment
A trend assessment of dissolved inorganic nutrient data collected by the Marine Institute in winter between 2006 and 2014, and also between 1997 and 2014 is shown below in Table 3 and 4, respectively.

Table 2. Trend results for median nutrient and salinity concentrations (at salinity > 33). Significant P-values (<0.05) are highlighted.

	Sal >33	Trend (uM/yr)	Trend (%/yr)	P-value	Units
NE Irish Sea 2006-2014	PO4	-0.02	-2.68	0.12	µM
	TOxN	0.04	0.48	0.47	µM
	Silicate	0.00	0.05	1.00	µM
	Salinity	0.01	0.03	0.60	
	N:P	0.44	3.19	0.03	
SE Irish Sea 2006-2014	PO4	0.00	0.07	1.00	µM
	TOxN	0.04	0.47	0.75	µM
	Silicate	0.04	0.68	0.75	µM
	Salinity	-0.02	-0.05	0.60	
	N:P	0.05	0.31	0.92	
Celtic Sea 2006-2014	PO4	0.01	2.05	0.76	µM
	TOxN	0.07	0.77	1.00	µM
	Silicate	0.08	1.65	0.76	µM
	Salinity	-0.01	-0.02	1.00	
	N:P	-0.13	-0.76	0.37	
SW Coastal 2006-2014	PO4	0.00	-0.25	0.83	µM
	TOxN	0.25	2.57	0.25	µM
	Silicate	0.06	1.20	0.60	µM
	Salinity	-0.07	-0.21	0.35	
	N:P	0.17	0.99	0.35	
Western Shelf 2006-2014	PO4	-0.01	-0.93	0.37	µM
	TOxN	-0.22	-2.37	0.37	µM
	Silicate	-0.02	-0.78	0.77	µM
	Salinity	-0.01	-0.02	1.00	
	N:P	-0.11	-0.64	0.76	
Rockall 2006-2014	PO4	-0.01	-2.16	0.09	µM
	TOxN	-0.24	-2.24	0.46	µM
	Silicate	-0.28	-8.27	0.09	µM
	Salinity	-0.02	-0.05	0.22	
	N:P	-0.04	-0.21	1.00	
Liffey Transect 2006-2014	PO4	-0.01	-2.11	0.35	µM
	TOxN	0.21	2.67	0.03	µM
	Silicate	0.09	1.46	0.92	µM
	Salinity	0.00	0.01	0.92	
	N:P	0.56	4.39	0.03	
Boyne Transect 2006-2014	PO4	-0.02	-3.71	0.02	µM
	TOxN	-0.26	-3.44	0.12	µM
	Silicate	-0.21	-3.19	0.03	µM
	Salinity	0.07	0.22	0.03	
	N:P	0.01	0.05	1.00	
Arklow Transect 2006-2014	PO4	-0.01	-1.16	1.00	µM
	TOxN	0.30	3.21	0.55	µM
	Silicate	0.08	1.42	0.55	µM
	Salinity	-0.03	-0.09	0.37	
	N:P	0.26	1.66	0.76	
Slaney Transect 2006-2014	PO4	0.02	3.08	0.65	µM
	TOxN	0.20	2.00	0.55	µM
	Silicate	0.21	3.44	0.55	µM
	Salinity	-0.01	-0.03	1.00	
	N:P	0.23	1.28	0.37	

Table 3. Trend results for median nutrient and salinity concentrations (at salinity > 33). Significant P-values (<0.05) are highlighted.

	Sal>33	Trend (unit/yr)	Trend (%/yr)	P-value	Units
NE Irish Sea 1997-2014	PO4	0.00	0.61	0.36	µM
	TOxN	0.00	-0.02	1.00	µM
	Silicate	0.11	1.68	0.07	µM
	Salinity	-0.02	-0.06	0.01	
	NP	-0.07	-0.45	0.65	
SE Irish Sea 1997-2014	PO4	0.01	1.16	0.01	µM
	TOxN	0.02	0.18	0.79	µM
	Silicate	0.05	0.94	0.13	µM
	Salinity	-0.02	-0.05	0.02	
	NP	-0.19	-1.08	0.06	
Celtic Sea 2003-2014	PO4	0.02	2.74	0.21	µM
	TOxN	0.11	1.20	0.72	µM
	Silicate	0.03	0.57	0.86	µM
	Salinity	0.00	0.00	1.00	
	NP	-0.34	-1.98	0.05	
Liffey Transect 1997-2014	PO4	0.00	-0.01	0.94	µM
	TOxN	-0.14	-1.65	0.40	µM
	Silicate	0.07	1.18	0.26	µM
	Salinity	-0.01	-0.02	0.47	
	NP	-0.20	-1.43	0.40	
Boyne Transect 1997-2014	PO4	0.00	-0.03	0.94	µM
	TOxN	-0.09	-1.19	0.05	µM
	Silicate	-0.01	-0.12	0.91	µM
	Salinity	-0.01	-0.02	0.50	
	NP	-0.08	-0.64	0.23	
Arklow Transect 1997-2014	PO4	0.01	1.44	0.03	µM
	TOxN	0.00	-0.05	1.00	µM
	Silicate	0.12	2.20	0.12	µM
	Salinity	-0.03	-0.09	0.01	
	NP	-0.29	-1.68	0.14	
Slaney Transect 1997-2014	PO4	0.01	2.52	0.03	µM
	TOxN	0.04	0.44	0.52	µM
	Silicate	0.03	0.55	0.62	µM
	Salinity	-0.01	-0.03	0.30	
	NP	-0.23	-1.25	0.17	

There are no trends in nutrient concentrations in offshore waters along the western shelf and Rockall Trough between 2006 and 2014. These offshore datasets provide information on background or oceanic nutrient concentrations and support an assessment of the natural variability of nutrient concentrations in seawater.

The more enclosed Irish Sea is subject to greater freshwater influences and the potential for anthropogenic nutrient inputs. No significant trends in nutrient concentrations were observed in the western Irish Sea areas (at salinities > 33) between 2006 and 2014. Individual

	transects were examined where greater year to year consistency of sampling was achieved (Figure 6). There is an increase in N:P ratio in the NE Irish Sea over the same period, with an upward trend in both Total Oxidised Nitrogen (TOxN) and N:P ratio along the Liffey transect (within the NE Irish Sea region). There are very small negative trends in phosphate and silicate along the Boyne transect, coinciding with a small positive increase in salinity but this may be an artefact of the evolving sampling regime. Similarly, there is a small negative trend in salinity in both the NE and SE Irish Sea, with a positive trend in phosphate between 1997 and 2014 may also be an artefact of sampling. In summary, while there are some significant trends in the data depending on the timescale, these are small and should be treated with caution. There are no major trends in surface nutrient concentrations in coastal (salinity > 33) and offshore waters. Median TOxN and ortho-phosphate were lower than the OSPAR criteria (50% above background- 12µm TOxN for the Irish Sea and 15µM TOxN for other offshore waters; 0.8µM P) in all regions over this period. Overall while concentrations of TOxN and P are higher into the Irish Sea and eastern Celtic Sea the concentrations offshore are within the OSPAR criteria. In conclusion, there are no indications of elevated nutrient concentrations in Irish coastal (salinity >33) and offshore waters relative to the OSPAR assessment criteria.
Impact	Nutrient levels in the MSFD assessment areas are low with elevated concentrations only found in Water Framework Directive (WFD) transitional water areas. The current status of nitrogen and phosphorus has been determined using the Environmental Quality Standards (EQS) specified in national legislation implementing the Water Framework Directive, and the corresponding area-specific assessment levels used in the OSPAR Common Procedure. Good Environmental Status has been achieved for this criterion.
Response	Impacts relating to elevated nutrients are confined to waters covered under the WFD. The programmes of measures under this legislation are outlined in the River Basin Management plans. These include measures such as: • The new, strengthened Nitrates Action Programme (2018–2021) for preventing and reducing water pollution from nutrients (nitrogen and phosphorus) arising from agricultural sources.

	• Domestic Waste-Water Treatment Regulations and associated inspection regime. • Ensuring compliance with the Urban Waste Water Treatment Directive to contribute to the improvement and protection of waters in keeping with the water-quality objectives established in the River Basin Management plans
Assessment Method	The main source of data used in this assessment is derived from the Environmental Protection Agency's national estuarine and nearshore coastal waters monitoring programme and the Marine Institute's annual winter monitoring programme of coastal and offshore Irish waters. The winter component of the both the EPA and Marine Institute programmes are carried out between the months of November to March inclusive, with the summer component of the EPA programme being undertaken between the months of May to September inclusive. Environmental Protection Agency – sampling and analytical methods Monitoring is undertaken four times per annum, once in winter and three times over the summer months (May-September) in estuarine and coastal areas around Ireland. Winter monitoring is carried out to assess trends and maximum concentrations in inorganic nutrients in the absence of biologically induced variability, whereas summer monitoring is designed to detect the direct and indirect effects of nutrient enrichment such as accelerated plant growth and impacts on oxygenation conditions. Sampling is carried out at multiple locations throughout the water body, and at multiple depths and is undertaken, where practicable, as close to low and high water to capture tidally driven variability. Field measurements include temperature, salinity, dissolved oxygen (percent saturation), secchi depth. The water samples, which are collected using Ruttner sampling bottles, are analysed for pH, ammonia (NH3), total oxidised nitrogen (NO_2 + NO_3), ortho-phosphate (PO_4, - Molybdate Reactive Phosphorus), biochemical oxygen demand (BOD) and chlorophyll A variety of techniques are used to analyse the samples such as flow-injection colorimetry for nutrients and UV spectrometry for chlorophyll, which is extracted using the hot methanol technique. Field instruments used to measure salinity are calibrated against Potassium Chloride (KCL) standards of known conductance and

	chlorophyll fluorescence readings are calibrated against discrete water samples whose chlorophyll a content has been determined in the laboratory. Analytical techniques are validated through intercalibration and inter-comparison exercises carried out between the different EPA laboratories. Marine Institute – sampling and analytical methods Annual winter nutrient sampling is carried out in January/February on board the RV Celtic Voyager for coastal surveys and on the RV Celtic Explorer for surveys across the shelf and the Rockall Trough. Over the last two decades the sampling programme has evolved with coverage initially focusing on the Western Irish Sea but subsequently extending into the Celtic Sea. The current winter environmental programme on board the Celtic Voyager includes sampling for dissolved inorganic nutrients around the entire Irish coast (coastal water focus) biennially, along with a number of offshore transects completed. Nutrients samples are also collected during Celtic Voyager hydrographic surveys along 53 Degrees N (shelf) and across the Rockall Trough. Actual winter sampling is highly weather dependent and annex 2b shows the sampling completed on a year by year basis. Given the weather dependence and evolution of sampling approaces, caution must be exercised in comparing summary results from year to year for given areas. The assessment includes surface waters only, collected from each station at a depth of 2 to 3 metres using either the on-board peristaltic pumping system or using Niskin bottles on the conductivity, temperature and depth (CTD) rosette. All seawater samples for nutrient analysis were filtered using acid-cleaned polycarbonate filters and preserved by freezing. A sub-sample was collected for each sample for accurate salinity analysis. Total oxidized nitrogen (TOxN), ortho-phosphate (ortho-P), nitrite and silicate were analysed using segmented flow analysers. Discrete salinity samples were analysed using Guildline benchtop salinometers. Vertical profiles of conductivity and temperature were recorded using a Seabird SBE - 911 CTD system. A rigorous quality assurance scheme underpins analysis, including accreditation to ISO 17025 for both nutrient and salinity analysis and participation in QUASIMEME proficiency testing exercises. A detailed description of sample collection, analysis and quality control is outlined in McGrath et al. (McGrath et al. 2013).

	A relatively simple approach was used to assess temporal trends in surface winter dissolved inorganic nutrient concentrations using non-parametric Mann-Kendall tests using the R platform and the TTA trend analysis package(Devreker and Lefebvre 2014). Coastal waters with salinity > 33 and offshore waters are compared directly with the OSPAR area-specific assessment criteria for elevated TOxN (15µM for off-shelf waters and 12µM for the Irish Sea) and ortho-phosphate (0.8µM). Although assessment parameters are related to dissolved inorganic nitrogen (DIN), ammonia was not determined so TOxN are reported.
Assessment Result	Included in State.
Results (figures & tables)	Included in State.
Conclusion	Overall, nutrient enrichment within Ireland's Assessment Area is good, with nutrient enrichment events reduced to a level that Good Environmental Status is achieved for this criterion.
Knowledge gaps	Work is ongoing in OSPAR to look at greater harmonisation of assessment criteria across the OSPAR areas. This includes modelling scenarios to consider historical background condition on nutrients across the North East Atlantic.
References	Toner, P., Bowman, J., Clabby, K., Lucey, J., McGarrigle, M., Concannon, C., Clenaghan, C., Cunningham, P., Delaney, J., O'Boyle, S., MacCárthaigh, M., Craig, M. and Quinn, R. (2005). Water Quality in Ireland 2001-2003. Water Quality in Ireland. Wexford, Environmental Protection Agency. S. O'Boyle, W. Trodd, C. Bradley, D.Tierney, R. Wilkes, S. Ní Longphuirt, J. Smith, A. Stephens, J. Barry, P. Maher, R. McGinn, E. Mockler, J. Deakin, M. Craig and Gurrie., M. (2019). Water Quality in Ireland, 2013–2018. Wexford, ENVIRONMENTAL PROTECTION AGENCY. McGrath, T., Kivimäe, C., McGovern, E., Cave, R. R. and Joyce, E. (2013). Winter measurements of oceanic biogeochemical parameters in the Rockall Trough (2009–2012). Earth Syst. Sci. Data 5(2): 375-383. 10.5194/essd-5-375-2013

	Devreker, D. and Lefebvre, A. (2014). TT Ainterface Trend Analysis: An R GUI for routine Temporal Trend Analysis and diagnostics. 2014 7(1).			
	Assessment Data			
Data Sources	WFD monitoring programme www.catchments.ie OSPAR data via ICES https://www.ices.dk/data/dataset-collections/Pages/default.aspx Water Quality in Ireland report 2013-2018 http://www.epa.ie/pubs/reports/water/waterqua/waterqualityinireland2013-2018.html OSPAR common Procedure report 2014 https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/eutrophication/third-comp-summary-eutrophication/			
Data Locations (URL)	www.epa.ie https://gis.epa.ie/ www.catchments.ie www.marine.ie			
Data Time Line	Start Date:	1-1-2006	End Date:	31-12-2018
Point of Contact	Robert Wilkes, EPA			
Email	r.wilkes@epa.ie			

D5 C2

<table>
<tr><td>Ref D5C2</td><td>Assessment Sheet: Descriptor 5 Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters
D5C2 — Primary: Chlorophyll a concentrations are not at levels that indicate adverse effects of nutrient enrichment.</td></tr>
<tr><td>Background</td><td>Eutrophication is diagnosed using OSPAR’s harmonised criteria of nutrient inputs, concentrations and ratios, chlorophyll-a concentrations, phytoplankton indicator species, macrophytes, dissolved oxygen levels, incidence of fish kills and changes in zoobenthos (OSPAR Agreement 2010-3). As there is no single indicator of disturbance caused by marine eutrophication, OSPAR applies a multi-step method using the harmonised criteria. Eutrophication is considered to have occurred if there is evidence for all of the stages shown in Figure 1 and of causal links between them (ECJ, 2009).

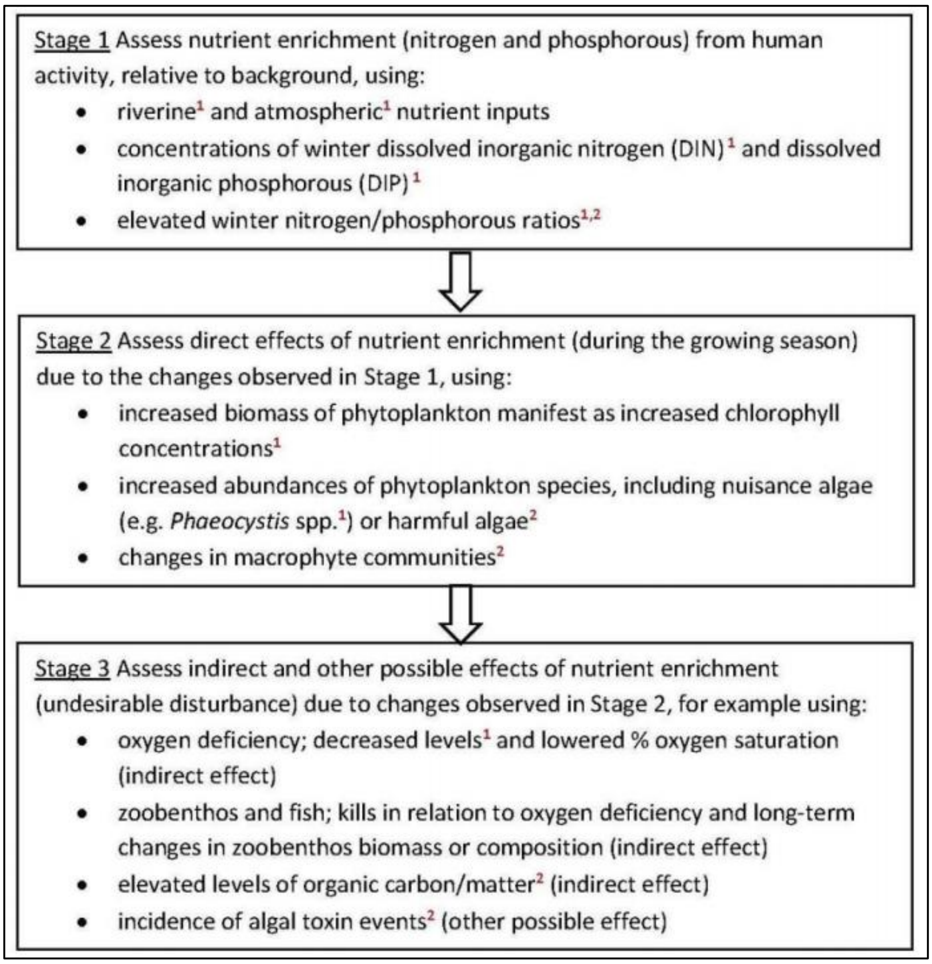

</td></tr>
</table>

	Figure 1: Three stages in the identification of eutrophication. The criteria marked [1] are common indicators for the OSPAR Intermediate Assessment 2017. The criteria marked [2] are not relevant in all Contracting Parties' waters Elevated nutrient concentrations promote the growth of phytoplankton and other plant life. Long-term winter dissolved inorganic nutrient concentrations and ratios, namely of nitrogen and phosphorus, act as indicators for quantifying the pressures of human activities and for evaluating the success of measures taken. For the interpretation of winter inorganic nutrient concentration gradients, sources and sinks and the influx of nutrients from long distance transport and local upwelling events are important. Nutrient concentrations in coastal waters are mainly determined by riverine nutrient inputs and the mixing of these inputs with seawater. Riverine inputs are reflected by higher nutrient concentrations in coastal areas with lower salinity, decreasing seaward with lower concentrations in the open sea with deeper and more saline offshore waters (i.e. exhibiting nutrient gradients). The effect of these mixing processes on the assessment of nutrient concentrations needs to be taken into account. This is achieved by assessing nutrient concentrations within defined salinity bands.
Objective	D5C2 — Primary: Chlorophyll a concentrations are not at levels that indicate adverse effects of nutrient enrichment.
Drivers (Activities) (**Pressures**	Nutrients such as nitrogen, phosphorus and silicate enter the marine environment from the atmosphere, rivers, land runoff, or by direct discharges into the sea. Human activities can result in large quantities of nutrients entering the sea from sources that include agriculture, combustion processes (road traffic, shipping, power plants), municipal and industrial waste water treatment and aquaculture. Such nutrient discharges can lead to elevated nutrient concentrations in the marine environment, of which dissolved inorganic winter nutrient concentrations are a good indicator. Dissolved inorganic nitrogen, phosphorus and silicate concentrations are measured in winter when biological activity and uptake of nutrients by phytoplankton is low. Eutrophication is the result of excessive enrichment of water with nutrients. This may cause accelerated growth of algae and / or higher forms of plant life. This may result in an undesirable disturbance to the balance of organisms present and thus to the overall water quality.

	Undesirable disturbances can include shifts in the composition and extent of flora and fauna and the depletion of oxygen due to decomposition of accumulated biomass. Such disturbances then have other effects, such as changes in habitats and biodiversity, blooms of nuisance algae or macroalgae, decrease in water clarity and behavioural changes or even death of fish and other species. Identifying causal links between these disturbances and nutrient enrichment can be complicated by other pressures. Cumulative effects, including climate change, may have similar effects on biological communities and dissolved oxygen, further complicating efforts to demonstrate causal links.
State	For OSPAR's Intermediate Assessment 2017, harmonised eutrophication criteria have been assessed at a regional scale including chlorophyll-a concentrations. This assessment provides useful information about trends and is important for informing management measures. https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/eutrophication/ Chlorophyll-a was assessed in the OSPAR Quality Status Report (QSR) 2010 (OSPAR, 2010) as part of the Common Procedure for the identification of eutrophication (OSPAR Agreement 2013-8). In general, chlorophyll-a concentrations in coastal and estuarine areas are higher than concentrations in offshore waters. While a statistically significant upward trend was observed in the offshore waters of the Celtic Seas, the dataset contained a relatively high number of years with missing data. Also, this dataset contains data from different laboratories with different analytical methods, which may have led to a bias in the calculated 90-percentiles. As set out in the OSPAR procedure, the assessment of direct effects of nutrient enrichment is undertaken where evidence of change in the nutrient dynamics has been observed. As no evidence of this has been found in Ireland's offshore MSFD waters the assessment of D5C2 has been undertaken in the coastal and transitional waters as designated under the Water Framework Directive (WFD). The assessment of direct effects of nutrient enrichment on the phytoplankton community was obtained from information gathered as part of the WFD monitoring programme. The Irish WFD assessment tool calculates two Ecological Quality Ratios for the assessment of

phytoplankton- one based on the Chlorophyll concentration and a second metric looking at abundance of individual taxa above an assessment threshold. WFD assessments of moderate status or worse were considered as indictors of possible direct effects of nutrient enrichment. The most recent assessment of WFD status is for the years 2013-2018. The phytoplankton assessment for coastal waters is shown in Figure 1. No coastal areas were classified below good status in this period. (EPA, 2019)

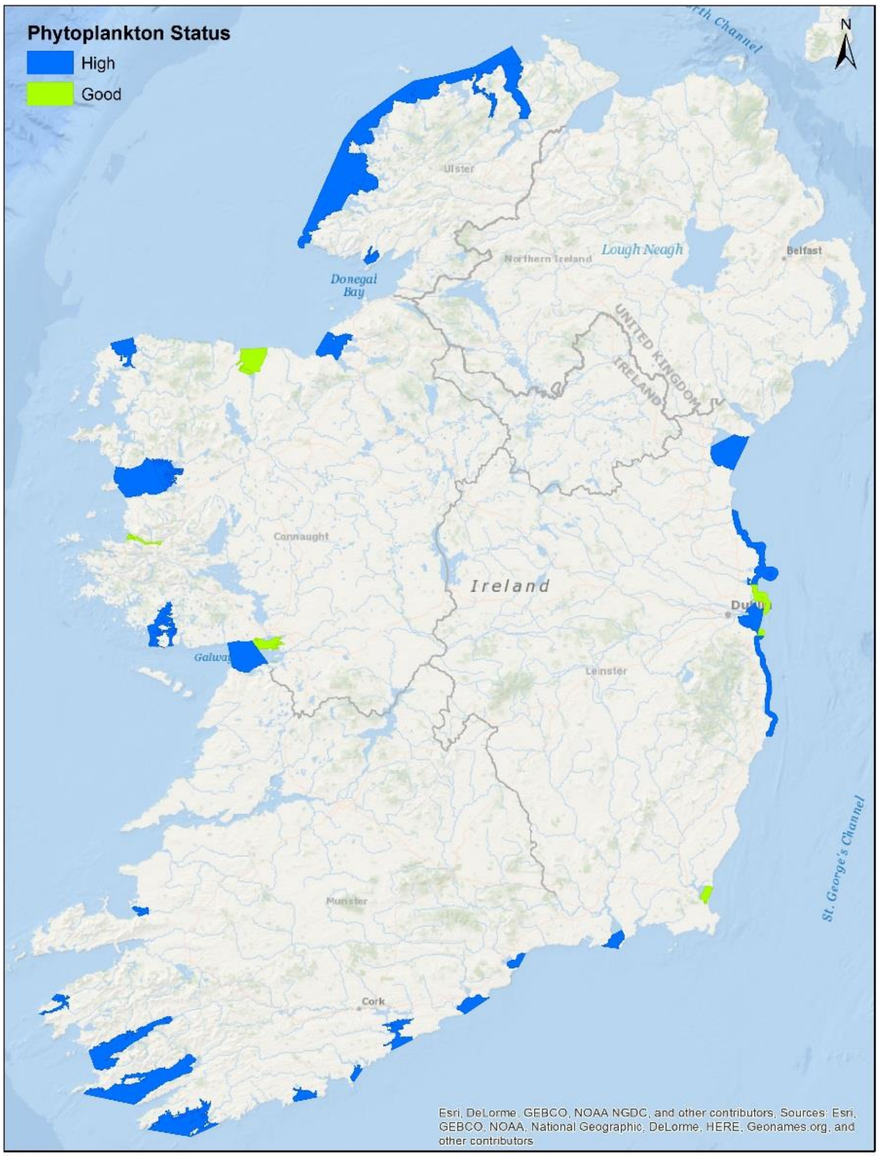


Figure 2. WFD assessment of elevated Chlorophyll and elevated individual taxa counts using the WFD assessment tool (2013-2018).

Impact	The current status of chlorophyll as an indicator of phytoplankton response to elevated nutrients has been determined using the EQS specified in national legislation implementing the Water Framework

	Directive, and the corresponding area-specific assessment levels used in the OSPAR Common Procedure. The only areas that exceed the threshold set in SI 77 of 2019 for the WFD are in transitional waters. For MSFD areas, Good Environmental Status has been achieved for this criterion.
Response	Impacts relating to elevated nutrients are confined to waters covered under the WFD. The programmes of measures under this legislation are outlined in the River Basin Management plans. These include measures such as: • The new, strengthened Nitrates Action Programme (2018–2021) for preventing and reducing water pollution from nutrients (nitrogen and phosphorus) arising from agricultural sources. • Domestic Waste-Water Treatment Regulations and the associated inspection regime. • Ensuring compliance with the Urban Waste Water Treatment Directive to contribute to the improvement and protection of waters in keeping with the water-quality objectives established by Plan
Assessment Method	**A Method Based on Phytoplankton Bloom Frequency and Chlorophyll-a Concentrations for the Assessment of the phytoplankton status in Irish Coastal and Transitional Waters.** **Introduction** Phytoplankton is one of the biological elements to be used to classify coastal and transitional waters under the European Water Framework Directive (WFD). The current Irish method for WFD assessment of estuarine and coastal waters is the EPA blooming tool. This tool has been inter-calibrated with other tools developed by North East Atlantic countries (Carletti and Heiskanen, 2009). The tool contains a two-stage process consisting of the determination of phytoplankton bloom frequency and biomass. **Sampling and laboratory analysis methods** For transitional waters, the data set are obtained through the Environmental Protection Agency's Estuarine and Coastal Waters Monitoring Programme. Each waterbody is sampled four times a year, once in the winter months and three times during the summer (May to September).

	Chlorophyll samples are taken from the surface and bottom of the water column. When there is no difference between the surface and bottom salinities a composite sample, where equal volumes of the surface and bottom samples, is taken. Total Chlorophyll Pigments are extracted using hot methanol (not corrected for the presence of pheopigments) and are measured using a spectrophotometer (Standing Committee of Analysts, 1980). Phytoplankton samples are pooled by combining a surface and bottom sample. Each waterbody is divided in to two or three areas depending on salinity. Equal volumes of water from each station are pooled in a container and mixed well. A subsample is taken for phytoplankton analysis as well as a salinity and fluorescence measurement. Samples are taken on high and low tide. Only composite samples are used in the tool. However single station samples are only used when there was no other data for that date or if the composite sample did not include the single station. A subsample of the whole waterbody sample was taken in a 30-ml universal tube and preserved with Lugol's iodine. Cell counts were undertaken in 1 ml of sample on a Sedgewick Rafter Cell using a compound microscope. Cells were recorded to an appropriate taxonomic level and damaged cells were not counted as part of the analysis. The Sedgewick Rafter Cell has a limit of detection of 1,000 cells/l. **Biomass** The median and 90th percentile chlorophyll concentrations are determined for each waterbody over a 6-year period. The reference conditions and class boundaries are salinity dependent; for example, the reference conditions for fully saline waters are 3.33 mg l^{-1} (Carletti and Heiskanen, 2009). This gives an EQR of 1 for any concentrations at or below this value. An EQR for both the median and 90%ile are determined and the lowest EQR of these is taken forward. **Bloom Frequency** Bloom frequency is determined over the 6-year WFD cycle (four sampling occasions per year) through the analysis of taxonomic abundance of the dominant taxa (EPA, 2011). A bloom is considered to occur when the frequency of individual phytoplankton (taxon) exceeds 500,000 cells/l, at salinities of ≤17, or 250,000 cells/L for coastal waters of salinities above 17. Reference conditions are met if blooms are under a threshold of 2 for every 3 years and a high status is applied. A bloom every 2 years will place the waterbody at good status, while a bloom every year (or for 25% of sampled dates) will place the waterbody at

	moderate status. Ecological quality ratios (EQRs) were then calculated by dividing the reference values by the observed values. **Phytoplankton Status** The overall phytoplankton status is considered as the average of the EQR's calculated for chlorophyll and bloom frequency for each waterbody over the 6-year period.
Assessment Result	Water Quality in Ireland 2013-2018 (EPA, 2019)
Conclusion	Overall, nutrient enrichment within Ireland's Assessment Area is good, with nutrient enrichment events reduced to a level that Good Environmental Status has been achieved for this criterion.
Knowledge gaps	Work is ongoing at OSPAR level to use satellite data to increase the confidence in the offshore chlorophyll assessments outside of the WFD regions.
References	OSPAR Agreement 2010-3. The North-East Atlantic Environment Strategy. Strategy of the OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic 2010–2020 ECJ 2009. European Court of Justice Judgment of the Court (Third Chamber) of 10 December 2009. European Commission v United Kingdom of Great Britain and Northern Ireland. Failure of a Member State to fulfil obligations – Environment – Directive 91/271/EEC – Urban waste water treatment - Article 3(1) and (2), Article 5(1) to (3) and (5) and Annexes I and II – Initial failure to identify sensitive areas – Concept of 'eutrophication' – Criteria – Burden of proof – Relevant date when considering the evidence – Implementation of collection obligations – Implementation of more stringent treatment of discharges into sensitive areas. Case C-390/07 European Court Reports 2009 I-00214 OSPAR, 2010. Quality Status Report 2010. OSPAR Commission, London, 176pp http://qsr2010.ospar.org OSPAR Agreement 2013-8. Common Procedure for the Identification of the Eutrophication Status of the OSPAR Maritime Area. Supersedes Agreements 1997-11, 2002-20 and 2005-3 S. O'Boyle, W. Trodd, C. Bradley, D.Tierney, R. Wilkes, S. Ní Longphuirt, J. Smith, A. Stephens, J. Barry, P. Maher, R. McGinn, E. Mockler, J. Deakin, M. Craig and Gurrie., M. (2019). Water Quality in

	Ireland, 2013–2018. Wexford, ENVIRONMENTAL PROTECTION AGENCY. Carletti, A., and Heiskanen, A.-S. (2009). Water framework directive intercalibration technical report – part 3: coastal and transitional waters. JRC Sci. Techn. Rep. 240, 138–169 EPA (2011). Water Framework Directive Status Update 2007-2009. Wexford: Environmental Protection Agency Standing Committee of Analysts (1980). The Determination of Chlorophyll a in Aquatic Environments. London: Her Majesty's Stationary Office.
	Assessment Data
Data Sources	WFD monitoring programme www.catchments.ie OSPAR data via ICES https://www.ices.dk/data/dataset-collections/Pages/default.aspx Water Quality in Ireland report 2013-2018 http://www.epa.ie/pubs/reports/water/waterqua/waterqualityinireland2013-2018.html OSPAR common Procedure report 2014 https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/eutrophication/third-comp-summary-eutrophication/
Data Locations (URL)	www.epa.ie https://gis.epa.ie/ www.catchments.ie www.marine.ie
Data Time Line	Start Date: 1-1-2006 | End Date: 31-12-2018
Point of Contact	Robert Wilkes, EPA
Email	r.wilkes@epa.ie

D5 C5

<table>
<tr><th>Ref D5C5</th><th>Assessment Sheet: Descriptor 5 Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters

D5C5 — Primary (may be substituted by D5C8): The concentration of dissolved oxygen is not reduced, due to nutrient enrichment, to levels that indicate adverse effects on benthic habitats (including on associated biota and mobile species) or other eutrophication effects.</th></tr>
<tr><td>Background</td><td>Eutrophication is diagnosed using OSPAR’s harmonised criteria of nutrient inputs, concentrations and ratios, chlorophyll-a concentrations, phytoplankton indicator species, macrophytes, dissolved oxygen levels, incidence of fish kills and changes in zoobenthos (OSPAR Agreement 2010-3). As there is no single indicator of disturbance caused by marine eutrophication, OSPAR applies a multi-step method using the harmonised criteria.

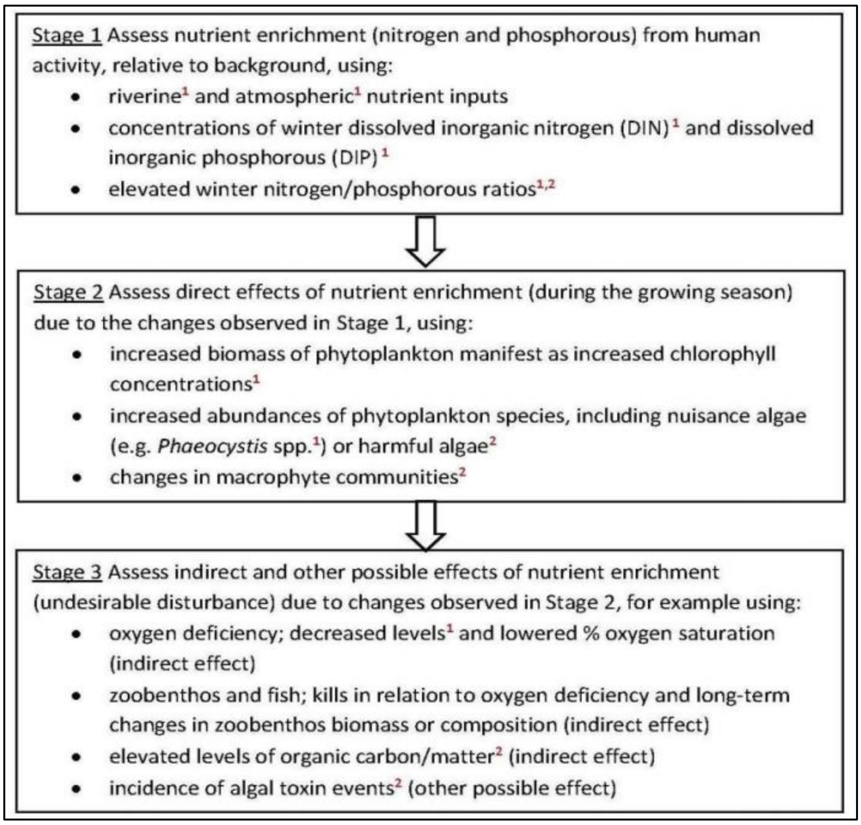
Eutrophication is considered to have occurred if there is evidence for all of the stages shown in Figure 1 and of causal links between them (ECJ, 2009).

</td></tr>
</table>

	Figure 1: Three stages in the identification of eutrophication. The criteria marked [1] are common indicators for the OSPAR Intermediate Assessment 2017. The criteria marked [2] are not relevant in all Contracting Parties' waters. Elevated nutrient concentrations promote the growth of phytoplankton and other plant life. Long-term winter dissolved inorganic nutrient concentrations and ratios, namely of nitrogen and phosphorus, act as indicators for quantifying the pressures of human activities and for evaluating the success of measures taken. For the interpretation of winter inorganic nutrient concentration gradients, sources and sinks, influx of nutrients from long distance transport and local upwelling events are important. Nutrient concentrations in coastal waters are mainly determined by riverine nutrient inputs and the mixing of these inputs with seawater. Riverine inputs are reflected by higher nutrient concentrations in coastal areas with lower salinity, decreasing seaward with lower concentrations in the open sea with deeper and more saline offshore waters (i.e. exhibiting nutrient gradients). The effect of these mixing processes on the assessment of nutrient concentrations needs to be taken into account. This is achieved by assessing nutrient concentrations within defined salinity bands.
Objective	D5C5 — Primary (may be substituted by D5C8): The concentration of dissolved oxygen is not reduced, due to nutrient enrichment, to levels that indicate adverse effects on benthic habitats (including on associated biota and mobile species) or other eutrophication effects.
Drivers (Activities) **Pressures**	Nutrients such as nitrogen, phosphorus and silicate enter the marine environment from the atmosphere, rivers, land runoff, or by direct discharges into the sea. Human activities can result in large quantities of nutrients entering the sea from sources that include agriculture, combustion processes (road traffic, shipping, power plants), municipal and industrial waste water treatment and aquaculture. Such nutrient discharges can lead to elevated nutrient concentrations in the marine environment, of which dissolved inorganic winter nutrient concentrations are a good indicator. Dissolved inorganic nitrogen, phosphorus and silicate concentrations are measured in winter when biological activity and uptake of nutrients by phytoplankton is low. Eutrophication is the result of excessive enrichment of water with nutrients. This may cause accelerated growth of algae and / or higher

	forms of plant life. This may result in an undesirable disturbance to the balance of organisms present and thus to the overall water quality. Undesirable disturbances can include shifts in the composition and extent of flora and fauna and the depletion of oxygen due to decomposition of accumulated biomass. Such disturbances then have other effects, such as changes in habitats and biodiversity, blooms of nuisance algae or macroalgae, decrease in water clarity and behavioural changes or even death of fish and other species. Identifying causal links between these disturbances and nutrient enrichment can be complicated by other pressures. Cumulative effects, including climate change, may have similar effects on biological communities and dissolved oxygen, further complicating efforts to demonstrate causal links.
State	Dissolved oxygen is one of a suite of five eutrophication indicators. When assessed and considered together in the OSPAR Common Procedure in a multi-step method, the suite can be used to diagnose eutrophication. https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/eutrophication/ Excessive enrichment of marine water with nutrients may lead to algal (phytoplankton) blooms, with the possible consequence of undesirable disturbance to the balance of organisms in the marine ecosystem and overall water quality. Undesirable disturbance includes shifts in the composition and extent of flora and fauna and depletion of oxygen caused by decomposition of accumulated organic material produced by phytoplankton or seaweed communities during their growing seasons. Oxygen depletion may result in behavioural changes or death of fish and other species. Although oxygen depletion can be an indirect effect of nutrient enrichment, other pressures often complicate the identification of causal links between disturbances and nutrient enrichment. Factors that influence oxygen concentrations include changes in water temperature and salinity, and climate change. Seasonal oxygen depletion can be a natural localised process, particularly where the water column stratifies seasonally. Oxygen concentrations above 6 mg/l are considered to support marine life with minimal problems, while concentrations less than 2 mg/l (hypoxia, i.e. oxygen deficiency) are considered to cause severe problems.

	Mean near-bed dissolved oxygen concentrations (2006–2014) assessed in large-scale regions of the northern North Sea, southern North Sea, English Channel, Celtic Seas, and Bay of Biscay and Iberian Coast were >6 mg/l. No statistically significant temporal trends were observed (1990–2014) in near-bed oxygen concentrations or percentage saturation in most of the large-scale regions (northern North Sea, southern North Sea, Skagerrak, Sound, English Channel, Celtic Seas, and Bay of Biscay and Iberian Coast). Overall, results indicate that oxygen concentrations were not depleted during the shorter (2006–2014) and longer (1990–2014) assessment periods.

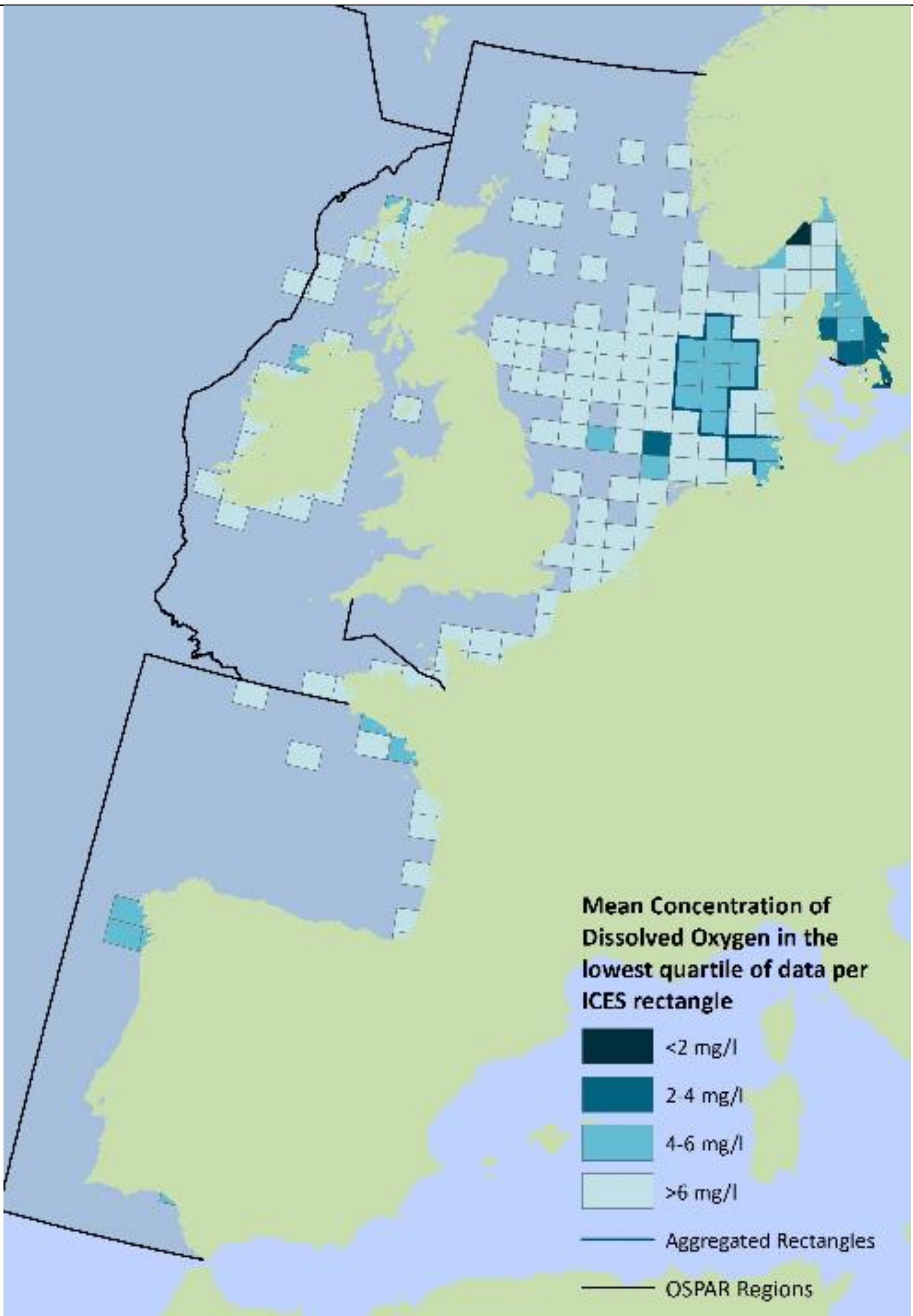
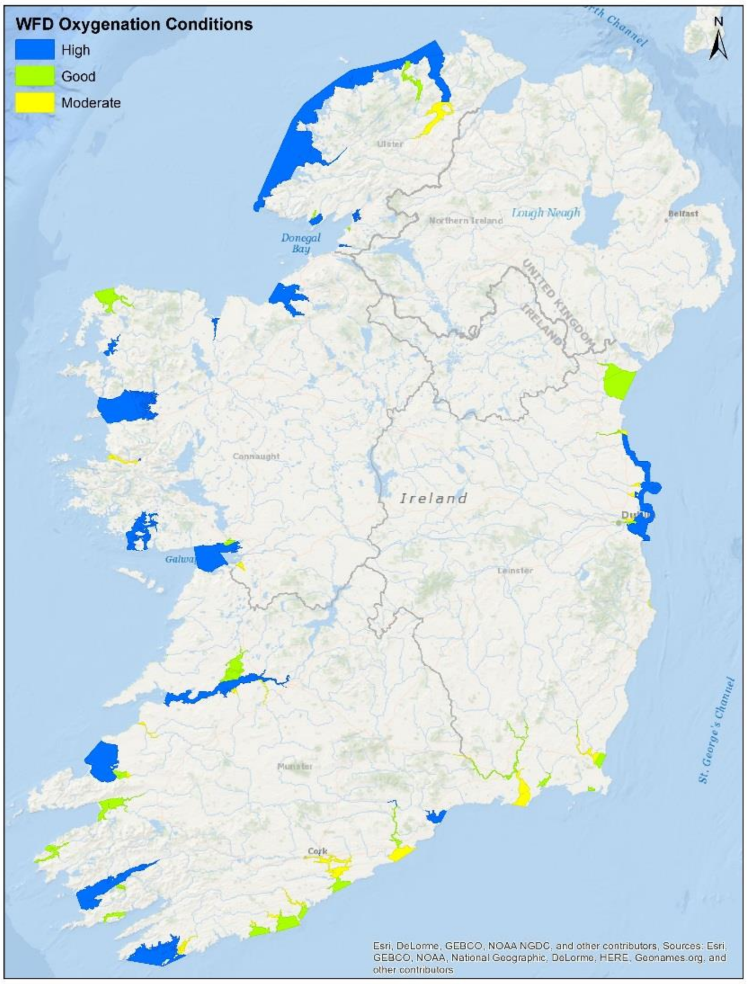


Figure 2: Mean concentration of dissolved oxygen in the lowest quartile of the data plotted by ICES rectangles for the period 1990-2014.

Rectangles aggregated for analyses are outlined in bold. Data were filtered by season (stratification season 1 July-31 October), depth (within 10m of the seafloor), and salinity (≥30). Results are shown for rectangles where there were five or more data points. Blank areas indicate where there were no data or insufficient data.

Impact	The current status of oxygenation conditions has been determined using the Environmental Quality Standards (EQS) specified in national legislation implementing the Water Framework Directive (in transitional and coastal waters), and the corresponding area-specific assessment levels used in the OSPAR Common Procedure (in the wider marine area). The present status highlights Good Environmental Status has been achieved.
Response	Impacts relating to elevated nutrients are confined to waters covered under the Water Framework Directive (WFD). The programmes of measures under this legislation are outlined in the River Basin Management plan. These include measures such as: • The new, strengthened Nitrates Action Programme (2018–2021) for preventing and reducing water pollution from nutrients (nitrogen and phosphorus) arising from agricultural sources. • Domestic Waste-Water Treatment Regulations and associated inspection regimes. • Ensuring compliance with the Urban Waste Water Treatment Directive to contribute to the improvement and protection of waters in keeping with the water-quality objectives established in the River Basin Management plans.
Assessment Method	Assessment method Dissolved oxygen is measured as part of the WFD monitoring programme. Monitoring is undertaken four times per annum, once in winter and three times over the summer months (May-September) in estuarine and coastal areas around Ireland. Winter monitoring is carried out to assess trends and maximum concentrations in inorganic nutrients in the absence of biologically induced variability, whereas summer monitoring is designed to detect the direct and indirect effects of nutrient enrichment such as accelerated plant growth and impacts on oxygenation conditions. Sampling is carried out at multiple locations throughout the water body, and at multiple depths and is undertaken, where practicable, as close to low and high water to capture tidally driven variability. Field measurements include temperature, salinity, dissolved oxygen (percent saturation), secchi depth. Oxygen concentration is measured throughout the water column using a multiparameter marine datasonde.

Assessment Result	Within Irelands WFD assessment in coastal and transitional waters, the assessment of oxygenation criteria under SI 77 of 2019 has been undertaken for 2013-2018. Outside of these areas no evidence of nutrient enrichment has been found. This assessment (EPA, 2019) shows that in general only transitional waters show any impacts on the oxygenation conditions (Figure 2). Only 5 coastal water bodies failed the WFD EQS for oxygen and these areas were experiencing elevated concentration due to upstream problems in their adjacent transitional water bodies.  **Figure 3**. WFD compliance with oxygenation conditions based on 2013 to 2018 assessment (EPA, 2019)
Conclusion	Overall, oxygenation conditions in Ireland's Assessment Area are good, with no adverse effects found. Good Environmental Status has been achieved for this criterion.
Knowledge gaps	Work is ongoing to assess oxygen conditions in the wider offshore areas where data is more limited.

References	S. O'Boyle, W. Trodd, C. Bradley, D.Tierney, R. Wilkes, S. Ní Longphuirt, J. Smith, A. Stephens, J. Barry, P. Maher, R. McGinn, E. Mockler, J. Deakin, M. Craig and Gurrie., M. (2019). Water Quality in Ireland, 2013–2018. Wexford, ENVIRONMENTAL PROTECTION AGENCY. OSPAR Agreement 2010-3. The North-East Atlantic Environment Strategy. Strategy of the OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic 2010–2020 ECJ 2009. European Court of Justice Judgment of the Court (Third Chamber) of 10 December 2009. European Commission v United Kingdom of Great Britain and Northern Ireland. Failure of a Member State to fulfil obligations – Environment – Directive 91/271/EEC – Urban waste water treatment - Article 3(1) and (2), Article 5(1) to (3) and (5) and Annexes I and II – Initial failure to identify sensitive areas – Concept of 'eutrophication' – Criteria – Burden of proof – Relevant date when considering the evidence – Implementation of collection obligations – Implementation of more stringent treatment of discharges into sensitive areas. Case C-390/07 European Court Reports 2009 I-00214			
	Assessment Data			
Data Sources	WFD monitoring programme www.catchments.ie OSPAR data via ICES https://www.ices.dk/data/dataset-collections/Pages/default.aspx Water Quality in Ireland report 2013-2018 http://www.epa.ie/pubs/reports/water/waterqua/waterqualityinireland2013-2018.html OSPAR common Procedure report 2014 https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/eutrophication/third-comp-summary-eutrophication/			
Data Locations (URL)	www.epa.ie https://gis.epa.ie/ www.catchments.ie www.marine.ie			
Data Time Line	Start Date:	1-1-2006	End Date:	31-12-2018
Point of Contact	Robert Wilkes, EPA			
Email	r.wilkes@epa.ie			

Descriptor 6 – Sea-floor integrity

D6 C1 & D6 C4

Descriptor 6 Sea-floor integrity	**Assessment Sheet: Benthic habitats** **Criteria D6C1 & D6C4** **Physical loss of the seabed (including intertidal areas)**
Key message	At the time of Ireland's MSFD Initial Assessment in 2013, quantitative thresholds were not yet developed to determine compliance with the objectives for sea-floor integrity that Ireland had set itself. Based on the updated assessment of physical loss now undertaken the conclusion is that Ireland is achieving Good Environmental Status (GES); this is because the extent of physical loss within the maritime area is lower than any potential threshold value. The overall percentage area loss of benthic habitat in Ireland's maritime area has been determined as less than half of 1% of the total area of sea-floor. The highest loss per benthic broad habitat type was almost 6% for infralittoral mud. The percentage area loss for other habitats was much lower.
Background	Benthic habitats are formed of marine organisms living on or within sediments and rock. They provide essential ecological processes and functions to support healthy ecosystems. They are a key component of the marine food web, including commercial fish and shellfish species, and provide a major food source for predators. The diversity of benthic habitats is shaped by factors such as depth, light penetration, substrate type and their flora and fauna communities. These create a huge variety of habitat types, with communities showing different levels of sensitivity to physical damage. Some are very sensitive (e.g. fragile coral gardens), whereas others are more robust (e.g. mobile sands). Physical loss and disturbance of the seafloor by human activities such as bottom contacting fishing, aggregate extraction or offshore construction can adversely affect benthic habitats, especially those with larger and fragile species exhibiting longer recovery times. This Indicator aims to assess the current spatial extent and level of habitat loss caused by human activities to the seafloor.
Objective	Commission Decision 2017/848 defines criterion D6C1 as "Spatial extent and distribution of physical loss (permanent change) of the natural seabed" and defines criterion D6C4 as "The extent of loss of the habitat type, resulting from anthropogenic pressures, does not exceed a specified proportion of the natural extent of the habitat type in the assessment area."

	In 2013 Ireland identified three objectives for safeguarding seafloor integrity. Of these, the first is of relevance to this criterion: "The extent and diversity of sea-floor habitats is maintained in line with prevailing physiographic, geographic and climate conditions". This assessment measures conformity with criterion D6C1 against the 2013 objective. The assessment also measures conformity with criterion D6C4, however no agreed threshold for a specified proportion of the habitat exists for this criterion.
Drivers (Activities)	Benthic habitats are characterised by animal and plant communities with no or slow mobility when compared to fish or marine mammals. The whole benthic community is therefore exposed when a pressure occurs. As a result, the condition (quality status) of benthic habitats is a reflection of the combined effects of pressures to which they are subject. The main activities driving pressures on benthic habitats, based on Commission Directive 2017/45 are: physical restructuring of rivers, coastline or seabed (water management), extraction of non-living resources, production of energy, extraction of living resources, cultivation of living resources, transport, urban and industrial uses, and tourism and leisure.
Pressures	The relevant pressure listed in Commission Directive 2017/845 is physical loss (due to permanent change of seabed substrate or morphology and to extraction of seabed substrate).
State	The habitat with the greatest area loss was infralittoral mud with 5.5% loss recorded. Other habitats which recorded percentage loss of greater than 1% overall were infralittoral mixed sediment (2.73%); infralittoral sand (2.49%), circalittoral mud (2.47%), infralittoral coarse sediment (2.43%), circalittoral sand (1.97%), circalittoral rock and biogenic reef (1.25%) and infralittoral rock and biogenic reef (1.15%). In all these cases, sealed loss was the predominant type, arising mainly from restructuring of the seabed and aquaculture. The habitats that recorded loss of less than 1% overall were offshore circalittoral rock and biogenic reef (0.67%), circalittoral mixed sediment (0.57%), circalittoral coarse sediment (0.47%), offshore circalittoral mud (0.44%), offshore circalittoral sand (0.21%) and offshore circalittoral coarse sediment (0.08%). In all these cases, sealed loss

	was the predominant type, arising mainly from restructuring of the seabed. Habitats with virtually no loss (<0.01%) were offshore circalittoral mixed sediment, upper bathyal sediment and lower bathyal sediment. Habitats recording no physical loss at all were littoral rock and biogenic reef, littoral sediment, upper bathyal rock and biogenic reef, lower bathyal rock and biogenic reef, and abyssal habitats. Habitat of unknown type was subject to loss of 0.38%. Unlike the named habitats unsealed loss accounted for a small percentage of this loss. The predominant activities causing this loss were restructuring of the seabed, land claim and aquaculture for sealed loss and transport infrastructure (unsealed loss). A large proportion of the unknown habitat was littoral habitat. Total sealed across the entire Irish MSFD area was 0.12%, almost all of which was sealed loss.
Impact	Species, habitats and ecosystems are among the parameters and characteristics specified in Commission Directive 2017/845 that are relevant to this descriptor. The species impacts can be identified as: changes to distribution and/or biomass; size, age and sex structure, fecundity, survival and mortality/injury; behaviour including movement and migration; habitat for the species (extent, suitability); and species composition within groups of species. The habitat impacts can be identified as: habitat distribution and extent (and volume, if appropriate); species composition, abundance and/ or biomass (spatial and temporal variation); size and age structure of species (if appropriate); physical, hydrological and chemical characteristics. The ecosystem impacts can be identified as: turbidity (silt/sediment loads); seabed substrate and morphology; pelagic-benthic community structure; and productivity.
Assessment Method	For the purposes of this assessment, physical loss can be defined as any human-induced permanent alteration of the physical habitat from which recovery is impossible, within one 6-year MSFD cycle, without further intervention.

	Spatial analysis based on Geographical Information System (GIS) techniques, were utilised to calculate the footprint of loss inducing activities per MSFD benthic broad habitat type, in Irish MSFD waters. Benthic habitat layers were obtained using the EUSeaMap broad scale habitats map (https://www.emodnet-seabedhabitats.eu). Loss inducing activities were defined, partially on the basis of the 2019 ICES workshop on scoping of physical pressure layers causing loss of benthic habitats D6C1–methods to operational data products exercise. Spatial pressure data were obtained from a number of sources (see below). The following section describes the methods employed to transform these data into uniform estimates of spatial extent of benthic habitat affected. These activities were classified as follows for sealed loss in bold, with the data sources noted: • **Restructuring of seabed morphology:** Environmental Protection Agency's Geo Portal, Marine Institute, Ireland's Marine Atlas, INFOMAR surveyed Shipwrecks, Department of Communications, Climate Action & Environment, Oil and Gas Exploration. Associated activities: dredging (dumping at sea), Shipwrecks, and Offshore Exploration (Irish offshore wells). • **Extraction of minerals -rock, metal ores, gravel, sand, shell:** Environmental Protection Agency, EMODnet Human Activities Central Portal. Associated activities: Extraction of marine aggregates and maërl. • **Renewable energy generation, including infrastructure**: Marine Institute, Ireland's Marine Atlas. Associated activities: Wind farms, energy test sites and subsea test sites. • **Land claim**: OceanWise Ltd., UK Admiralty chart data. Associated activities: Harbour facilities, shoreline, piers, wharfs, slipways, and shoreline constructions. • **Non-renewable energy offshore structures**: Marine Institute, Ireland's Marine Atlas. Associated activities: Offshore gas installations. • **Transmission of electricity and communications:** Marine Institute, Ireland's Marine Atlas, EMODnet Human Activities Central Portal. Associated activities: Submarine Cables.

	• **Aquaculture marine, including infrastructure**: Marine Institute. Associated activities: shellfish and finfish aquaculture. • **Coastal defence and flood protection:** Marine Institute, EPA Water Frame Work Directive. Associated activities: Hard coastal protections and artificial protections (dykes). and for unsealed loss in bold, with the data sources noted: • **Restructuring of seabed morphology, including capital dredging**: OceanWise, Admiralty chart data. Associated activities: Channel dredging. • **Canalisation and other watercourse modifications:** No Data. • **Transport infrastructure:** OceanWise, Admiralty chart data. Associated activities: Dock Anchorages. A Spatial Analysis was conducted using ESRI ArcMap 10.4 to calculate the extent of habitat loss. The relevant data were uploaded from sources outlined above. All analyses were confined to Ireland's MSFD area. GIS processing tools were used to quantify the extent of loss occurring on specific habitats. Two GIS models were used to enable individual habitats to be stripped from the overall habitat layer. Individual habitat classes were selected from the EU Seamap Shapefile using model builder in ArcMap. The Iterate feature selection iterator, which loops through the Broad habitat MSFD_BH17 field was used (in the attribute table); this iterator strips out the various habitats, stores them as individual shapefiles. These shapefiles are used in the second model to calculate the extent of habitat associated with the above-mentioned pressures. The folder containing the shapefiles from model 1 are added to model 2. The iterate feature iterator is used. This iterator loops through shapefiles contained in the folder. The summary statistics tool sums the habitat extent in square km for individual habitats; this figure is saved as habitat extent. Results were expressed as areas and percentages lost per benthic broad habitat type.
Assessment Result	The benthic habitat type with the greatest extent of area loss was infralittoral mud, with 5.5% loss recorded. Other habitats which recorded percentage loss of greater than 1% overall were infralittoral mixed sediment (2.73%); infralittoral sand (2.49%), circalittoral mud (2.47%), infralittoral coarse sediment (2.43%), circalittoral sand

	(1.97%), circalittoral rock and biogenic reef (1.25%) and infralittoral rock and biogenic reef (1.15%). In all these cases, sealed loss was the predominant type, arising mainly from restructuring of the seabed and aquaculture. The habitats that recorded loss of less than 1% overall were offshore circalittoral rock and biogenic reef (0.67%), circalittoral mixed sediment (0.57%), circalittoral coarse sediment (0.47%), offshore circalittoral mud (0.44%), offshore circalittoral sand (0.21%) and offshore circalittoral coarse sediment (0.08%). In all these cases, sealed loss was the predominant type, arising mainly from restructuring of the seabed. Habitats with virtually no loss (<0.01%) were offshore circalittoral mixed sediment, upper bathyal sediment and lower bathyal sediment. Habitats recording no physical loss at all were littoral rock and biogenic reef, littoral sediment, upper bathyal rock and biogenic reef, lower bathyal rock and biogenic reef, and abyssal habitats. Habitat of unknown type was subject to loss of 0.38%. Unlike the named habitats unsealed loss accounted for a small percentage of this loss. The predominant activities causing this loss were restructuring of the seabed, land claim and aquaculture for sealed loss and transport infrastructure (unsealed loss). A large proportion of the unknown habitat was littoral habitat. Total loss (sealed & unsealed) across the entire Irish MSFD area was 0.12%, almost all of which was sealed loss.

Results (figures & tables)

Table 1. Summary of calculated areas lost per benthic broad habitat type in Ireland's maritime area, presented in terms of area (km^2) and the percentage of that habitat type.

MSFD Benthic broad habitat type	km2	Sealed loss		Unsealed loss		Total loss	
		Area lost km^2	% loss	Area lost km^2	% loss	Area lost km^2	% loss
Littoral rock and biogenic reef	?						
Littoral sediment	?						
Infralittoral rock and biogenic reef	159	2	1%	0	0%	2	1%
Infralittoral coarse sediment	102	2	2%	0	0%	2	2%
Infralittoral mixed sediment	20	1	3%	0	0%	1	3%
Infralittoral sand	236	6	2%	0	0%	6	2%
Infralittoral mud	124	7	5%	0	0%	7	6%
Circalittoral rock and biogenic reef	3,011	37	1%	1	0%	38	1%
Circalittoral coarse sediment	4,209	17	0%	2	0%	20	0%
Circalittoral mixed sediment	147	1	1%	0	0%	1	1%
Circalittoral sand	2,563	44	2%	6	0%	50	2%
Circalittoral mud	1,026	17	2%	9	1%	25	2%
Offshore circalittoral rock and biogenic reef	3,381	23	1%	0	0%	23	1%
Offshore circalittoral coarse sediment	28,141	23	0%	0	0%	23	0%
Offshore circalittoral mixed sediment	2,907	0	0%	0	0%	0	0%
Offshore circalittoral sand	39,115	80	0%	0	0%	80	0%
Offshore circalittoral mud	33,548	149	0%	0	0%	149	0%
Upper bathyal rock and biogenic reef	4	0	0%	0	0%	0	0%
Upper bathyal sediment	101,324	2	0%	0	0%	2	0%
Lower bathyal rock and biogenic reef	9	0	0%	0	0%	0	0%
Lower bathyal sediment	46,260	0	0%	0	0%	0	0%
Abyssal	171,686	0	0%	0	0%	0	0%
Unknown	28,878	92	0%	17	0%	109	0%
Total	**466,852**	**503**	**0.11%**	**35**	**0.01%**	**538**	**0.12%**

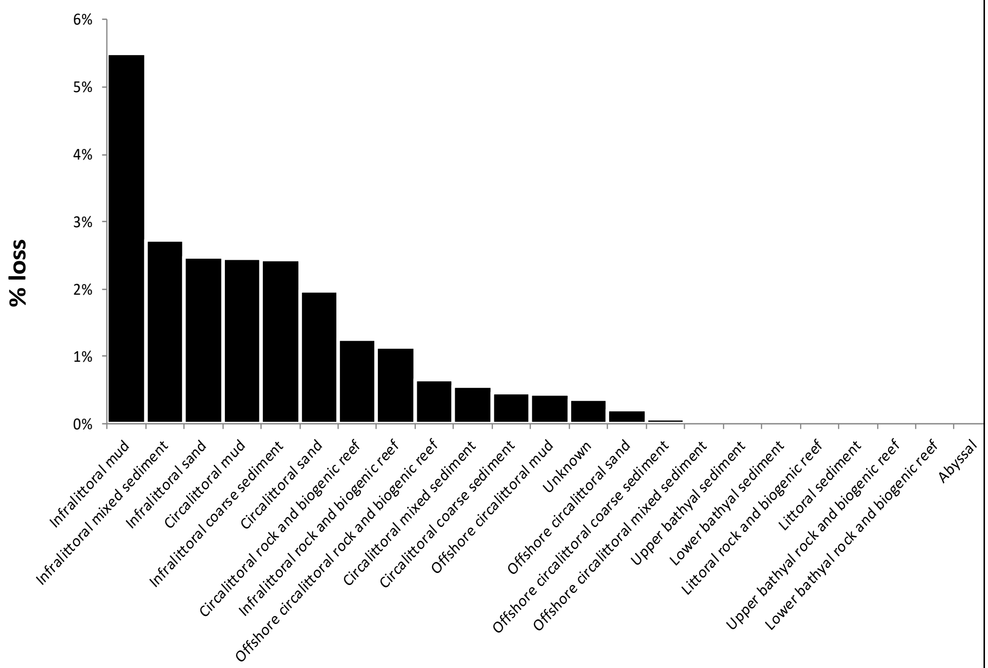


Figure 1. Summary of the physical loss per benthic broad habitat type, presented in terms of percentage area within the Irish maritime area.

Conclusion

Quantitative thresholds are currently not available for the acceptable extent of loss of the benthic habitat type, resulting from anthropogenic

	pressures. This and associated methodologies are coordinated works in progress at EU and Member State level. However, the general objectives around physical loss of the sea-floor have been met for Ireland's maritime area because the calculated extent of loss is lower than any potential threshold value. Hence Ireland is achieving GES for these MSFD criteria. The overall percentage area loss of benthic habitat in Ireland's maritime area is less than half of 1% of the total sea-floor area. The highest loss per habitat type was almost 6% for infralittoral mud. The percentage area loss for other habitats is much lower.
Knowledge gaps	It is not currently possible to assess all habitats in Irish waters against these criteria elements. In particular, it was not possible to assess littoral habitats, as the extent per habitat type overall in Irish MSFD waters is unknown. In assessing the extent of loss due to aquaculture, the current results may overestimate the degree of loss. This is because the area was calculated from the total area for which licences were granted and not all licensed areas may have been developed for long-term use. It is unknown what the extent of occupancy of these licensed areas or the exact degree of loss resulting from the activities in that occupied area.
	Assessment Data
Data Sources	The International Council for the Exploration of the Sea (ICES) EPA Geo Portal, data presented for download is made available under Creative Commons Attribution Licence 4.0 OceanWise Marine and Coastal Data Products The European Marine Observation and Data Network (EMODNet) European Environmental Agency, Data and maps Marine Institute - Ireland's Marine Atlas Department of Communications, Climate Action & Environment OSPAR Commission
Data Locations (URL)	EPA data download, Extractive Facilities Register/Dumping at Sea, Water/Water Framework Directive , http://gis.epa.ie/GetData/Download OceanWise Admiralty Charts/ Ports and Harbours Capital Dredging https://www.oceanwise.eu/about-us/ports-and-harbours/ EMODNet Human Activities Central Portal / Aggregate Extraction, Cables, Dredging, Hydrocarbon Extraction, Ocean Energy Facilities,

	Pipelines, Shipping Densities, Wind Farms https://www.emodnet-humanactivities.eu/view-data.php EMODNet Seabed Habitats / EUSeaMap MSFD Benthic Broad Habitat Types https://www.emodnet-seabedhabitats.eu/access-data/launch-map-viewer/ EMODNet Bathymetry / Bathymetry viewing and downloading service, DTM Tiles 2018 https://portal.emodnet-bathymetry.eu/ European Environmental Agency / Geomorphology, Geology, Erosion trends and Coastal Defence https://www.eea.europa.eu/data-and-maps/data/geomorphology-geology-erosion-trends-and-coastal-defence-works Ireland's Marine Atlas / Administrative Units, Energy Exploration, Energy Infrastructure, INFOMAR seabed survey, KIS-ORCA, Transport Networks, Aquaculture Sites, Utility and Government Services, Maritime Limits. https://atlas.marine.ie Oil and Gas Exploration & Production DCCAE / Irelands Offshore Grid, Wells in the Irish Offshore, Current authorisations https://www.dccae.gov.ie/en-ie/natural-resources/topics/Oil-Gas-Exploration-Production/data/Pages/Spatial-(GIS)-Data.aspx ICES. 2019. Workshop on scoping of physical pressure layers causing loss of benthic habitats D6C1–methods to operational data products (WKBEDLOSS). ICES Scientific Reports. 1:15. 37 pp. http://doi.org/10.17895/ices.pub.5138. OSPAR /Marine Protected Areas, Reporting Units, VME's, Dumping at Sea, Offshore Renewable Energy https://odims.ospar.org/odims_data_files/			
Data Time Line	Start Date:	2013	End Date:	2019
Point of Contact	Paul Coleman, Marine Institute FEAS, Rinville, Oranmore, Co. Galway			
Email	paul.coleman@marine.ie			

D6 C2

Descriptor 6 Sea-floor integrity	**Assessment Sheet: Benthic habitats** **Criterion D6C2** **Spatial extent and distribution of physical disturbance pressures on the seabed**
Key message	At the time of Ireland's MSFD Initial Assessment in 2013, quantitative thresholds were not yet developed to determine compliance with the objectives for sea-floor integrity that Ireland had set itself. Based on the updated assessment now undertaken of physical disturbance within Ireland's part of OSPAR Region III, the conclusion is that the extent and distribution of physical disturbance pressures on the seabed is significant. The results of analyses from certain fishing pressures from 2010 to 2015 showed physical disturbance to be widespread, occurring to some degree in 70% of the grid cells analysed. High disturbance was recorded in 46% of grid cells. Within a determination framework for Good Environmental Status (GES), the environmental status of sea-floor habitat under this criterion is currently unknown but is considered unlikely to be fully in a condition that achieves GES. Further coordinated work and development at EU and Member State level will be required in order to advance the assessment methodology, targets and proposed threshold values under this physical disturbance-related criterion.
Background	Benthic habitats are formed of marine organisms living on or within sediments and rock. They provide essential ecological processes and functions to support healthy ecosystems. They are a key component of the marine food web, including commercial fish and shellfish species, and provide a major food source for predators. The diversity of benthic habitats is shaped by factors such as depth, light penetration, substrate type and their flora and fauna communities. These create a huge variety of habitat types, with communities showing different levels of sensitivity to physical damage. Some are very sensitive (e.g. fragile coral gardens), whereas others are more robust (e.g. mobile sands). Physical loss and disturbance of the seafloor by human activities such as bottom contacting fishing, aggregate extraction or offshore construction can adversely affect benthic habitats, especially those with larger and fragile species exhibiting longer recovery times. This Indicator aims to assess the current spatial extent and level of habitat loss caused by human activities to the seafloor.

Objective	Commission Decision 848/2017 defines criterion D6C2 as "Spatial extent and distribution of physical disturbance pressures on the seabed." In 2013 Ireland identified three objectives for safeguarding seafloor integrity. Of these, the following two are of relevance to this criterion: "The extent and diversity of sea-floor habitats is maintained in line with prevailing physiographic, geographic and climate conditions" and "Sea-floor habitats (physically and structurally) are sufficiently productive and extensive to support natural functionality and a healthy and sustainable ecosystem for the long term." This assessment measures conformity with criterion D6C2 against the 2013 objective, by using the OSPAR Common Indicator BH3 assessment, for Irish MSFD waters of Region III. However, no quantitative thresholds exist which could be used to assess this criterion.
Drivers (Activities)	Benthic habitats are characterised by animal and plant communities with no or slow mobility when compared to fish or marine mammals. The whole benthic community is therefore exposed when a pressure occurs. As a result, the condition (quality status) of benthic habitats is a reflection of the combined effects of all the pressures to which they are subject. The main activities driving pressures on benthic habitats, based on Commission Directive 845/2017 are: extraction of living resources (fish and shellfish harvesting); transport; extraction of non-living resources; production of energy; and cultivation of living resources (marine aquaculture).
Pressures	The main pressures, as listed in Commission Directive 845/2017 of relevance to this descriptor are: physical disturbance to the seabed and extraction of or mortality/injury to wild species (by commercial and recreational fishing and other activities).
State	The state of the habitats assessed, in terms of the three disturbance classes, in the sub-set of the Irish MSFD area within OSPAR Region 3 is presented below, in order of the spatial extent of the habitats.

	Offshore circalittoral sand habitat occupies 38,953 km^2 of sea floor in the Irish segment of OSPAR Region 3. Only 3% of this habitat is experiencing no disturbance, while 67% of its extent is highly disturbed. **Offshore circalittoral mud** habitat occupies 32,014 km^2 of sea floor in the Irish segment of OSPAR Region 3. Only 27% of this habitat is experiencing low disturbance, while 73% of its extent is highly disturbed. None of this habitat's extent is experiencing no disturbance. **Offshore circalittoral coarse sediment** habitat occupies 27,083 km^2 of sea floor in the Irish segment of OSPAR Region 3. Only 29% of this habitat is experiencing no disturbance, with 39% of its extent highly disturbed. **Circalittoral coarse sediment** habitat occupies 4,209 km^2 of sea floor in the Irish segment of OSPAR Region 3. Only 5% of this habitat is highly disturbed, with 49% of its extent experiencing no disturbance. **Offshore circalittoral rock and biogenic reef** habitat occupies 3,381 km^2 of sea floor in the Irish segment of OSPAR Region 3. Only 24% of this habitat is experiencing no disturbance, with 72% of its extent highly disturbed. **Circalittoral rock and biogenic reef** habitat occupies 3,011 km^2 of sea floor in the Irish segment of OSPAR Region 3. Only 47% of this habitat is experiencing no disturbance, with 44% of its extent highly disturbed. **Circalittoral sand** habitat occupies 2,563 km^2 of sea floor in the Irish segment of OSPAR Region 3. Only 12% of this habitat is highly disturbed, with 45% of its extent experiencing no disturbance. **Offshore circalittoral mixed sediment** habitat occupies 1,936 km^2 of sea floor in the Irish segment of OSPAR Region 3. Only 11% of this habitat is highly disturbed, with 24% of its extent experiencing no disturbance. **Circalittoral mud** habitat occupies 1,026 km^2 of sea floor in the Irish segment of OSPAR Region 3. Only 37% of this habitat is experiencing no disturbance, while 30% of its extent is highly disturbed. **Infralittoral sand** habitat occupies 236 km^2 of sea floor in the Irish segment of OSPAR Region 3. Only 2% of this habitat is highly disturbed, with 76% of its extent experiencing no disturbance. **Infralittoral rock and biogenic reef habitat** occupies 159 km^2 of sea floor in the Irish segment of OSPAR Region 3. Only 10% of this habitat is highly disturbed, with 62% of its extent experiencing no disturbance. **Circalittoral mixed sediment** habitat occupies 147 km^2 of sea floor in the Irish segment of OSPAR Region 3. Only 7% of this habitat is highly disturbed, with 61% of its extent experiencing no disturbance.

	Infralittoral mud habitat occupies 124 km^2 of sea floor in the Irish segment of OSPAR Region 3. Only 1% of this habitat is highly disturbed, with 81% of its extent experiencing no disturbance. **Infralittoral coarse sediment** habitat occupies 102 km^2 of sea floor in the Irish segment of OSPAR Region 3. Only 3% of this habitat is highly disturbed, with 69% of its extent experiencing no disturbance. **Infralittoral mixed sediment** habitat occupies 20 km^2 of sea floor in the Irish segment of OSPAR Region 3. None of this habitat is highly disturbed, with 51% of its extent experiencing no disturbance, and 49% experiencing low disturbance. **Unknown** habitat occupies 28,333 km^2 or 19% of sea floor in the Irish segment of OSPAR Region 3. The disturbance levels in these areas are unknown.
Impact	Among the parameters and characteristics specified in Commission Directive 2017/845 that are relevant to this descriptor can be grouped by ecosystem element (species, habitats and ecosystems). The species impacts can be identified as: changes to distribution and/or biomass; size, age and sex structure, fecundity, survival and mortality/injury; behaviour including movement and migration; habitat for the species (extent, suitability); and species composition within groups of species. The habitat impacts can be identified as: habitat distribution and extent (and volume, if appropriate); species composition, abundance and/ or biomass (spatial and temporal variation); size and age structure of species (if appropriate); physical, hydrological and chemical characteristics. The ecosystem impacts can be identified as: turbidity (silt/sediment loads); seabed substrate and morphology; pelagic-benthic community structure; and productivity. ICES evaluated pressures arising from fishing as: extraction, abrasion and smothering. Physical disturbance (abrasion and smothering) of the seabed by fishing impacts on marine habitats in general, on benthos and on marine productivity. Abrasion is associated with bottom-contacting mobile and set fishing activities, in particular scallop dredging, beam trawling, and otter trawling but also other activities such as anchoring, hydrodynamic dredging, and cable burial. Smothering refers to activities contributing to change in siltation on the

<table>
<tr><td></td><td>seabed include dredging for shipping, disposal of materials to the seafloor, and commercial fishing.</td></tr>
<tr><td>Assessment Method</td><td>Quantitative metrics are currently unavailable to determine compliance with the objectives Ireland set itself in its 2013 MSFD Initial Assessment. This assessment uses the OSPAR Common Indicator BH3 regarding the extent of physical damage to predominant and special habitats; it shows the distribution and intensity of pressure from bottom-contact fishing activity and the associated disturbance to the seafloor at the scale of that part of OSPAR Region III within Ireland's maritime area. The approach uses a combination of semi-quantitative and categorical approaches of the pressure / impact relationship between habitats and fishing.

The basic assessment of OSPAR Common Indicator BH3 habitat classification was updated to EUNIS classification to comply with the latest Commission decision 848/2017.

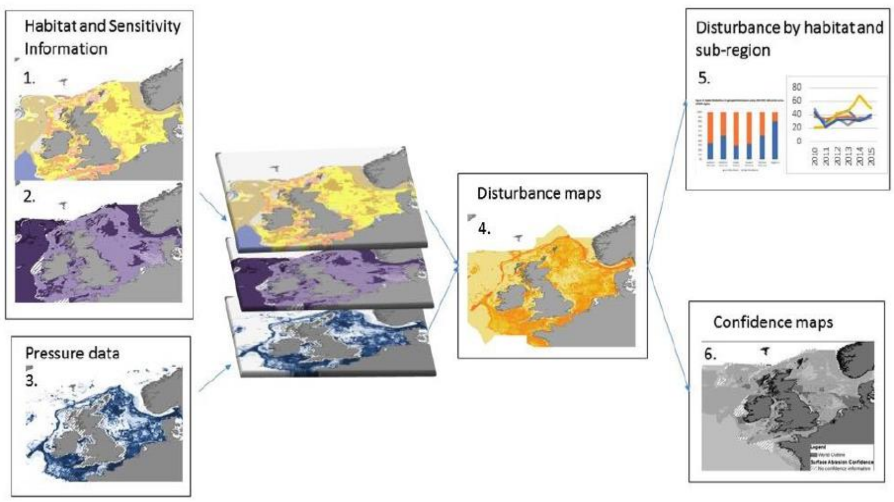


Figure 1. Conceptual overview of how the OSPAR Common Indicator BH3 is compiled.</td></tr>
<tr><td>Assessment Result</td><td>The assessment covers the period 2010–2015. It shows that up to 70% of the grid cells assessed in the Irish MSFD area within the Celtic Seas (OSPAR Region 3) show evidence of some physical disturbance of the seafloor from bottom contacting fishing gears, of which 46% of areas show higher levels of disturbance. Of the remainder, 18% of the grid cells were of unknown habitat type and were not included in the assessment.</td></tr>
</table>

The level of disturbance per benthic broad habitat type is shown in the table below.

MSFD Benthic Broad Habitat Types	No disturbance 0	Low disturbance 1-4	High disturbance 5-9	No Data
Infralittoral mud	81%	17%	1%	2%
Infralittoral sand	76%	22%	2%	0%
Infralittoral coarse sediment	69%	28%	3%	0%
Infralittoral rock and biogenic reef	62%	28%	10%	0%
Circalittoral mixed sediment	61%	32%	7%	0%
Infralittoral mixed sediment	51%	49%	0%	0%
Circalittoral coarse sediment	49%	46%	5%	0%
Circalittoral rock and biogenic reef	47%	9%	44%	0%
Circalittoral sand	45%	43%	12%	0%
Circalittoral mud	37%	33%	30%	0%
Offshore circalittoral coarse sediment	29%	32%	39%	0%
Offshore circalittoral rock and biogenic reef	24%	4%	72%	0%
Offshore circalittoral mixed sediment	24%	65%	11%	0%
Offshore circalittoral sand	3%	30%	67%	0%
Offshore circalittoral mud	0%	27%	73%	0%
Unknown	-	-	-	100%

The habitats with the least disturbance were infralittoral mud; infralittoral sand; infralittoral coarse sediment; and infralittoral rock and biogenic reef. The first three of these habitats also had the least degree of high disturbance along with infralittoral mixed sediment. Habitats with the least degree of low disturbance included some of the above categories along with circalittoral rock and biogenic reef; and offshore circalittoral rock and biogenic reef.

The habitats with the greatest degree of disturbance were: offshore circalittoral mud; offshore circalittoral rock and biogenic reef; offshore circalittoral sand and circalittoral rock and biogenic reef. Two habitat types displayed 100% levels of high disturbance (upper bathyal sediment or upper bathyal rock and biogenic reef; and upper bathyal sediment). However, this is an artefact resulting from the assessment being confined to OSPAR Region 3, where these habitats are only at the shallower edge of their wider extent. The habitats with the lowest degree of high disturbance were infralittoral mud; infralittoral sand; infralittoral coarse sediment; and circalittoral coarse sediment. The habitats with the greatest degree of moderate disturbance were offshore circalittoral mixed sediment; infralittoral mixed sediment; circalittoral coarse sediment; and circalittoral sand.

Two habitat types, offshore circalittoral sand and offshore circalittoral mud account for almost 50% of the assessed area. Both these habitats are highly disturbed (67% and 73% respectively).

Results (figures & tables)	

Results

(figures & tables)

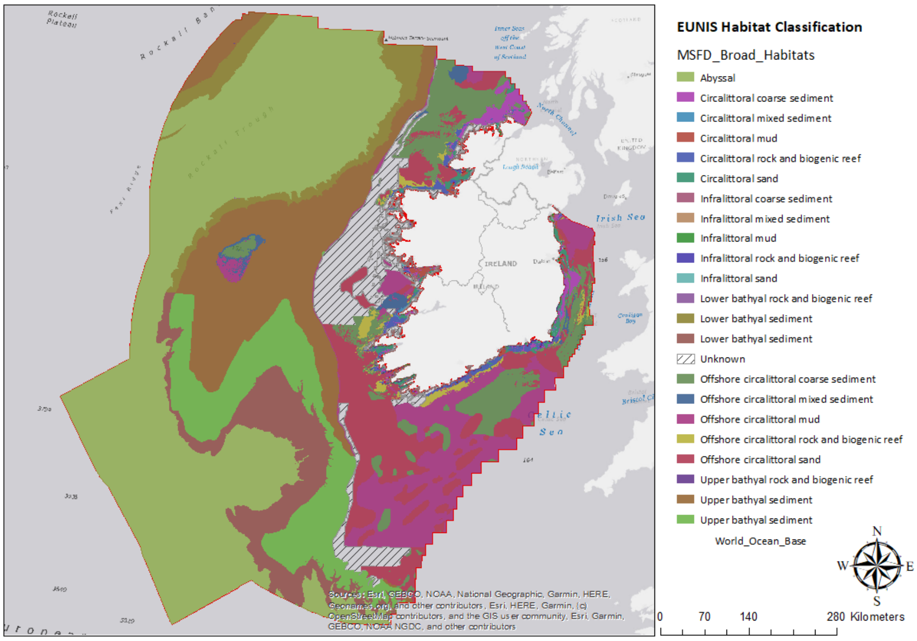


Figure 2. Map showing the occurrence of benthic broad habitat types in Ireland's maritime area.

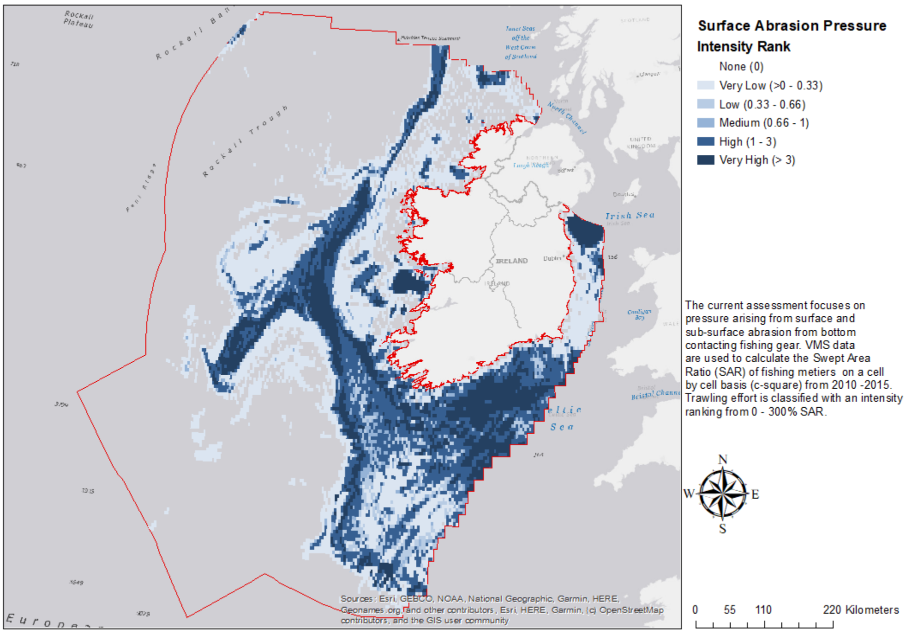


Figure 3. Map of surface and sub-surface abrasion pressures from bottom-contacting fishing gear in the Irish maritime area; these are ranked from no pressure (0) to very high (>3).

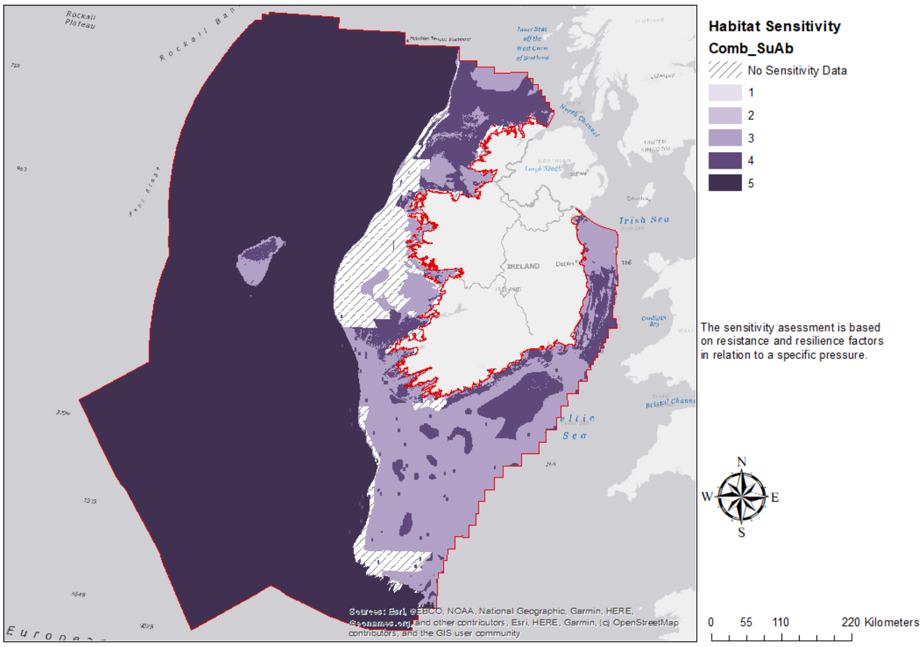


Figure 4. Map of benthic habitat sensitivity within the Irish maritime area.

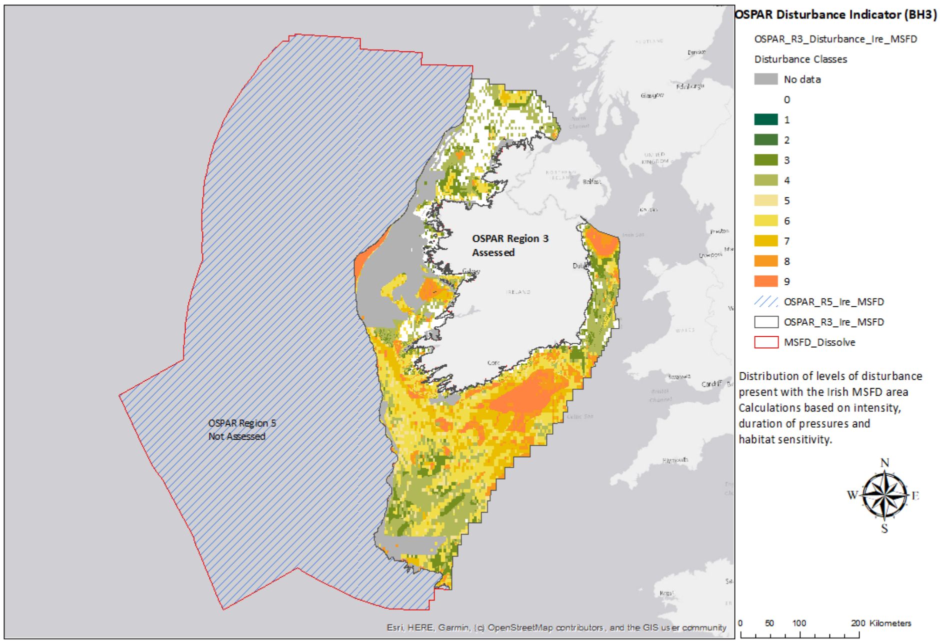


Figure 5. Representation of overall physical disturbance of benthic habitats indicated within the Irish maritime area (Ireland's OSPAR Region III component only).

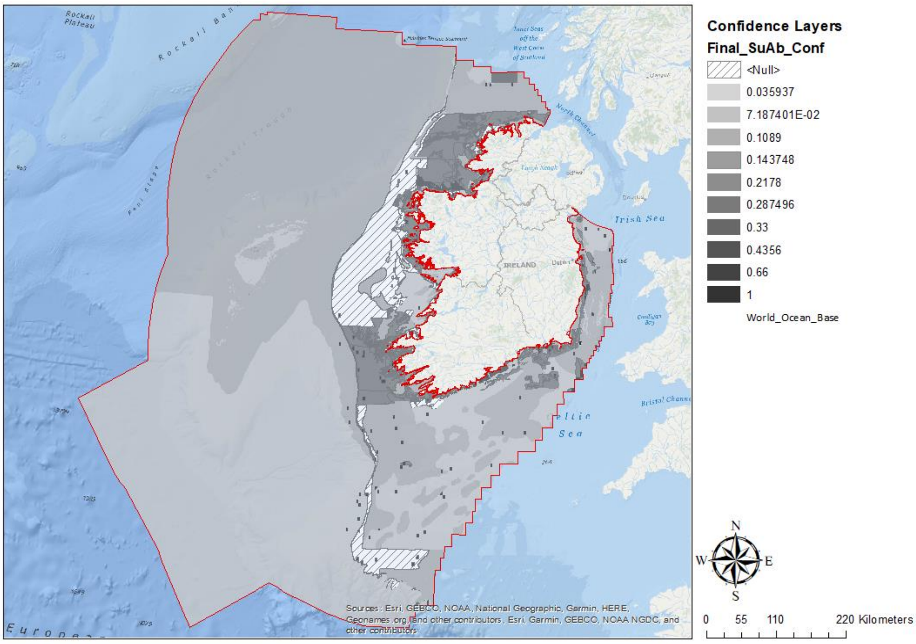


Figure 6. Relative confidence scores based on habitats and sensitivity data.

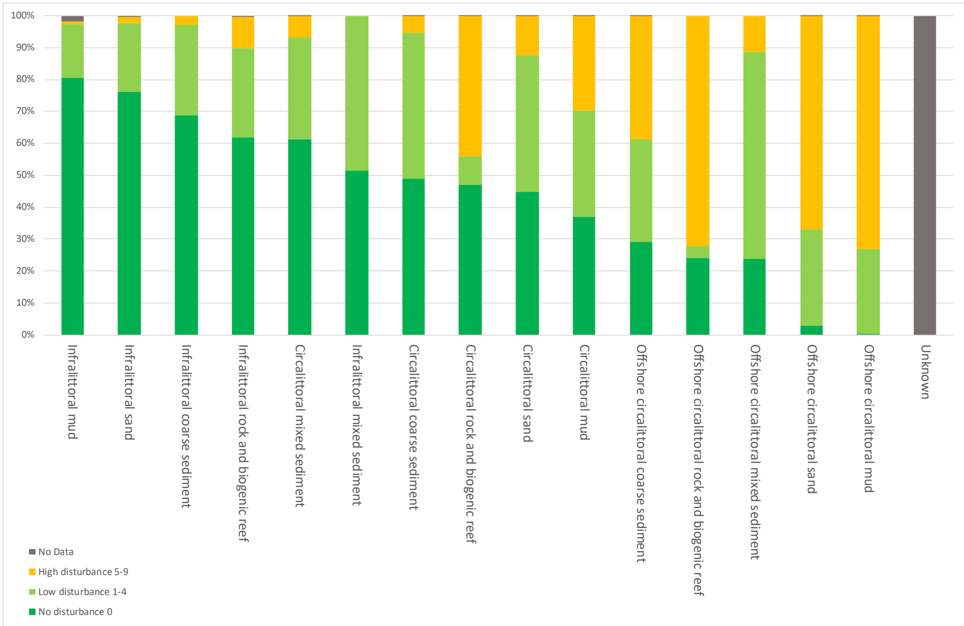


Figure 7. Level of physical disturbance per broad benthic habitat type; presented as a percentage of the total area of each habitat type.

Conclusion	Based on the updated assessment now undertaken of physical disturbance within Ireland's part of OSPAR Region III, the conclusion is that the extent and distribution of physical disturbance pressures on the seabed is significant. The results of analyses from certain fishing

	pressures from 2010 to 2015 showed physical disturbance to be widespread, occurring to some degree in 70% of the grid cells analysed. High disturbance was recorded in 46% of grid cells. The assessed areas with the highest levels of physical disturbance in Ireland's maritime area were in the northwest Irish Sea, the central Celtic Sea and southwest of the Aran Islands. The habitat identified as being subject to the highest disturbance was offshore circalittoral mud with 73% of its total habitat area identified as subject to high disturbance. Within a determination framework for Good Environmental Status (GES), the environmental status of sea-floor habitat under this criterion is currently unknown but is considered unlikely to be fully in a condition that achieves GES. Further coordinated work and development at EU and Member State level will be required in order to advance the assessment methodology, targets and proposed threshold values under this physical disturbance-related criterion.
Knowledge gaps	This is not a full evaluation of the adverse effects of all anthropogenic activities, because the analysis is confined to fishing. Furthermore, not all bottom contacting gears are fully included. There is also a complete lack of information from small inshore fishing vessels. The pressure data included in this assessment does not include Spanish data, as these were not made available to ICES. However, these data are subsequently being made available in late 2019. Habitat data are unavailable for a proportion of Irish MSFD waters, particularly inshore areas. A fully quantitative method is not possible at this stage as it would limit results to small-scale locations, or where long-term datasets are available. Achieving more quantitative approaches will require availability and accessibility of habitat survey data; the lack of data from small fisheries and other activities causing physical damage (e.g. sand extraction and offshore construction); a review of the sensitivity method; refinement of the disturbance matrix; calculation of a final physical damage index per habitat type and sub-region; and a better understanding of the impacts of different fishing gear types. Research is required to develop a fully quantitative and cost efficient method in collaboration with other countries (through OSPAR and the International Council for the Exploration of the Sea, for example).

<table>
<tr><td></td><td colspan="4">This analysis only covers Ireland's portion of OSPAR Region III (Celtic Seas) and not OSPAR Region V (Wider Atlantic). Region V accounts for 69% of Ireland's maritime area. There is a lack of benthic species survey data for OSPAR Region V, which inhibits calculation of a sensitivity score at the species level. This makes aggregation of sensitivity scores from the species level to the habitat polygon level impossible. Sensitivity from EUNIS Level 3 benthic habitat modelled data is used to act as a background map only. Sensitivity used at this level normally range from very low to very high with the maximum sensitivity being used.

A drawback with the current assessment is that it may overestimate the degree of pressure from fishing. This is because the currently low ping frequency of the Vessel Monitoring System (VMS) data may exaggerate the proportion of assessed squares swept by bottom trawl. A VMS higher ping frequency would deliver a higher spatial resolution swept area pressure metric.</td></tr>
<tr><td></td><td colspan="4">Assessment Data</td></tr>
<tr><td>Data Sources</td><td colspan="4">OSPAR, 2017. OSPAR CEMP Guidelines for the Common Indicator: BH3 Extent of Physical damage to predominant and special habitats1. London: OSPAR 61 pp.</td></tr>
<tr><td>Data Locations (URL)</td><td colspan="4">https://odims.ospar.org/layers/geonode:ospar_bottom_f_intensur_2012_01_002/metadata_detail
https://odims.ospar.org/layers/geonode:ospar_bottom_f_intensur_2015_01_002
https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/biodiversity-status/habitats/extent-physical-damage-predominant-and-special-habitats/
https://www.emodnet-seabedhabitats.eu/access-data/launch-map-viewer/</td></tr>
<tr><td>Data Time Line</td><td>Start Date:</td><td>2010</td><td>End Date:</td><td>2015</td></tr>
<tr><td>Point of Contact</td><td colspan="4">Paul Coleman, Marine Institute FEAS, Rinville, Oranmore, Co. Galway</td></tr>
<tr><td>Email</td><td colspan="4">paul.coleman@marine.ie</td></tr>
</table>

D6 C5

Descriptor 6 Sea-floor integrity	**Assessment Sheet: Benthic habitats Criterion D6C5 The extent of adverse effects from anthropogenic pressures on the condition of the habitat type**
Key message	At the time of Ireland's MSFD Initial Assessment in 2013, quantitative thresholds were not yet developed to determine compliance with the objectives for sea-floor integrity that Ireland had set itself. Based on the updated assessment of physical disturbance now undertaken, the conclusion is that the extent of adverse effects from anthropogenic pressures on the condition of Ireland's benthic habitat types is currently unknown. Thus within a determination framework for Good Environmental Status (GES), the environmental status under this criterion is currently unknown. Based on Ireland's 2019 assessment of Annex I sea-floor habitats protected under the EU Habitats Directive, there are indications that these specific subsets of benthic habitat in the Irish maritime area are currently not in a condition that achieves GES. However, these comprise a small proportion of the benthic broad habitat types occurring in Ireland's maritime area and all but one habitat type are inshore and shallow in nature. Further coordinated work and development at EU and Member State level will be required in order to advance the assessment methodology, targets and proposed threshold values under this physical disturbance-related criterion.
Background	Benthic habitats are formed of marine organisms living on or within the sediment and on rock. They provide essential ecological processes and functions to support healthy ecosystems. They are a key component of the marine food web, including commercial fish and shellfish species, and provide a major food source for predators. The diversity of seafloor habitats is shaped by factors such as depth, light penetration, substrate type and their fora and fauna communities. These create a huge variety of habitat types, with communities showing different levels of sensitivity to physical damage. Some are very sensitive (e.g. fragile coral gardens), whereas others are more robust (e.g. mobile sands). Physical disturbance of the seafloor by human activities such as bottom contacting fishing, aggregate extraction or offshore construction can adversely affect benthic habitats, especially those with larger and fragile species and those with longer recovery time. This Indicator aims to help assess the current

	spatial extent and level of physical disturbance that human activities have caused to the seafloor.
Objective	Commission Decision 2017/848 defines this criterion as "The extent of adverse effects from anthropogenic pressures on the condition of the habitat type, including alteration to its biotic and abiotic structure and its functions (e.g. its typical species composition and their relative abundance, absence of particularly sensitive or fragile species or species providing a key function, size structure of species), does not exceed a specified proportion of the natural extent of the habitat type in the assessment area." In 2013 Ireland identified three objectives for safeguarding seafloor integrity. Of these, the following one is of relevance to this criterion: "Sea-floor habitats and their constituent species identified as needing protection under national or international agreements are effectively protected or conserved through the appropriate national, regional or international mechanisms." This assessment measures conformity with criterion D6C5 against the 2013 objective, by using the EU Habitats Directive Article 17 assessments completed in 2019 by Ireland (NPWS, 2019a,b and references therein). Habitats assessed as having a "Favourable Conservation Status" under the Habitats Directive are considered to have achieved GES under criterion D6C5.
Drivers (Activities)	Benthic habitats are characterised by animal and plant communities with no or slow mobility when compared to fish or marine mammals. The whole benthic community is therefore exposed when a pressure occurs. As a result, the condition (quality status) of benthic habitats is a reflection of the combined effects of all the pressures to which they are subject. The main activities driving pressures on benthic habitats, based on Commission Directive 845/2017 are: urban and industrial uses (including water treatment and disposal and industrial uses); physical restructuring of rivers, coastline or seabed (watercourse modifications, dredging); cultivation of living resources (marine aquaculture); extraction of living resources (fish and shellfish harvesting).
Pressures	The main pressures on seabed habitats are: physical disturbance to the seabed, extraction of or mortality/injury to wild species (by commercial and recreational fishing and other activities); abrasion;

	substrate loss; changes to hydrological conditions, inputs of nutrients and/or organic matter and input and spread of non-indigenous species.
State	Sandbanks and Submarine Structures made by Leaking Gases were habitats that were found to be of Favourable status in 2019. Habitats with Unfavourable-Inadequate status were Estuaries, Tidal Mudflats/Sandflats and Reefs. Unfavourable-bad status was found for Lagoons and Large Shallow Inlets/Bays. Habitats of unknown status were Maërl Beds and Seacaves.
Impact	**Sandbanks:** No significant pressures were identified acting on this habitat. **Estuaries**: Most of the pressures on estuaries come from various sources of pollution, including domestic wastewater, agriculture and marine aquaculture. Non-indigenous species such as the naturalised Pacific oyster (*Crassostrea gigas*) is considered a significant pressure in some areas. The Overall Status of the habitat is Inadequate and deteriorating. This status is the same as the 2013 assessment; however, the trend has changed, due to more accurate data, from improving to declining. **Mudflats/Sandflats:** The main impacts on this habitat are pollution from agricultural, forestry and wastewater sources, as well as impacts associated with marine aquaculture, particularly the Pacific oyster (*Crassostrea gigas*). **Lagoons**: Several high-ranking pressures were identified acting on this habitat: eutrophication, modification of hydrological flow, and drainage. Other pressures noted include erosion and silting up, accumulation of seaweed, and sedimentation from peat related to turf cutting and/or forestry. **Large shallow inlets and bays:** Pressures on this habitat include nutrient enrichment, dredging and invasive alien species. **Reefs**: The main pressures come from bottom contacting fishing methods, comprising dredging, beam trawls, bottom trawls, pelagic trawls when deployed on the bottom, static nets, bottom set longlines and pots. Even low levels of fishing activity could produce catastrophic pressures on these habitats, depending on how vulnerable they are.

	Submarine structures made by leaking gasses: Fishing is a potential pressure on this habitat and in other jurisdictions moves are afoot to protect such structures to damage from fishing. Even low levels of fishing activity could produce catastrophic pressures on these habitats, depending on how vulnerable they are.
Assessment Method	The results of Ireland's assessment of Habitats under the Habitats Directive Article 17 (NPWS 2019a,b and references therein) were used to assess this criterion. Habitats assessed as Favourable in the Habitats Directive assessment were interpreted to have achieved GES, whilst those assessed as Unfavourable were considered to have failed to achieve GES. The assessments conducted in the Habitats Directive, for those small parts of the area were considered indicative of these habitats in general. **Sandbanks**: 69km^2 of the total resource of 247km^2 of the Sandbanks habitat within four Special Areas of Conservation (SACs) around the coast of Ireland were surveyed to assess the Structure and functions of this habitat during the current reporting period. This represents 28% of the total national resource for this habitat. **Estuaries**: 433km^2 of the total resource of 761km^2 of the Estuary habitat within 11 Special Areas of Conservation (SACs) around the coast of Ireland were surveyed to assess the Structure and functions of this habitat during the current reporting period. This represents 56.9% of the total national resource for this habitat. **Mudflats/sandflats**: 313km^2 of the total national resource of 646km^2 of Mudflats and sandflats not covered by seawater at low tide within 21 Special Areas of Conservation (SACs) around the coast of Ireland were surveyed to assess the Structure and functions of this habitat during the current reporting period. This represents 49% of the total national resource for this habitat. **Lagoons**: A lagoon in Favourable condition, as determined by the site-specific conservation objectives (https://www.npws.ie/protected-sites), is said to have a median annual salinity and temporal variation within natural range; annual water level fluctuations and minima within natural range; appropriate hydrological connections between lagoons and sea including, where necessary, appropriate management; annual median chlorophyll a within natural ranges and <5µg/l (or <2.5 µg/l in one case); annual median MRP within natural ranges and <0.1mg/l (or <0.01mg/l in one case); annual median DIN within natural ranges and

	less than 0.15mg/l, macrophyte colonisation to maximum depth for shallow (<2m) lagoons or to >2m (or >4m) for all other lagoons; maintain number and extent of listed plant lagoonal specialists, subject to natural variation, maintain listed animal lagoonal specialists, subject to natural variation, and negative indicator species absent or under control. **Large sandy inlets and bays**: 1,690 km^2 of the total resource of 4,768 km^2 of Large shallow inlets and bays within fourteen Special Areas of Conservation (SACs) around the coast of Ireland were surveyed to assess Structure and functions of this habitat during the current reporting period. This represents 35% of the total national resource of this habitat and it was deemed to be representative of the national resource. **Reefs**: 618km2 of inshore reef habitat within twelve Special Areas of Conservation (SACs) around the coast of Ireland were surveyed to assess Structure and functions during the current reporting period. The Sea Rover surveys of 2017 and 2018 delivered a considerable amount of information on extent and species composition of both biogenic and geogenic reef encountered. However further work is required. **Submarine structures made by leaking gasses**: The condition of the habitat was assessed by using a seabed survey.
Assessment Result	**Sandbanks**: The overall assessment was Favourable. **Estuaries**: The overall site-based conservation assessment was recorded as Unfavourable-Inadequate at three sites (Lough Swilly SAC, Dundalk Bay SAC and Lower River Shannon SAC). This amounted to 33,190ha or 76.6% of the area surveyed, but only accounts for 27.3% of the sites surveyed. The remaining eight sites (Castlemaine Harbour SAC, Blackwater River (Cork/Waterford) SAC, Ballymacoda (Clonpriest & Pillmore) SAC, Bannow Bay SAC, Slaney River Valley SAC, West of Ardara/Maas Road SAC, Tralee Bay & Magharees Peninsula, West to Cloghane SAC and River Barrow & River Nore SAC) were assessed as Favourable. This amounted to 10,154ha or 23.4% of the area sampled but represents 72.7% of the sites surveyed. **Mudflats/sandflats:** The overall site-based conservation assessment was recorded as Unfavourable-Inadequate in three sites (Dundalk Bay

	SAC, Lower River Shannon SAC and Castlemaine Harbour SAC). This amounted to 17,470ha or 56% of the area sampled and represents 14% of the sites surveyed. The remaining 19 were assessed as Favourable. This represents 13,786ha or 44% of the area sampled but represents 86% of the sites sampled. Using the Structure and functions criteria would result in the habitat being assessed as Unfavourable-Bad. However, this does not accurately reflect the conditions at a site level and highlights the difficulties in using area to assess Structure and functions in an aquatic environment. For this habitat, therefore, the more accurate assessment of Structure and functions was deemed to be Unfavourable-Inadequate. Dundalk Bay failed to meet Favourable Conservation Status due to a change in the sediment composition of the intertidal stations sampled. An increase in fine grain size classes, indicative of an increase in sedimentation, was recorded. Two intertidal stations on the north and south sides of the Lower River Shannon also failed to meet Favourable Conservation Status due to an increase in fine grain size classes. Castlemaine Harbour SAC failed to meet Favourable Conservation Status due to the presence of invasive alien species impacting on the intertidal *Zostera noltei* beds. The large area of intertidal flats (174 km2) within the three sites which failed to meet Favourable Conservation Status represents a considerable proportion of the national resource of this habitat and significantly contributed to the overall failure of the habitat to meet Favourable Conservation Status. **Lagoons**: The overall site-based conservation assessment was recorded as Unfavourable-Inadequate in three sites (Dundalk Bay SAC, Lower River Shannon SAC and Castlemaine Harbour SAC). This amounted to 17,470ha or 56% of the area sampled and represents 14% of the sites surveyed. The remaining 19 were assessed as Favourable. This represents 13,786ha or 44% of the area sampled but represents 86% of the sites sampled. **Large shallow inlets and bays:** The site-based conservation assessment was Unfavourable-Bad at eight sites (Kenmare River SAC, Valentia Harbour/Portmagee Channel SAC, Mulroy Bay SAC, Clew Bay Complex SAC, Broadhaven Bay SAC, Mullet/Blacksod Bay Complex SAC, Kingstown Bay SAC and Roaringwater Bay SAC). This

	amounted to 88,037ha or 52% of the area surveyed and 57% of the sites sampled. One site, Kilkieran Bay and Islands SAC, was assessed as Unfavourable-Inadequate, representing 18,760ha or 11% of the area sampled. Four sites (West of Ardara/Mass Road SAC, Galway Bay Complex SAC, Tralee Bay and Magharees Peninsula, West to Cloghane SAC and Lower River Shannon SAC) were assessed as Favourable. This represents 62,169ha or 37% of the area sampled. **Reefs:** While considerable work remains to be done to assess the condition of the reef surveyed in the 102 dives undertaken covering 277km of the seafloor, the greater proportion of the sites showed no evidence of fishing pressure. Preliminary results of Sea Rover surveys in 2017 and 2018 showed some evidence of human impacts. Although this is not specified in the Habitats Directive assessment it is understood that this is the reason why an Unfavourable-inadequate status was assigned to these habitats. **Submarine structures made by leaking gasses:** Although there is indication of ghost fishing gear in proximity to the habitat features, there is evidence that the habitat itself is actively avoided by fishermen due to the risk of snagging or losing fishing gear. The habitat appeared to be in good condition but vulnerable to damage from fishing activity.

Results
(figures & tables)

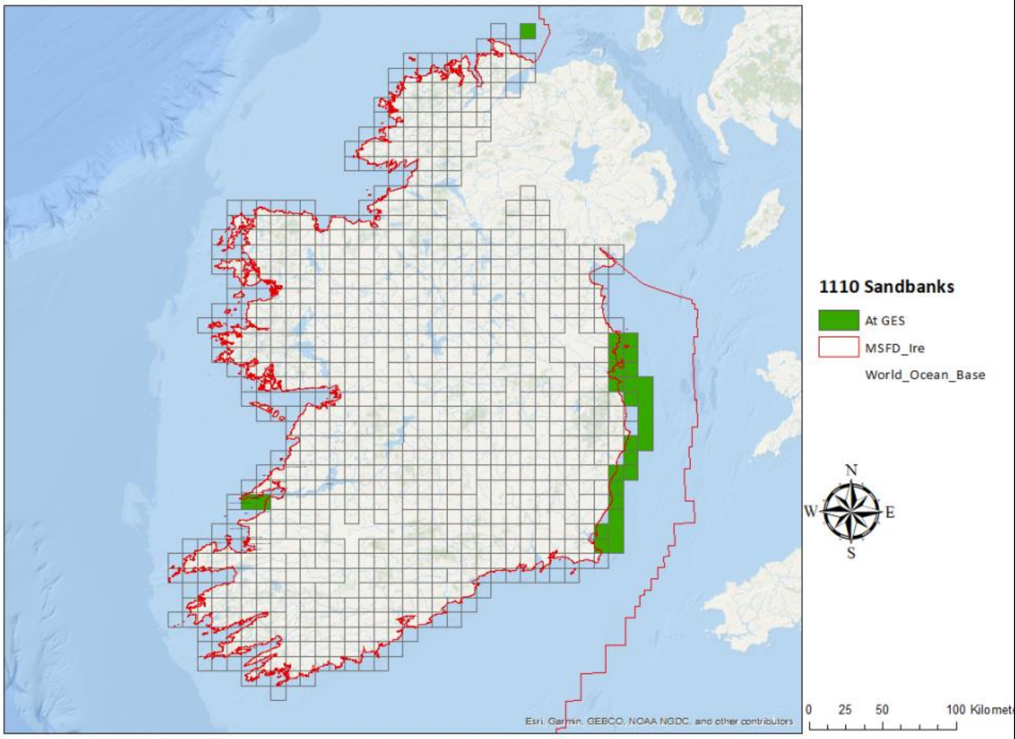


Figure 1. Summary of the environmental status of EU Annex I Sandbank habitat.

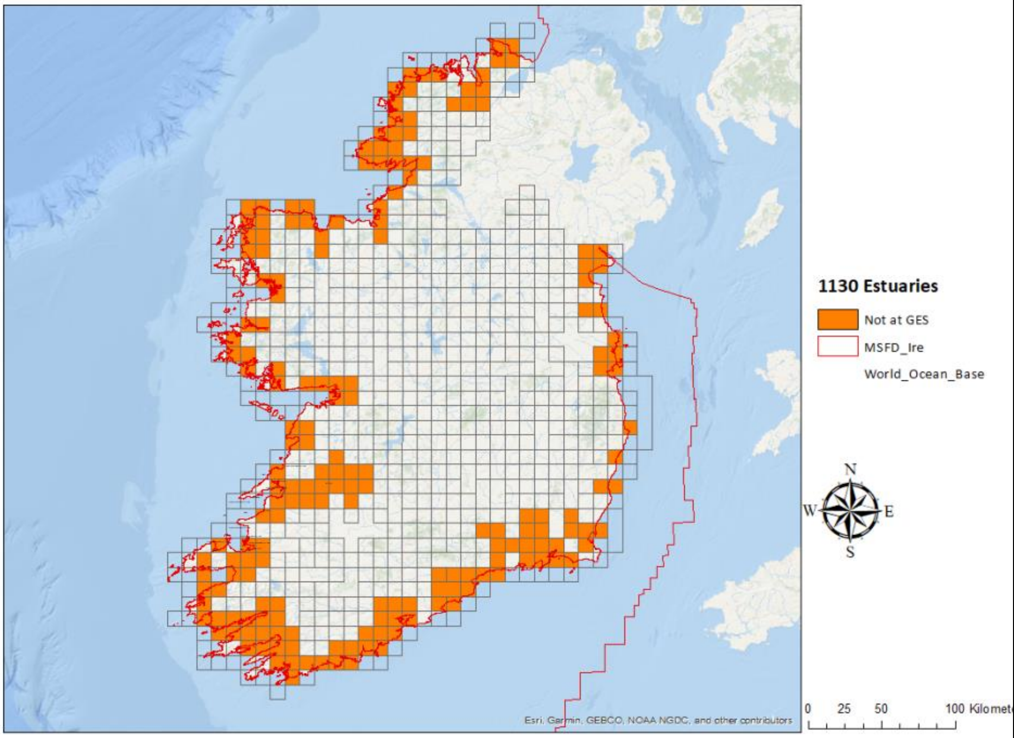


Figure 2. Summary of the environmental status of EU Annex I Estuary habitat.

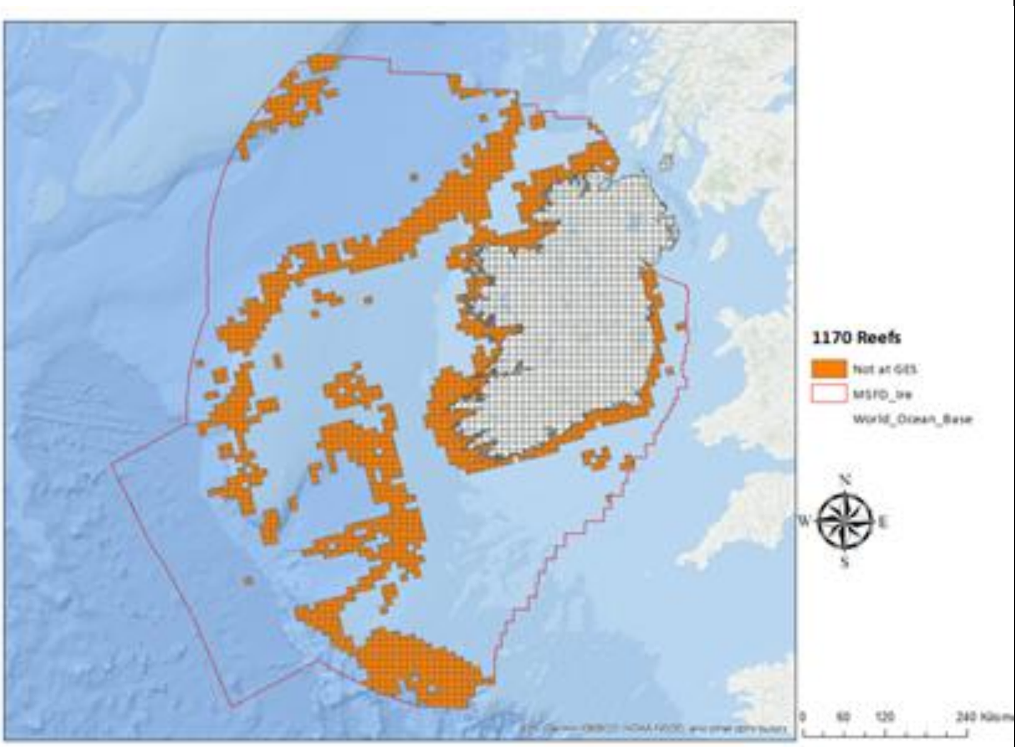


Figure 3. Summary of the environmental status of EU Annex I Reef habitat.

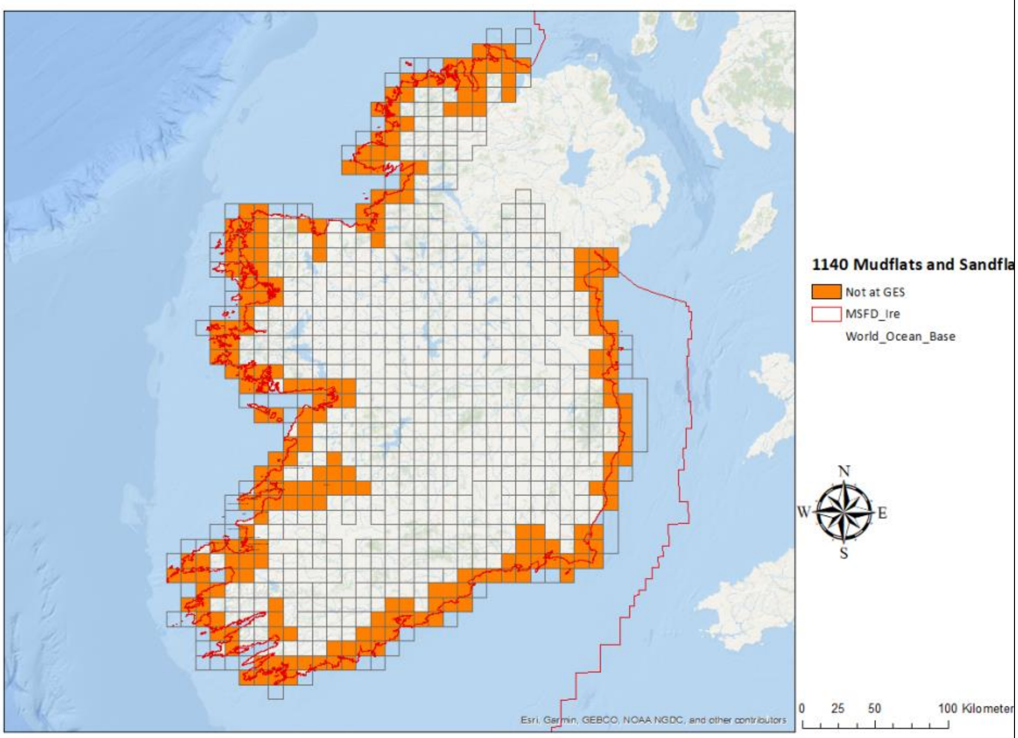


Figure 4. Summary of the environmental status of EU Annex I Mudflat and Sandflat habitat.

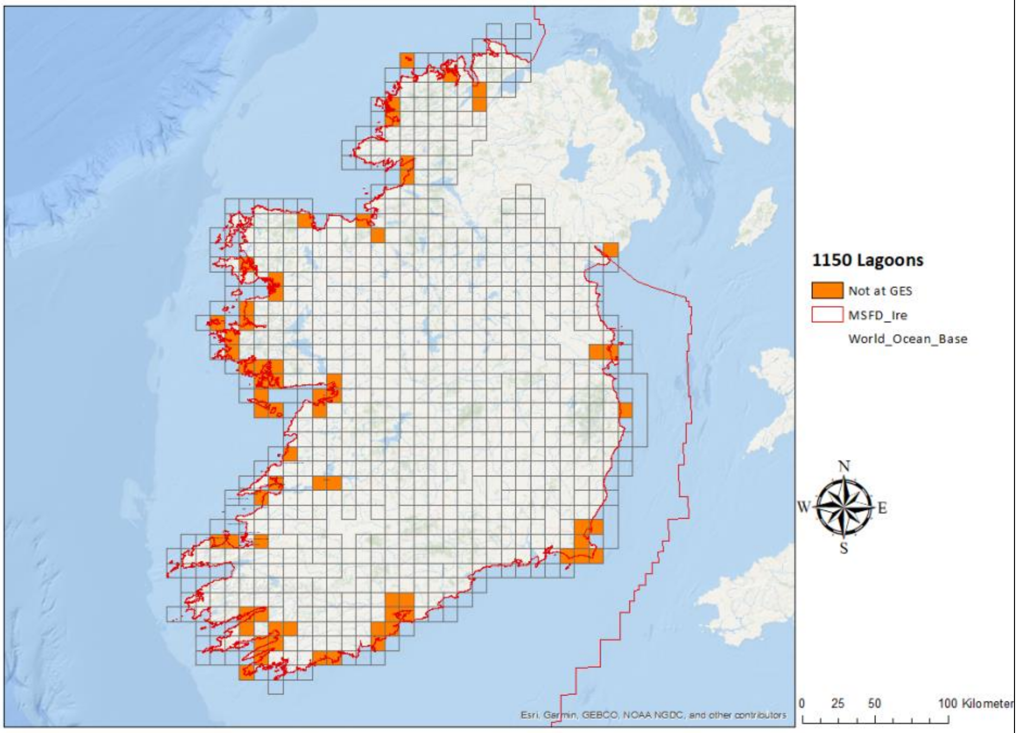


Figure 5. Summary of the environmental status of EU *Annex I* Lagoon habitat.

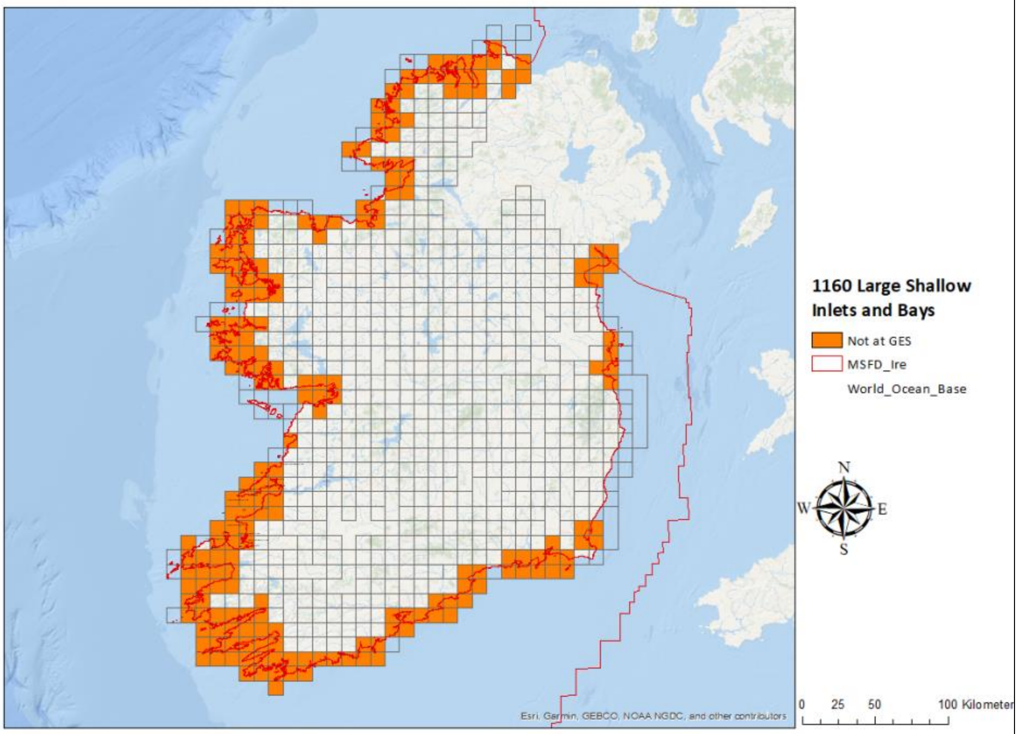


Figure 6. Summary of the environmental status of EU Annex I Large Shallow Inlet and Bay habitat.

Conclusion	It is not currently possible to assess all habitats in Irish waters against this criterion. Instead the assessment has relied on work conducted on defined sites listed as protected under the EU Habitats Directive. Based on the updated assessment of physical disturbance now undertaken, the conclusion is that the extent of adverse effects from anthropogenic pressures on the condition of Ireland's benthic habitat types is currently unknown. Thus within a determination framework for Good Environmental Status (GES), the environmental status is currently unknown. Further coordinated work and development at EU and Member State level will be required in order to advance the assessment methodology, targets and proposed threshold values under this physical disturbance-related criterion.			
Knowledge gaps	Information on habitat status from the Water Framework Directive monitoring was not integrated into this assessment, because of incompatibilities in habitat classification. Further work is required to resolve this matter. No attempt was made to integrate the individual habitat types into a single assessment of adverse effects on defined habitats under the MSFD. This is because no internationally agreed standard is yet available.			
	Assessment Data			
Data Sources	NPWS (2019a). The Status of EU Protected Habitats and Species in Ireland. Volume 1: Summary Overview. Unpublished NPWS report. NPWS (2019b). The Status of EU Protected Habitats and Species in Ireland. Volume 2: Habitat Assessments. Unpublished NPWS report.			
Data Locations (URL)	https://www.npws.ie/publications/article-17-reports https://www.npws.ie/maps-and-data			
Data Time Line	Start Date:	2007	End Date:	2019
Point of Contact	Paul Coleman, Marine Institute FEAS, Rinville, Oranmore, Co. Galway			
Email	paul.coleman@marine.ie			

Descriptor 7 – Hydrographical conditions

D7 C1

Reference D7C1 Rev 3	Assessment Sheet: D7C1 - Hydrographical changes to the seabed and water column.
Key message	In 2013 Ireland completed an Initial Assessment of its maritime area, under the 2008 Marine Strategy Framework Directive (MSFD). An updated assessment has now been carried out in respect of the original Directive and newly established criteria, elements and methodological standards as set out in Commission Decision (EU) 2017/848 and amending Commission Directive (EU) 2017/845. In relation to Descriptor 7 - Alteration of hydrographical conditions these criteria and standards provide a basis for assessment. The level of activities causing hydrographical changes to the seabed and water column within Irelands designated Marine Strategy Framework Directive area were very low overall during the assessment period of 2014-2018. A key finding is that the hydrological condition of the Irish Marine environment is compatible with Good Environmental Status. It is expected that further work, methodological refinement and environmentally sustainable practices will be needed to maintain this position in future MSFD cycles.
Introduction / Objective	The objective of this assessment is to evaluate the “Spatial extent and distribution of permanent alteration of hydrographical conditions (e.g. changes in wave action, currents, salinity, temperature) to the seabed and water column, associated in particular with physical loss of the natural seabed.” Considering whether these permanent alterations do or do not adversely affect marine ecosystems. This evaluation considers the locations where permanent changes are made to the seabed by large scale human activates including the disposal of dredged material, offshore platforms / structures and associated connecting pipelines and cables. The potential impact on marine ecosystems is considered based on this.
Background	This assessment considers the developments and activities which may impact on hydrographical conditions within the limitation that the majority of work on ports, harbours and marinas and offshore construction project (pipelines / interconnectors) was undertaken prior

	to MSFD being implemented. It is not feasible to consider the impact on hydrographical from these developments due to the following; • There are a considerable number of developments undertaken over hundreds of years in Irelands major ports and harbours. • The conditions prior to developments are not known This MSFD Cycle 2 assessment for D7 focuses on the following anthropogenic activities within the Irish MSFD area, which have the potential to cause an impact: • Dredging and spoil disposal, • Offshore installations and associated pipelines, • Interconnecting pipelines, • Underwater cables interconnectors to UK, telecommunications & others. This assessment considers the scale of these developments in the MSFD area and their potential impact relative to the overall scale of the Irish MSFD area. This assessment is recognised as being limited in its scope however it serves to establish the scale and potential impact on Hydrographical changes. **Initial Assessment** The characteristics of GES outlined in the Initial Assessment 2013: “Good status is achieved when the nature and scale of any permanent changes (individual and cumulative) to the prevailing hydrographical conditions, resulting from large-scale anthropogenic activities such as coastal defence works, damming of large rivers, land reclamation projects, and structures in open and coastal sea such as wind farms, ocean energy device arrays and large scale aquaculture facilities, do not lead to significant long term impacts on marine ecosystems, in particular those biological components considered under Descriptors, 1, 4 and 6.” The IA 2013 concluded, “the current status of anthropogenic interference to hydrographic processes and the impacts on marine habitats and communities has not been assessed due to insufficient data and lack of established methods”. “Current data sources provide an adequate indication of the location of sectoral activities that may lead to hydrological changes, but the

actual environmental impacts associated with the activities remains difficult to determine and have therefore not been assessed. Ireland is currently developing methods to expand baseline data to support the future establishment of appropriate targets and indicators”

The IA 2013 also outlined a target associated with D7 as follows:
All developments that may give rise to significant permanent changes in the hydrographical regime of currents, waves, or sediments must comply with the existing regulatory regimes and guidance should be followed to ensure that regulatory assessments are undertaken in a way that ensures the full consideration of any potential impacts, including cumulative effects at the most appropriate spatial scales to ensure that GES is not compromised.

Identification of Activities
The EU Commission website (https://ec.europa.eu/environment/marine/good-environmental-status/descriptor-7/index_en.htm) outlines details on D7 and it specifically outlines the following disruptions which have an impact on a local scale.

Activity	Applicability for Ireland
infrastructure construction on the coast and offshore, i.e. embankments	On coast construction of ports, harbours, marinas all predate MSFD. Off shore construction is very limited, much of which predated MSFD There are proposals for offshore developments which will have to consider hydrographical changes.
offshore platforms and marine renewable energy installations	Very limited: 2 Gas Platforms, 1 Gas seabed installation and 1 Windfarm (7 Turbines)
channel creation	Not applicable
navigation channel dredging	Limited capital and maintenance Dredging in ports and harbours. The amount dredged in Ireland during the assessment period 2014-2018 is as follows: 2014 – 680, 521 dry tonnes 2015 - 644,018 dry tonnes 2016 – 1, 072, 439 dry tonnes 2017 – 1,361,656 dry tonnes 2018 – 1,244,196 dry tonnes.

		This material has been removed from **10** km^2 and deposited in **523** km^2.
	maritime traffic (in channels, shallow waters)	Limited applicability
	sediment remobilization by fishing equipment (trawls, dredges)	The hydrographical impact of trawling is localised in the vicinity of the trawl and for a very limited time after the trawling event
	sand extraction, offshore mining	Not applicable
	changes in freshwater riverine inputs as a consequence of damming and irrigation	Not applicable
	changes in solid matter riverine inputs	Not applicable
	release of large quantities of warm (power plant cooling) or salty water (from desalination facilities)	Desalination - Not applicable Power Stations in Ireland which discharge cooling water to transitional and coastal waters were all constructed well in advance of MSFD. The locations and construction dates of the stations that are still operational are as follows: Aghada Cork (1977 to 1980) Money Point Clare (1979-1987) Poolbeg Dublin (1965 to 1978) Great Island Wexford (1967) Marina Cork (1954) North Wall Dublin (1949) Tarbert Kerry (1966 to 1969)

Commission Decision
The Commission Decision (2017/848 EC) outlines Descriptor 7 (Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems) under two secondary criteria, with the outcome from D7C1 assessment being used to an assessment of D7C2.

Hydrographical changes to the seabed and water column (including intertidal areas) - D7C1 — Secondary: Spatial extent and distribution of permanent alteration of hydrographical conditions (e.g. changes in wave action, currents, salinity, temperature) to the seabed and water

	column, associated in particular with physical loss (1) of the natural seabed. Benthic broad habitats types or other habitat types, as used for Descriptors 1 and 6 - D7C2 — Secondary: Spatial extent of each benthic habitat type adversely affected (physical and hydrographical characteristics and associated biological communities) due to permanent alteration of hydrographical conditions.
Objective	The objective of this assessment is to evaluate the “Spatial extent and distribution of permanent alteration of hydrographical conditions (e.g. changes in wave action, currents, salinity, temperature) to the seabed and water column, associated in particular with physical loss of the natural seabed.” This evaluation considers the locations where permanent changes are made to the seabed by large scale human activates including the dredging and the disposal of dredged material, offshore platforms / structures and associated connecting pipelines and cables.
Drivers	The Drivers which could impact on D7C1 include: Economic Development resulting in physical restructuring of coastline or seabed: The level of coastal or seabed restructuring to impact has not been undertaken in the Irish MSFD area. There are localised activities in the following but not at levels or over extensive areas to cause hydrological changes; • dredging and deposition of material • energy production • Cultivation of living resources (Aquaculture) • Transport infrastructure • Wastewater treatment & disposal • Tourism activities and infrastructure These are activities that have a localised impact on hydrological conditions but will not cause hydrographical changes over extensive areas.

Pressures	The pressures which can cause permanent changes to hydrographical conditions are: • Physical disturbance to the seabed • Physical loss due to permanent change of the sea bed • Changes of hydrological conditions These can result from the following activities: • dredging and deposition of material • offshore energy, both hydrocarbon and renewable as a result of structures Within the Irish MSFD Area the pressures relating to Descriptor 7 in the current assessment period 2013 to 2018 come from Dredging and the disposal of dredged material. The Increased interest in offshore energy especially renewables may have an impact in future assessments for D7
State	The level of pressure causing Hydrographical changes to the seabed and water column within Irelands MSFD area is very low. Localised impacts will be felt in the vicinity of any developments and / or activities. However, the level of activity with the potential to cause Hydrographical changes in Irelands MSFD area is low and limited a very small portion of the area (**533** km^2 out of a total **488,000** km^2 or **0.109** % this estimate is based on the available data and expert judgement. This leads to the current state being evaluated as Good with respect to Hydrographical changes to the seabed and water column.
Impact	The current levels of activity and development in the Irish Maritime area which may cause permanent alterations of Hydrographical conditions are very limited in both number and extent. During the assessment period 2014 to 2018 the levels of activity and development in the Irish Maritime area, which may cause permanent alterations of Hydrographical conditions were very limited, in both number and extent. In the context of the Irish MSFD area of **488,000** km^2 the total area where hydrographical conditions were impacted by human activities during the assessment period (2014-2018) is calculated at **533** km^2 resulting from dredging activities and dredged

spoil disposal. In total this represents **0.109%** of the Irish MSFD area indicating the low impact on hydrological conditions overall. Table 1 outlines the annual quantities of dredged material disposed during the assessment period. This data is reported to OSPAR and has contributed to the OSAPR Intermediate Assessment 2017[1]. It is acknowledged that the areas where dredging and spoil disposal takes place experience localised changes in hydrographical conditions but these areas are very small relative to the overall scale of the MSFD area.

Year	Material Disposed (Dry Tonnes)
2014	680,521
2015	644,018
2016	1,072,439
2017	1,361,656
2018	1,244,196

Table 1: Quantities of Dredge Spoil disposed 2014 to 2018

Cables pipelines and platforms cause localised changes in hydrographic conditions but these changes are not considered significant in the overall scale of the marine environment. The vast majority of development in Irish marine waters including ports, harbours, jetties and their associated impact, had taken place prior to the implementation of MSFD in 2008, so it is not possible to evaluate the impact of these developments on hydrological conditions.

Response

The DHPLG is developing the Marine Planning and Development Management Bill which will be advanced through the Oireachtas during 2020.

This bill will update the legislation addressing the following elements of Irelands Marine Planning System:

- Forward planning through the National Marine Planning Framework
- Development management through an updated process of considering applications for development
- Enforcement

[1] https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/dumping-and-placement-dredged-material/

	This new legislation will provide a single state consent regime for the entire maritime area, reinforce the environmental impact assessment and appropriate assessment requirements for maritime developments under Irish law and improve compliance / enforcement provisions.
Assessment Method	**Considerations** The Assessment of D7C1 is limited to the changes on the seabed and have the potential to cause localised changes in wave action and currents such as structures, installations and dredging activities at both dredge sites and disposal sites. The impact from cables and pipelines on the hydrographical conditions are limited to effects under or immediately around the item itself. The potential for changes in salinity and temperature are limited to the discharges from power generation stations on the coast line. However, the construction of these stations dates between 1949 and 1987 so all of these installations predate MSFD by at least 20 years and now form the background conditions. During the assessment period 2013 to 2019 none of the current activities in the Irish MSFD area are envisaged as having further impact on salinity or temperature. The Commission Decision (2017/848 EC) outlines Descriptor 7 (Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems) under two secondary criteria, with the outcome from D7C1 assessment being used to an assessment of D7C2 Hydrographical changes to the seabed and water column (including intertidal areas) - D7C1 - Secondary: Spatial extent and distribution of permanent alteration of hydrographical conditions (e.g. changes in wave action, currents, salinity, temperature) to the seabed and water column, associated in particular with physical loss (1) of the natural seabed. **Methodology** The Commission Decision outlines specifications and standardised methods for assessment: 1. Regarding methods for monitoring and assessment: a) Monitoring shall focus on changes associated with infrastructure developments, either on the coast or offshore.

	b) Environmental impact assessment hydrodynamic models where required, which are validated with ground-truth measurements or other suitable sources of information, shall be used to assess the extent of effects from each infrastructure development. c) For coastal waters, the hydromorphology data and relevant assessments under Directive 2000/60/EC shall be used. 2. Regarding methods for assessment, the data shall be aggregated so that: a) D7C1 is assessed in relation to total natural extent of all habitats in the assessment area; b) D7C2 is assessed in relation to total natural extent of each benthic habitat type assessed. Units of measurement for the criteria: • D7C1: extent of the assessment area hydrographically altered in square kilometres (km^2), • D7C2: extent of each habitat type adversely affected in square kilometres (km2) or as a proportion (percentage) of the total natural extent of the habitat in the assessment area. Focusing on changes associated with infrastructural developments both on the coast or offshore in the assessment period: due to prevailing economic conditions there has been very limited development in these areas during the assessment period 2013-2019. Scale of assessment: As used for assessment of the benthic broad habitat types under Descriptors 1 and 6.
Assessment Result	The levels of development in the Irish Marine area, beyond the foreshore has been low historically. During the assessment period 2013 to 2019 development has been extremely limited. Developments prior to 2012 • Kinsale Head - 2 Platforms (combined footprint 7,393 m^2 including ancillary structures) and associated pipelines (152.6 km)

	• Corrib field –wells and manifold structure (1,362 m^2) and associated pipelines (90km) • Gas interconnectors 400 km including elements outside Irish MSFD waters • Arklow Bank Windfarm (7 Turbines and associated interconnectors) No Developments since 2012 The dredging data comes from Annual dredging volumes reported to OSPAR and dumping areas are reported to the EPA. **Monitoring** Ireland has been undertaking a seabed mapping project (INFOMAR) for the past decade of more. The outcome of this project will be the complete mapping of Irelands seabed. Using this survey as a baseline it may be possible to monitor changes in seabed / bathymetry.
Results (figures & tables)	During the period 2014- 2018 the assessment calculated an area of 533 Km^2 as having been disturbed by dredging out of a total area of 488,000 representing 0.109% disturbance to the Irish MSFD area. This indicates that the Irish MSFD area is at GES due to the very low levels of hydrographical disturbance.
Conclusion	The permanent alteration of hydrographical conditions during the period 2014 to 2018 is limited to 0.109 % of the Irish Marine Strategy Framework Directive area. The impact from these alterations was localised with respect to hydrographical conditions and the short-term water quality impacts experienced during the dredging and disposal activities. The adverse impacts on the marine ecosystems are minimal from the very limited hydrological changes which have occurred. There are no proposals to change the characteristic of Good Environmental Status as previously outlined in the Initial Assessment (2013) for Descriptor 7.
Other Descriptors	The extent to which D7 impacts on other Descriptors is limited to D6 Sea Floor Integrity. It is important in the Electronic Reporting that the Linkages between D7C1 and D6C1, D6C2 & D6C3 are outlined.

<table>
<tr><td>Linkages</td><td colspan="4">Other Criteria and elements which relate to the D7C1 assessment are as follows:
D6C1 – Physical loss: extent & distribution
D6C2 – Disturbance: extent & distribution
D6C3 – Disturbed habitats: spatial extents</td></tr>
<tr><td>Knowledge gaps</td><td colspan="4">Assessing D7 is realistic for Off-shore areas (>12NM) and In-shore areas (<12 NM) but not for nearshore developments.
Evaluating the impact of existing coastal infrastructure with respect to D7 is not currently possible due to the length of Irelands coastline, the numbers of coastline structures and the lack of available data on hydrographical information available for pre-development conditions. In addition, the vast majority of this development has been undertaken prior to the implementation of MSFD.

It should be possible in future after the delivery of the Marine Planning and Development Management Bill to collect the information required to evaluate the impact on hydrographical conditions from future coastal structures.

The full details and mapping of structures / pipelines / cables in the marine environment should be developed from the following sources:
Foreshore license applications relating to completed developments including as built details
Monitoring of the impacts associated with both construction stage and as-build stage where relevant to both D7C1 and D11C1</td></tr>
<tr><td></td><td colspan="4">Assessment Data</td></tr>
<tr><td>Data Sources</td><td colspan="4">OSPAR Reports Dredged Material
Kingfisher Undersea Cables</td></tr>
<tr><td>Data Locations (URL)</td><td colspan="4">No on-line accessible data sets</td></tr>
<tr><td>Data Time Line</td><td>Start Date:</td><td>2014</td><td>End Date:</td><td>2018</td></tr>
<tr><td>Point of Contact</td><td colspan="4">Donal Cronin</td></tr>
<tr><td>Email</td><td colspan="4">Donal.Cronin@housing.gov.ie</td></tr>
</table>

Descriptor 8 – Contaminants

D8 C1 Metals in Shellfish

Ref D8C1 a Rev 1	Assessment Sheet: Status and Trends in the Concentrations of Metals in Shellfish MSFD Cycle 1: D8.1 - Concentration of contaminants MSFD Cycle 2: D8C1 (Element - Metal Concentrations in Biota)
Key message	Concentrations of metals in shellfish, sampled in Irish waters, are generally low. Overall the concentrations encountered are below levels likely to harm marine species. Concentrations of cadmium, lead and mercury in biota are broadly stable or are in a downward direction. Approximately 98% of assessments met the individual target thresholds. This indicator is based on OSPAR Coordinated Environmental Monitoring Programme Assessment (2019)
Introduction / Objective	Monitoring for hazardous substances is risk based and primarily focussed on coastal waters as most sources are terrestrial and marine sources are generally more concentrated in coastal waters (e.g. shipping concentrated around ports). If problems are not detected in inshore waters, monitoring is not widely extended beyond Irish coastal waters (which in themselves can reach near full ocean salinity) unless there is a specific risk factor (such as specific offshore sources). As part of the OSPAR Coordinated Environmental Monitoring Programme concentrations of metals are measured in shellfish (mussels and oysters) and data are reported to ICES and assessed according to OSPAR methodology. Mercury is highly toxic. Mercury and cadmium accumulate in the food chain. Lead is not accumulated via the food chain. Heavy metals do not disappear over time and can be trapped in deeper levels of sediment until mining, geological or biological processes release them, at which point they may affect biota. Concentrations were compared against two assessment criteria: the OSPAR Background Assessment Concentrations (BACs) and Environmental Assessment Criteria (EACs). EACs are assessment tools intended to represent the contaminant concentration in sediment and biota below which no chronic effects are expected to occur in

	marine species, including the most sensitive species. BACs are used to assess whether concentrations are near background values for naturally occurring substances, this is the ultimate aim of the OSPAR Hazardous Substances Strategy. OSPAR uses the human consumption maximum concentration limits for heavy metals set by the European Commission as proxy values for Environmental Assessment Criteria (EAC). There are natural concentrations of heavy metals in all waters, sediments, mussels and fish, referred to as background concentrations. The OSPAR Hazardous Substances Strategy has the ultimate aim of achieving concentrations in the marine environment near background values for non-synthetic substances and close to zero for synthetic substances. Due to their persistence in the marine environment, their potential to bioaccumulate and their toxicity, concentrations of metals in shellfish are reported in the OSPAR Coordinated Environment Monitoring Programme (CEMP). Monitoring of metals in shellfish from Irish waters began in approximately 1995.
Drivers	Mercury, cadmium and lead enter the marine environment from a number of natural, agricultural and industrial processes, via long-range transportation by air, riverine input or run-off from land. In some cases, direct input occurs from land or sea-based sources. For example, some metals used as antifouling chemicals (mainly copper) and corrosion anodes (mainly zinc) are deliberately placed in the marine environment, through their use on ships' hulls or marine installations, causing hot spots of metal concentrations in and around harbours. Commission Directive 2017/845 activity themes: Extraction of non-living resources, Production of energy, Transport, Urban and industrial uses, Physical restructuring of rivers, coastline or seabed, Cultivation of living resources.
Pressures	MSFD qualitative descriptors are linked to their key pressure elements via Commission Directive 2017/845 (amending Directive 2008/56/EC). Pressure via anthropogenic input of substances, litter and/or energy and specifically those from synthetic and non-synthetic substances via diffuse and point sources, atmospheric deposition and acute events are specifically identified as key pressures for GES descriptors 8 and 9.

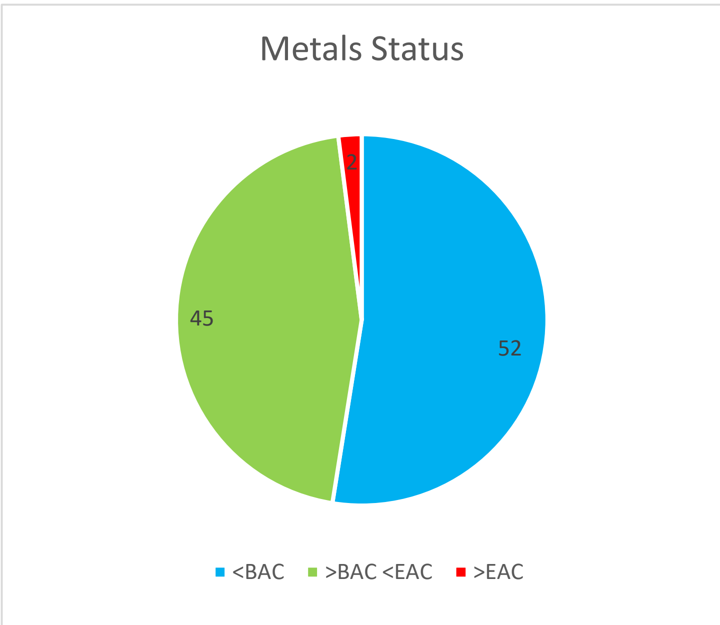
Key pressures associated with these contaminants are riverine and direct inputs of metals from point and diffuse sources, atmospheric deposition and acute events that have entered marine sediments. Metals can then accumulate in biota.

State

Overall Metals status

5 metals are assessed Mercury (Hg), Cadmium (Cd), Lead (Pb), Copper (Cu) and Zinc (Zn) at 33 stations. 99 individual assessments (excluding assessment relative to food safety thresholds).

<BAC	>BAC <EAC	>EAC
52	45	2
52.5%	45.5%	2.0%



Status assessment exclude metals where EC thresholds are utilised while temporal trend summaries include all metal parameters as the trend direction is independent of the threshold.

	Downward Trend ↓	No trend↔	Upward Trend↑
Metals	42 (25.5%)	123 (75%)	None

Summary Parameter Groups Trend direction in shellfish from 33 locations around the Irish coast. Number of occurrences and percentage in parenthesis.

Note: OSPAR temporal trend assessments can often be completed where sufficient monitoring data exist irrespective of the number of threshold values available. Full status assessments require both BAC

	and EAC (or equivalent) to be available. Consequently, this may result in a different number of individual parameter temporal and status assessments being available.

	Downward Trend ↓	No trend↔	Upward Trend↑
CD	21 (63.6)	12 (36.4)	
CU	6 (18.2)	27 (81.8)	
HG	4 (12.1)	29 (87.9)	
PB	2 (6.06)	31 (93.9)	
ZN	9 (27.3)	24 (72.7)	

Conclusion	OSPAR assessments indicate that metal contaminants in shellfish from Irish coastal waters are predominantly within the OSPAR EAC thresholds. These imply adverse effects on marine life would not be expected. For the most part trends are not detected but where they do occur, they are typically in a downward direction, most notably for cadmium. Good Environmental Status has been achieved for concentration of metals in biota in the Irish maritime area. However, for mercury in shellfish the inconsistency in Water Framework Directive (WFD) Environmental Quality Standards (EQS_{biota}) and OSPAR assessment criteria needs to be resolved.
Assessment Result	OSPAR assessments indicate that metal contaminants in shellfish in all assessed sub-regions (Irish Sea, Celtic Seas and West Coast) are predominantly within the OSPAR thresholds used in lieu of an EAC. These imply adverse effects on marine life would not be expected. For the most part trends are not detected but where they do occur, they are typically in a downward direction, most notably for cadmium. Overall metals levels in shellfish were either stable or decreasing in all locations assessed. No upward trends were determined.
Knowledge gaps	Assessment criteria only available for a limited set of metals in shellfish. The derivation of EACs for shellfish would enhance assessments. Food safety thresholds for some metals are utilised as upper thresholds by OSPAR but continued collaborative efforts within OSPAR is required to establish common threshold values for contaminants and their effects.

	There is an inconsistency with the WFD EQS_{biota} for mercury in fish and OSPAR assessment criteria which needs to be resolved. The potential impact of cumulative effects of combinations of contaminants is unknown.
Background	Metals are ubiquitous hazardous substances in the environment, and are found in mussels and fish in all OSPAR regions. The most toxic metals to humans and animals are mercury, cadmium and lead, known as heavy metals, all of which naturally occur in the environment. Mercury, cadmium and lead enter the marine environment from a number of natural, agricultural and industrial processes (heavy metal inputs indicator assessment), via long-range transportation by air, riverine input or run-off from land. In some cases, direct input occurs. For example, some metals used as antifouling chemicals (mainly copper) and corrosion anodes (mainly zinc) are deliberately placed in the marine environment, through their use on ships' hulls or marine installations, causing hot spots of metal concentrations in and around harbours. Mercury is highly toxic. Mercury and cadmium accumulate in the food chain. Lead is not accumulated via the food chain. Heavy metals do not disappear over time and can be trapped in deeper levels of sediment until mining, geological or biological processes release them, at which point they may affect biota. There are natural concentrations of heavy metals in all waters, sediments, mussels and fish, referred to as background concentrations. OSPAR uses the human health maximum concentration limits for heavy metals set by the European Commission as proxy values for Environmental Assessment Criteria (EAC).
Assessment Method	https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/contaminants/ This assessment of data from the OSPAR Programme describes the trends and status of contaminant concentrations at biota monitoring stations around Irish waters and includes both temporal trend and status assessments for metals, for which assessment criteria were available. In accordance with OSPAR methodologies individual time series of metal concentrations were assessed for status where: • there is at least one year with data in the period 2010 to 2015

	• there are at least 3 years of data over the whole time-series • a parametric model can be fitted to the data and used to estimate the mean concentration in the final monitoring year (or occasionally, if a non-parametric test of status is applied). The time series was assessed for trends where: • there are at least 5 years of data over the whole time-series • a parametric model can be fitted to the data and used to estimate the trend in mean concentrations. • Information on how the individual time series are assessed for status and trends is available. For regional assessment, data from individual time series were combined and a summary measure of status or trend obtained from each time series. Larger scale regional assessment only considers coastal and offshore stations and excludes estuarine stations. Full details of the individual methodologies are available at. https://ocean.ices.dk/ohat/trDocuments/2019/help_methods_biota_metals.html Assessment criteria for metals in biota are available https://ocean.ices.dk/ohat/trDocuments/2019/help_ac_biota_metals.html Monitoring follows OSPAR Guidelines for monitoring contaminants in biota: https://www.ospar.org/work-areas/cross-cutting-issues/cemp The Initial Assessment (2013) outlined the target for contaminants as that **“Concentrations of substances identified within relevant legislation and international obligations are below the concentrations at which adverse effects are likely to occur (e.g. are less than Environmental Quality Standards applied within the Water Framework Directive (European Commission, 2000) and Environmental Assessment Criteria applied within OSPAR)**”. Two assessment criteria are used to assess the status of metal concentrations: the

- **B**ackground **A**ssessment **C**oncentration (BAC)
- **E**uropean **C**ommission food standard (EC)

BACs were developed within the OSPAR framework with scientific advice from the International Council for the Exploration of the Sea. Mean concentrations significantly below the BAC are said to be near background.

ECs are used in the absence of any satisfactory criteria for assessing the ecological significance of metal concentrations in shellfish. ECs are the maximum acceptable concentrations in food for the protection of public health. BACs and ECs are available for the following.

	BAC			**EC**	
	mussels	**oysters**	**fish**	**fish and bivalves**	**crustaceans**
Cadmium	960	3000	26	1000	500
Copper	6000	6000			
Mercury	90	180	35	500	500
Lead	1300	1300	26	1500	500
Zinc	63000	63000			

- BAC units are μg kg−1−1 dw for mussels and oysters and μg kg−1−1 ww for fish
- EC units are μg kg−1−1 ww
- cadmium and liver are usually monitored in fish liver for which no food standard exists; concentrations in fish liver are naturally higher than in fish muscle, so the food standards for fish muscle are not used; instead the food standards for shellfish are used as a proxy
- BACs and EACs are converted to other bases (wet, dry or lipid weight) using species-specific conversion factors https://ocean.ices.dk/ohat/trDocuments/2019/help_ac_basis_conversion.html

Assessment Result (extended)

OSPAR assessments indicate that metal contaminants in shellfish in all assessed sub-regions (Irish Sea, Celtic Seas and West Coast) are predominantly within the OSPAR thresholds used in lieu of an EAC.

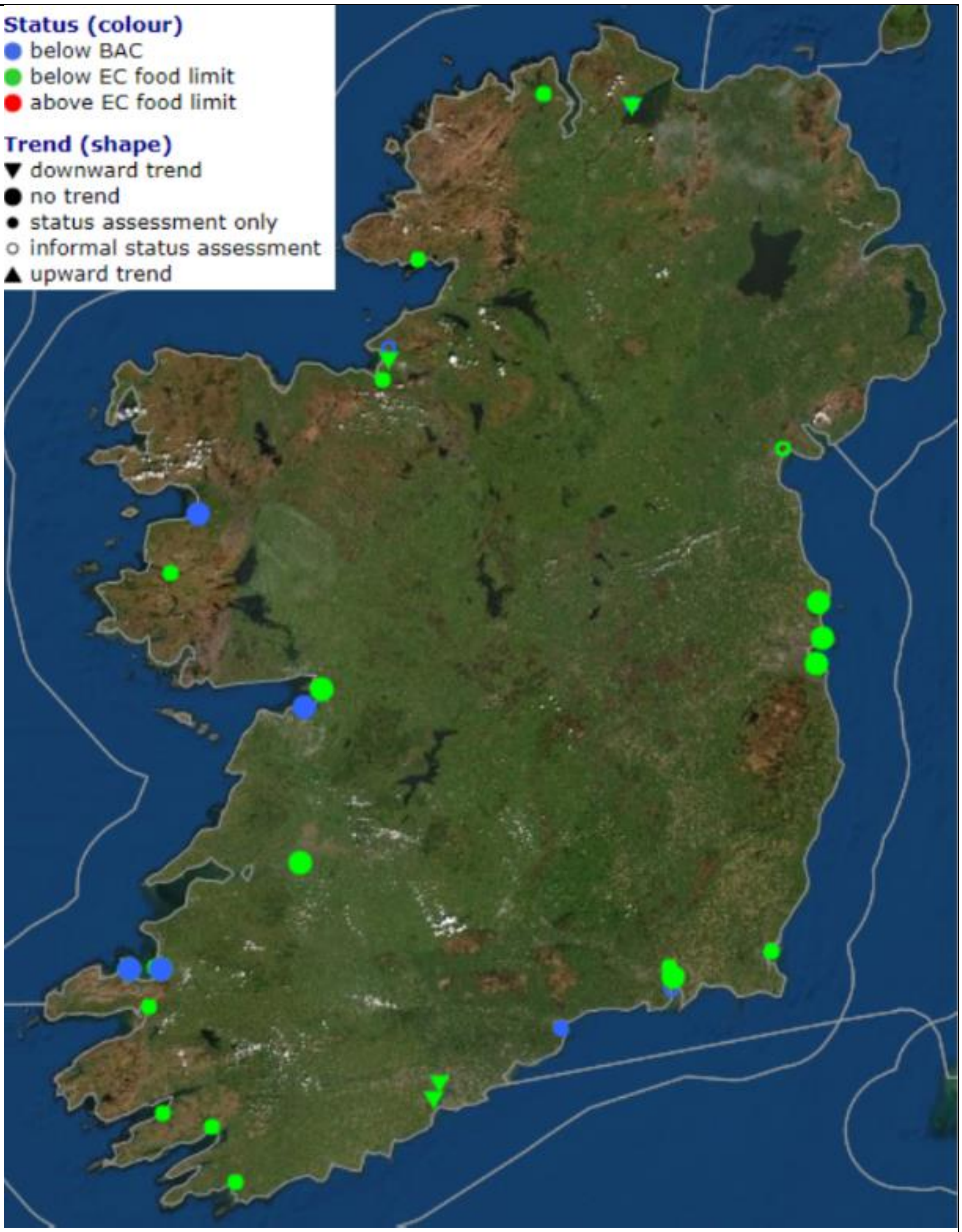
These imply adverse effects on marine life would not be expected. For the most part trends are not detected but where they do occur, they are typically in a downward direction, most notably for cadmium. Overall metals levels in shellfish were either stable or decreasing in all locations assessed. No upward trends were determined.
See results section below

Results (figures & tables)

Table 1: Status assessment and temporal trend direction for individual metals in shellfish from Irish waters.
Key: Number in brackets is number of years for which data points are available.
Blue = final year “at background” (<BAC), Green final year within OSPAR EAC (>BAC <EC/EAC), Red final year does not meet OSPAR EC/EAC Orange status indicates that data are >BAC but that no EC/EAC is available. ↑/↓. Arrows indicate upward/downward significant trend. No arrow means no significant trend or trend not assessed (<5 year’s data).

Station	**CD**	**CU**	**HG**	**PB**	**ZN**
Cork Harbour North Channel	(6) ↓	(6)	(6) ↓	(6)	(6)
Cromane	(18) ↓	(18) ↓	(8)	(18)	(18)
Glengariff	(17) ↓	(17)	(2)	(17)	(17)
Kilmakillogue	(21) ↓	(21) ↓	(2)	(21)	(21)
Ringaskiddy	(20) ↓	(20) ↓	(20) ↓	(19) ↓	(20) ↓
Roaringwater Bay Inner	(17) ↓	(17)	(2)	(17)	(16) ↓
Aughinish Bay	(17) ↓	(17)	(18)	(17)	(17)
Ballysadare Bay	(12) ↓	(12)	(8)	(12)	(12) ↓
Bruckless	(12) ↓	(12)	(8)	(12)	(12)
Clarenbridge	(7) ↓	(7)	(7)	(7)	(7)
Clew Bay South	(8)	(8)	(6)	(8)	(8)
Clew Bay South	(2)	(2)	(2)	(2)	(2)
Drumcliff	(4)	(4)	(2)	(4)	(4)
Fenit	(3)	(3)	(3)	(3)	(3)
Killary Harbour Inner	(18) ↓	(18)	(2)	(18)	(18)
Maharees	(6) ↓	(6)	(6)	(6)	(6) ↓
Maharees	(12)	(12)	(12)	(12)	(12)
Mulroy Bay - Broadwater	(14) ↓	(14)	(2)	(14)	(14)

	Quigleys Point	(20) ↓	(20)	(20) ↓	(20)	(20) ↓
	Quigleys Point	(3)	(3)	(2)	(3)	(3)
	Rosses Point	(11) ↓	(11)	(11) ↓	(11)	(11) ↓
	Shannon Estuary - Aughinish	(15) ↓	(15)	(15)	(15)	(15)
	Tralee Bay Inner	(8)	(8)	(8)	(8)	(8)
	Tralee Bay Inner	(20)	(20)	(19)	(20)	(20)
	Arthurstown	(20) ↓	(20)	(20)	(20)	(20)
	Cheekpoint	(12)	(12) ↓	(4)	(12)	(12)
	Duncannon	(4)	(4)	(2)	(4)	(4)
	Dundalk Bay Inner	(1)	(1)	(1)	(1)	(1)
	Dungarvan Bay	(15) ↓	(15) ↓	(2)	(15) ↓	(15) ↓
	Rogerstown Estuary	(13) ↓	(13)	(13)	(13)	(13) ↓
	Sea Point	(8)	(8)	(8)	(8)	(8)
	Sutton	(19) ↓	(19) ↓	(18)	(19)	(19) ↓
	Wexford Harbour Outer	(17) ↓	(17)	(6)	(17)	(17)

	 **Figure 1:** Example of OSPAR status for mercury in shellfish from Irish waters. https://ocean.ices.dk/oat/

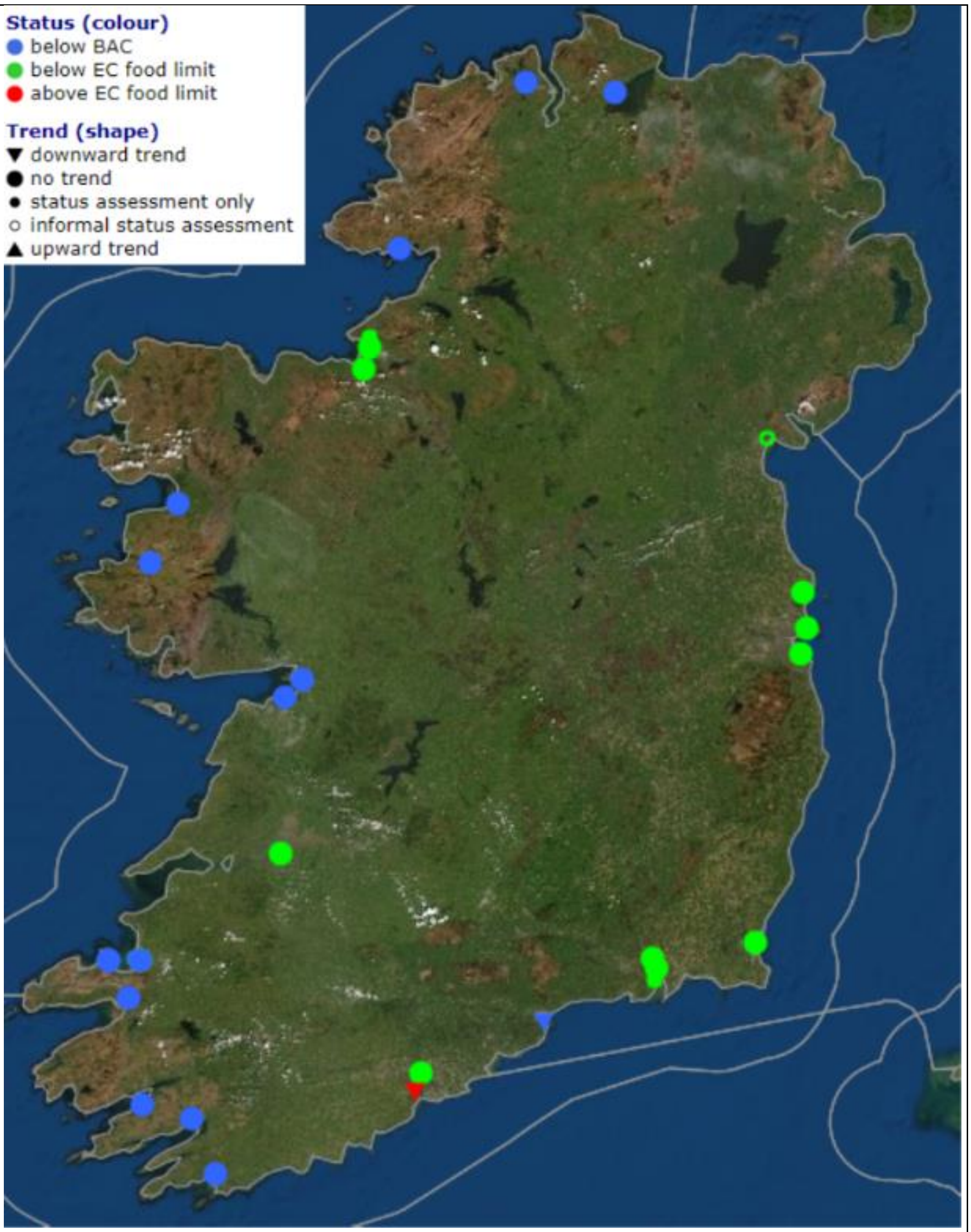


Figure 2: OSPAR status for lead in shellfish from Irish waters. https://ocean.ices.dk/ohat/

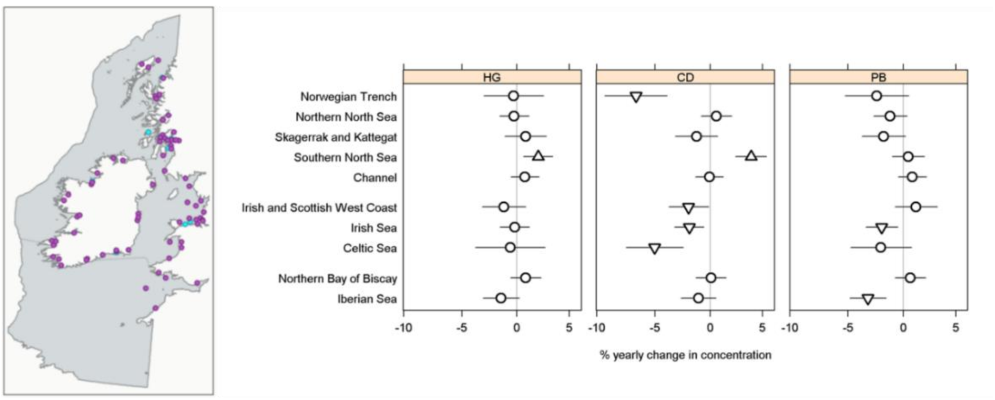


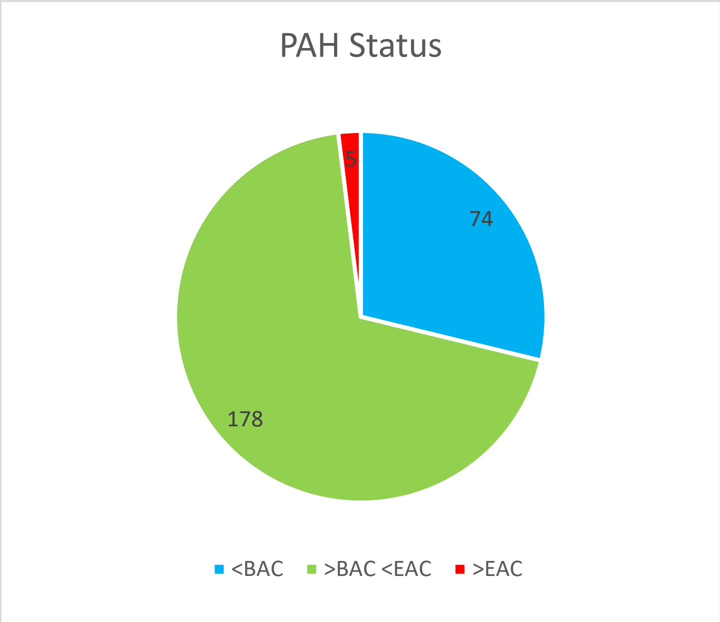
	Figure 3: Regional trend monitoring stations and estimates detailing the percentage yearly change in averaged metal concentrations in shellfish (95% confidence intervals). Monitoring stations (purple = temporal trend. blue = status only). **Note:** Downward triangles= the mean concentration is significantly decreasing ($p < 0.05$) Circle = No significant change in mean concentration ($p > 0.05$)
Conclusion	OSPAR assessments indicate that metal contaminants in shellfish from Irish coastal waters are predominantly within the OSPAR EAC thresholds. These imply adverse effects on marine life would not be expected. For the most part trends are not detected but where they do occur, they are typically in a downward direction, most notably for cadmium. Good Environmental Status has been achieved for metal concentrations in biota in the Irish maritime area.
Knowledge gaps	Assessment criteria only available for a limited set of metals in shellfish. The derivation of EACs for in shellfish would enhance assessments. Food safety thresholds for some metals are utilised as upper thresholds by OSPAR but continued collaborative efforts at OSPAR is required to establish common threshold values for contaminants and their effects. There is an inconsistency with the WFD EQS_{biota} for mercury in fish and OSPAR assessment which needs to be resolved. The potential impact of cumulative effects of combinations of contaminants is unknown.
	Assessment Data
Data Sources	Monitoring is undertaken by the Marine Institute and reported to ICES database. OSPAR Intermediate assessment 2017 Metals in biota https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/contaminants/metals-fish-shellfish/

Data Locations (URL)	Monitoring is undertaken by the Marine Institute and reported to ICES database. https://ocean.ices.dk/ohat/ OSPAR Assessment OSPAR assessment site (most recent) https://ocean.ices.dk/ohat/ OSPAR Assessment output 2019 (used this assessment) https://ocean.ices.dk/ohat/?assessmentperiod=2019			
Data Time Line	Start Date:	1995	End Date:	2017
Point of Contact	Brendan McHugh/ Evin McGovern. Marine Institute			
Email	Brendan.mchugh@marine.ie; evin.mcgovern@marine.ie			

D8 C1 PAH in Shellfish

Ref D8C1 a Rev 1	**Assessment Sheet: Status and Trends in the Concentrations of Polycyclic Aromatic Hydrocarbons (PAHs) in Shellfish** **MSFD Cycle 1: D8.1 - Concentration of contaminants** **MSFD Cycle 2: D8C1 (- PAH Concentrations in Biota)**
Key message	Concentrations of polycyclic aromatic hydrocarbons (PAHs) in shellfish, sampled in Irish waters, are generally above natural background concentrations. There are areas where PAHs are at background concentrations, however, the concentration encountered are below levels likely to harm marine species. Concentrations are decreasing or show no statistically significant change in the majority of the areas assessed. This indicator is based on OSPAR Coordinated Environmental Monitoring Programme (CEMP) Assessment (2019).
Introduction / Objective	Polycyclic aromatic hydrocarbons (PAHs) are natural components of coal and oil, they are also formed during industrial activities and the combustion of fossil fuels and organic material. In addition, PAHs also occur as a result of natural processes such as forest fires. PAHs enter the marine environment through atmospheric deposition, road run-off, industrial discharges and as a result of oil spills. PAHs in the marine environment often end up in marine sediment, where they can become trapped in lower layers unless the sediments are disturbed. PAHs also accumulate in shellfish, either absorbed directly from the marine environment or indirectly through food consumption. In contrast fish metabolise PAHs and therefore concentrations in fish are low. The problems caused by PAHs in the marine environment vary considerably from tainting the taste of fish and shellfish to potential carcinogenic effects on humans and animals. As part of the OSPAR Coordinated Environmental Monitoring Programme concentrations of Polycyclic Aromatic Hydrocarbons are measured in shellfish (mussels and oysters) and data are reported to ICES and assessed according to OSPAR methodology.

	PAH concentrations were compared against two assessment criteria: the OSPAR Background Assessment Concentrations (BACs) and Environmental Assessment Criteria (EACs). Adverse effects on marine organisms are rarely observed when concentrations are below the EAC. BACs are used to assess whether concentrations are near background values for naturally occurring substances, such as PAHs. The OSPAR Hazardous Substances Strategy has the ultimate aim of achieving concentrations in the marine environment near background values for naturally occurring substances such as PAH. Due to their toxicity and persistence in the marine environment and their potential to bioaccumulate, analyses of PAH concentrations in sediment and shellfish is reported in the OSPAR Coordinated Environment Monitoring Programme (CEMP). Monitoring of PAHs in shellfish from Irish waters began in approximately 1995.
Drivers	Commission Directive 2017/845 –activity themes: Extraction of non-living resources, Production of energy, Transport, Urban and industrial uses. Coals, Coal Tar Creosote Spills, discharges and losses of oils and fossils fuels and petroleum products. Additional sources include industrial activities, combustion of fossil fuels and organic material or natural processes such as forest fires.
Pressures	MSFD qualitative descriptors are linked to their key pressure elements via Commission Directive 2017/845 (amending Directive 2008/56/EC). Pressure via anthropogenic input of substances, litter and/or energy and specifically those from synthetic and non-synthetic substances via diffuse and point sources, atmospheric deposition and acute events are specifically identified as key pressures for GES descriptors 8 and 9. For PAH: Riverine input, Atmospheric Input (especially associated with incomplete combustion of fossil fuels and noting; this can be due to long range transport) and direct input including from sea-based sources PAH's are ubiquitous and persistent contaminants

<table>
<tr>
<td>State</td>
<td>
Table 1: PAH in shellfish status assessment, n=29 stations and 257 individual PAH parameter assessments
<table>
<tr><th>blue</th><th>green</th><th>red</th></tr>
<tr><td>74</td><td>178</td><td>5.0</td></tr>
<tr><td>28.8%</td><td>69.3%</td><td>1.9%</td></tr>
</table>


Some PAH time series end 2012 (spatial sampling locations). Other time series can range from a start date of 2005 through to 2017.

Table 2: PAH temporal trend directions.
<table>
<tr><th></th><th>Downward Trend ↓</th><th>No trend↔</th><th>Upward Trend↑</th></tr>
<tr><td>PAH</td><td>15 (5.4%)</td><td>261 (93.2%)</td><td>4 (1.4%)</td></tr>
</table>

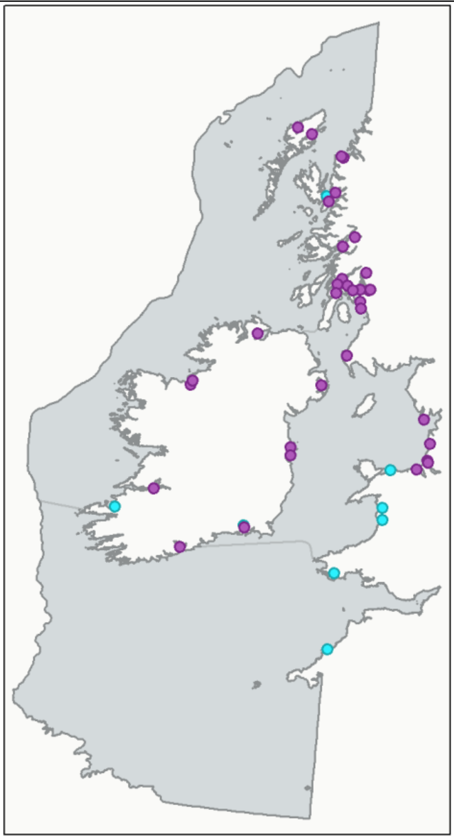
Note: OSPAR temporal trend assessments can often be completed where sufficient monitoring data exist irrespective of the number of threshold values available. Full status assessments require both BAC and EAC (or equivalent) to be available. Consequently, this may result in a different number of individual parameter temporal and status assessments being available.
</td>
</tr>
<tr>
<td>Impact</td>
<td>This is a state variable. However, PAH’s measured are typically not at levels likely to harm marine species (i.e. <EACs)</td>
</tr>
</table>

Conclusion	Concentration of PAHs in shellfish as measured under the OSPAR CEMP generally meet agreed OSPAR target thresholds and trends are not broadly increasing. Good Environmental Status has been achieved for PAH concentrations in biota in Irish maritime area.
Assessment Result .	PAH concentrations in shellfish are generally above background in all assessed sub-regions (**Irish Sea, Celtic Seas and West Coast**). It should be noted that BAC thresholds for PAHs are low. However, with the exception of one location, concentrations were below the EAC and therefore are unlikely to cause adverse effects in marine organisms. A total of 3 upward trends were observed for Pyrene and one for Fluoranthene (1.4% of trend assessments). Overall PAH concentrations in shellfish were either stable (>93%) or decreasing in all other locations assessed (5.4%).
Knowledge gaps	Environmental Assessment Criteria (EAC) are available for a limited set of parent PAHs only. Therefore, continued collaborative efforts at OSPAR to establish common threshold values for contaminants and their effects. The derivation of EACs for alkylated PAHs in shellfish would enhance assessments. Monitoring under this indicator is for shellfish in coastal waters only. Coastal monitoring is where primary risk occurs, associated with land-based inputs. Other approaches are needed for offshore monitoring. The potential impact of cumulative effects of combinations of contaminants is unknown.
Background	Polycyclic aromatic hydrocarbons (PAHs) are hydrocarbons composed of two or more fused aromatic rings, encompassing both parent (non-alkylated) compounds and alkylated homologues. Although PAHs can be produced through natural processes, they also arise from anthropogenic sources. Incomplete combustion processes are a major source of PAHs, but they can also be of petrogenic origin (crude oils or refinery products). PAHs of petrogenic origin include mainly alkylated, 2-ring and 3-ring PAHs formed as a result of diagenetic processes, whereas PAHs from pyrolytic sources comprised mainly of the heavier, parent (non-alkylated) PAHs. Assessment of the PAH profile, including PAH ratios such as the

	phenanthrene/anthracene ratio or the fluoranthenene/pyrene ratio can give an indication of the source of the PAHs. PAH properties will vary considerably depending on the number of rings. Low molecular weight PAHs can cause tainting of fish and shellfish and render them unfit for sale (Davis et al., 2002); secondly, metabolites of some of the high molecular PAHs, such as benzo[*a*]pyrene, are potent animal and human carcinogens. Less is known about the toxicity of alkylated PAHs, although one study has demonstrated that alkylated PAHs may have increased toxicity compared to the parent compound (Marvanova et al., 2008). There are marked differences in the behaviour of PAHs in the aquatic environment between the low molecular weight compounds (e.g. naphthalene) and the high molecular weight compounds (e.g. benzo[*ghi*]perylene) as a consequence of their differing physico-chemical properties. The low molecular weight compounds are appreciably water soluble and can be bioaccumulated from the dissolved phase by transfer across the gill surfaces of aquatic organisms; whereas the high molecular weight compounds are relatively insoluble and hydrophobic, and can attach to both organic and inorganic particulates within the water column. PAHs derived from combustion sources may be deposited directly to the marine environment already adsorbed to atmospheric particulates, such as soot particles. PAHs can enter the marine environment through atmospheric deposition, run-off, industrial discharges and as a result of oil spills. Sediment will act as a sink for PAHs in the marine environment. PAHs are readily taken up by marine animals both across gill surfaces (lower molecular weight PAHs) and from their diet (Baumard *et al.*, 1999). Filter-feeding organisms such as bivalve molluscs can accumulate high concentrations of PAHs. Fish are exposed to PAHs both *via* uptake across gill surfaces and from their diet, but do not generally accumulate high concentrations of PAHs as they possess an effective mixed-function oxygenase (MFO) system which allows them to metabolise PAHs and to excrete them in bile (Stagg *et al*., 1995 and Richardson *et al.,* 2001). Other marine vertebrate and marine mammals also metabolise PAHs efficiently. PAHs are of concern due to their persistence, potential to bioaccumulate and toxicity, and are therefore included on the OSPAR List of Chemicals for Priority Action. The analyses of PAHs in both

	sediment and shellfish are reported in the OSPAR Coordinated Environment Monitoring Programme (CEMP).
	References Baumard, P., Budzinski, H., Garrigues, P., Narbonne, J. F., Burgeot, T. Michel, X. and Belloccq, J. 1999. Polycyclic aromatic hydrocarbon burden of mussels (*Mytilius sp*.) in different marine environments in relation with sediment and PAH contamination and bioavailability. *Marine Environment Research,* 47, 415 – 439. Davis, H. K., Moffat, C. F. and Shepherd N. J. 2002. Experimental tainting of marine fish by three chemical dispersed petroleum products, with comparisons to the *Braer* oil spill. *Spill Science and Technology Bulletin*, 7, 257 – 278 Marvanova S, Vondracek J, Pencikova K, Trilecova L, Krcmar P, Topinka J, Novakova Z, Milcova A, Machala M (2008) 'Toxic effects of methylated benz[a]anthracenes in liver cells' Chemical Research in Toxicology 21: 503 – 512 OSPAR Publication 2008-379 CEMP Assessment Manual: Co-ordinated Environmental Monitoring Programme Assessment Manual for contaminants in sediment and biota OSPAR Publication 2009-461 Background Document on CEMP Assessment Criteria for the QSR 2010 Richardson, D.M., Davies, I.M., Moffat, C.F., Pollard, P. and Stagg, R.M. Biliary PAH metabolites and EROD activity in flounder (Platichtys flesus) from a contaminated estuarine environment. J. Environ. Monit., 3, 610-615. Stagg, R. M., McIntosh A. M. and Mackie, P. (1995). 'The induction of hepatic mono-oxygenase activity in dab (Limanda limanda) in relation to environmental contamination with petroleum hydrocarbons in the North Sea', Aquatic Toxicology, 33: 254-264.
Objective	Assess the spatial distribution, temporal trends and status of PAH in shellfish (bivalve molluscs) from Irish marine water.
Assessment Method	Assessment method (extended) – From OSPAR Regional Assessment This assessment of data reported to OSPAR describes the trends and status of contaminant concentrations at biota monitoring stations in

	Irish waters and includes both temporal trend and status assessments using a total of 9 polycyclic aromatic hydrocarbon compounds, for which assessment criteria were available. In accordance with OSPAR methodologies https://ocean.ices.dk/ohat/trDocuments/2019/help_methods_biota_pah_(parent).html individual time series of polycyclic aromatic hydrocarbon concentrations were assessed for status where: • there is at least one year with data in the period 2010 to 2015 • there are at least 3 years of data over the whole time-series • a parametric model can be fitted to the data and used to estimate the mean concentration in the final monitoring year (or, occasionally, if a non-parametric test of status is applied). The time series was assessed for trends where: • there are at least 5 years of data over the whole time-series • a parametric model can be fitted to the data and used to estimate the trend in mean concentrations. • Information on how the individual time series are assessed for status and trends is available. For regional assessment, data from individual time series were combined and a summary measure of status or trend was obtained from each time series. Larger scale regional assessment only considers coastal and offshore stations and excludes estuarine stations.

	 **Figure 2.** Assessment scale. Monitoring stations (purple = temporal trend. blue = status only) for regional assessment of PAH in shellfish. Full details of the assessment methodologies is available at. https://ocean.ices.dk/ohat/trDocuments/2019/help_methods_biota_pah_(parent).html https://ocean.ices.dk/ohat/trDocuments/2019/help_ac_biota_pah_(parent).html Monitoring follows OSPAR Guidelines for monitoring contaminants in biota: https://www.ospar.org/work-areas/cross-cutting-issues/cemp The Initial Assessment (2013) target for contaminants states that **“Concentrations of substances identified within relevant legislation and international obligations are below the concentrations at which adverse effects are likely to occur (e.g. are less than Environmental Quality Standards applied within the Water Framework Directive (European Commission, 2000) and Environmental Assessment Criteria applied within OSPAR)**”. Two assessment criteria have been used by OSPAR to assess polycyclic aromatic hydrocarbon concentrations in biota (OSPAR Commission, 2008 and 2009b). Background Assessment

Concentrations were developed by OSPAR for testing whether concentrations are near background levels. Mean concentrations significantly below the Background Assessment Concentration are said to be near background. Environmental Assessment Criteria for polycyclic aromatic hydrocarbons in sediment were not recommended for use in environmental assessments. Therefore, the Effects Range-Low values are used by OSPAR for the assessment of polycyclic aromatic hydrocarbon in sediment. Effects Range-Low values were developed by the United States Environmental Protection Agency for assessing the ecological significance of sediment concentrations. Concentrations below the Effects Range-Low rarely cause adverse effects in marine organisms. Therefore, polycyclic aromatic hydrocarbon concentrations in sediment should be below the Effects Range-Low values for Good Environmental Status to be achieved.

Table 1. Background Assessment Concentrations (BAC) (OSPAR Commission, 2009b) and Effects Range-Low values (ER-L) available for the assessment of polycyclic aromatic hydrocarbons in mussels. All concentrations are expressed as µg per kg dry weight (dw). Background Assessment Concentrations and Environmental Assessment Criteria are converted to other bases (wet, dry or lipid weight) using species-specific conversion factors. Polycyclic aromatic hydrocarbons are not routinely monitored in fish, so no Background Assessment Concentrations and Environmental Assessment Criteria for fish have been derived.

Human health Environmental Quality Standards (EQS) are also available for fluoranthene and benzo[a]pyrene, which reflect the human health limits for PAH in bivalve molluscs set in Reg 1881/2006 as amended.

Table 3: Maximum OSPAR and WFD (Directive 2013/39/EU) thresholds for PAH's.

PAH	**BAC (µg kg-1 dry weight w**	**EAC (µg kg-1dry weight)**	**WFD EQS_{biota} µg kg-1 wet weight** [1]
Phenanthrene	11.0	1700	
Anthracene		290	
Fluoranthene	12.2	110	
Pyrene	9.0	100	
Benz[a]anthracene	2.5	80	

Chrysene /Triphenylene	8.1		
Benzo[a]pyrene[3]	1.4	600	5
Benzo[ghi]perylene	2.5	110	
Indeno[123-cd]pyrene	2.4		
Sum 4 indicator PAH[2]			30

[1] Based on human health protection, Refers to crustaceans and molluscs. For assessing chemical status, monitoring in fish is not appropriate.
[2] Sum of benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene
[3] Benzo(a)pyrene can be considered as a marker for the other PAHs, hence only benzo(a)pyrene needs to be monitored for comparison with the EQSbiota or the corresponding AA- EQS in water

BAP WFD limit is 5 µg/kg. All 126 measurements in shellfish from 2016 onwards are below the threshold (wet weight) Max 3.55 and Max Sum 4 indicators = 19.5 µg/kg.

Note: BAC/EACs concentrations are expressed as µg kg^{-1} dw (dry weight), BACs and EACs are converted to other bases (wet, dry or lipid weight) using species-specific conversion factors in accordance with OSPAR methodologies.

Assessment Result (extended)	PAH concentrations in shellfish are generally above background in all assessed sub-regions (**Irish Sea, Celtic Seas and West Coast**). It should be noted that BAC thresholds for PAHs are low. However, with the exception of one location, concentrations were below the EAC and therefore are unlikely to cause adverse effects in marine organisms. A total of 3 upwards trends were observed for Pyrene and one for Fluoranthene (1.4% of trend assessments). Overall PAH concentrations in shellfish were either stable (>93%) or decreasing in all other locations assessed (5.4%). **See Results section**

Results (figures & tables)

Table 4: Status assessment and temporal trend direction for individual PAHs in shellfish from Irish waters.

Key: Number in brackets is number of years for which data points are available.

Green final year within OSPAR EAC (FECG), Red final year does not meet OSPAR EAC, Orange = above BAC (where no EAC is available)

↑/↓Arrows indicate upward/downward significant trend. No arrow means no significant trend or trend not assessed (<5 year's data)

	ANT	BAA	BAP	BGHIP	CHR	FLU	ICDP	PA	PYR
Cork Hbr N Channel (ME)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Cromane (ME)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Glengariff (ME)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Kilmakillogue (ME)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Ringaskiddy (ME)	(10) ↓	(11) ↓	(11)	(11)	(11) ↓	(11)	(11)	(10)	(11) ↓
Roaringwater Bay (ME)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Aughinish Bay (CG)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Ballysadare Bay (ME)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Bruckless (ME)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Clarenbridge (CG)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Clew Bay South (CG)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Clew Bay South (ME)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Drumcliff (CG)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Fenit (ME)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Killary Harbour Inner (ME)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Maharees (OE)	(2)	(2)	(2)	(2)	(2)	(2)	(2)		(2)
Mulroy Bay - Broadwater (ME)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Quigleys Point (ME)	(5)	(5)	(5)	(5)	(5)	(5) ↑	(5)	(5) ↑	(5) ↑
Quigleys Point (OE)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Rosses Point (ME)	(8)	(8)	(6)	(8)	(8)	(8)	(8)	(8) ↓	(8) ↑
Shannon Est - Aughinish (ME)	(10) ↓	(10) ↓	(10)	(10)	(10) ↓	(10)	(10)	(10)	(10) ↓
Tralee Bay Inner (OE)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Arthurstown (ME)	(10)	(10) ↓	(10)	(10)	(10) ↓	(10)	(10)	(10)	(10)
Cheekpoint (ME)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Duncannon (CG)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Dundalk Bay Inner (ME)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Dungarvan Bay (CG)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Rogerstown Estuary (ME)	(9) ↓	(9)	(8)	(9)	(9)	(9)	(9)	(9)	(9)

Sutton (ME)	(12) ↓	(12) ↓	(12)	(12)	(12) ↓	(12)	(12)	(11)	(12)

ANT = anthracene, BAA = benzo[a]anthracene, BAP= benzo[a]pyrene, BGHIP= benzo[ghi]perylene, CHR= chrysene, FLU= fluoranthene, ICDP= indeno[1 2 3-cd]pyrene, PA = Phenanthrene and PYR = Pyrene.

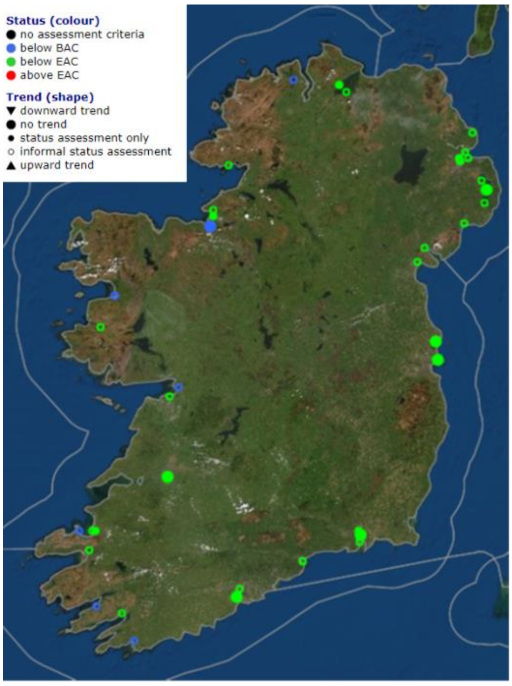


Figure 3: Example of current OSPAR status for Benzo a-Pyrene in shellfish.
https://ocean.ices.dk/ohat/

Table 5: Individual contaminant temporal trend directions

	Downward Trend **downward_triangle**	*No trend*	Upward Trend **upward_triangle**	*Locations*
ANT	4	25		29
BAA	4	25		29
BAP		29		29
BGHIP		29		29
CHR	4	25		29
FLU		28	1	29
ICDP		29		29
NAP		20		20
PA	1	26	1	28
PYR	2	25	2	29

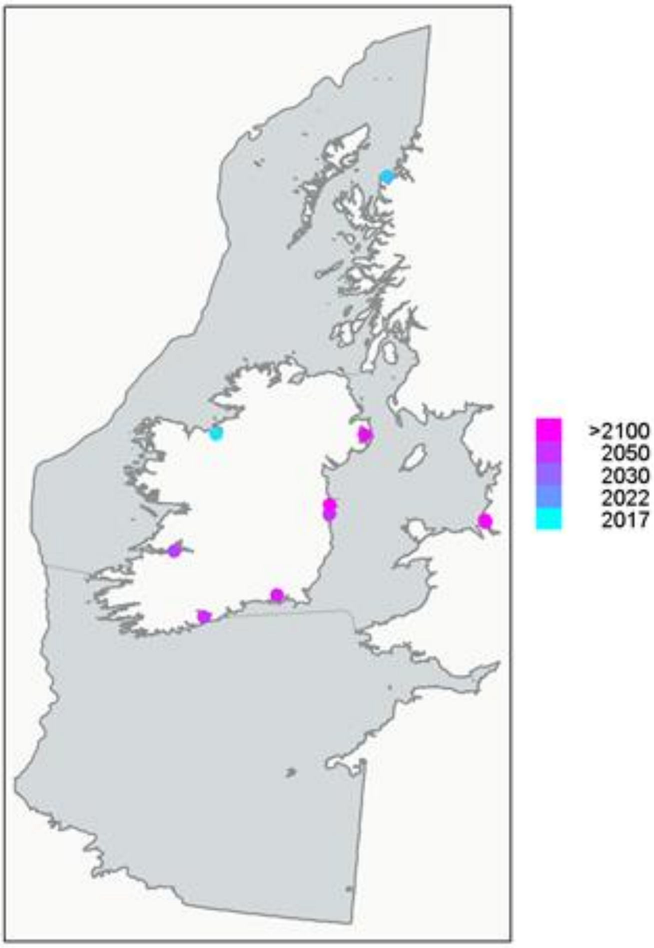


Figure 4: Example for Benzo a-Pyrene, showing the time (year) at which it is projected low concentration for BaP would be achieved based on current trends. All stations are shown for which a trend was estimated (essentially those stations with at least five years of data) or where the time series is too short to estimate a trend but the mean concentration is already at the low concentration. https://ocean.ices.dk/ohat/trDocuments/2019/distance_lc_biota_pah_(parent).html

<table>
<tr>
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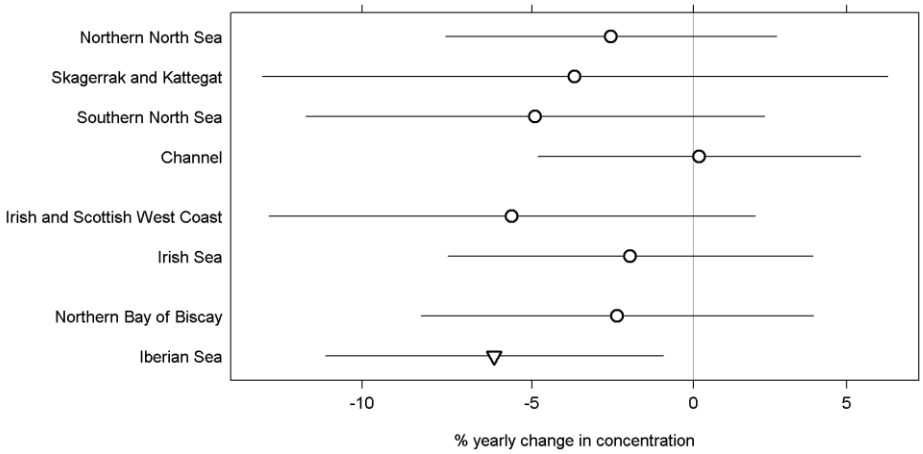
<td>


Figure 5: Regional trend estimates detailing the percentage yearly change in averaged PAH concentrations in shellfish (95% confidence intervals). Monitoring stations (purple = temporal trend. blue = status only).

Note: Downward triangles= the mean concentration is significantly decreasing ($p < 0.05$)
Circle = No significant change in mean concentration ($p > 0.05$)
</td>
</tr>
<tr>
<td>**Conclusion**</td>
<td>Concentration of PAHs in shellfish as measured under the OSPAR CEMP generally meet the agreed OSPAR target thresholds and trends are not broadly increasing. Good Environmental Status has been achieved for concentrations of PAH’s in shellfish</td>
</tr>
<tr>
<td>**Knowledge gaps**</td>
<td>Environmental Assessment Criteria (EAC) are only available for a limited set of parent PAHs only. Therefore, continued collaborative efforts at OSPAR to establish common threshold values for contaminants and their effects.

The derivation of EACs for alkylated PAHs in shellfish would enhance assessments.

Monitoring under this indicator is for shellfish in coastal waters only. Coastal monitoring is where primary risk occurs, associated with land-based inputs. Other approaches are needed for offshore monitoring.

The potential impact of cumulative effects of combinations of contaminants is unknown.</td>
</tr>
</table>

	Assessment Data			
Data Sources	Monitoring is undertaken by the Marine Institute and reported to the ICES database where it is used for OSPAR Joint assessment https://ocean.ices.dk/ohat/ OSPAR Assessment https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/contaminants/status-and-trends-concentrations-polycyclic-aromatic-hydrocarbon/ OSPAR Intermediate Assessment 2017 PAHs in biota			
Data Locations (URL)	OSPAR assessment site (most recent) https://ocean.ices.dk/ohat/ OSPAR Assessment output 2019 https://ocean.ices.dk/ohat/?assessmentperiod=2019			
Data Time Line	Start Date:	2001	End Date:	2017
Point of Contact	Dr. Brendan McHugh, Dr. Evin McGovern, Marine Institute			
Email	Brendan.mchugh@marine.ie, evin.mcgovern@marine.ie			

D8 C1 PBDE in Shellfish

Ref D8C1 a Rev 1	**Assessment Sheet: Status and Trends in the Concentrations of Polybrominated Diphenylethers (PBDEs) in Shellfish** **MSFD Cycle 1: D8.1 - Concentration of contaminants** **MSFD Cycle 2: D8C1 (Element - PBDE Concentrations in Biota)**
Key message	Concentrations of PBDEs in shellfish, sampled in Irish waters, are above OSPAR background concentrations (i.e. not close to zero). Concentrations encountered are below levels likely to harm marine species based on OSPAR assessment thresholds. Where significant trends are detected they are in a downwards direction. This indicator is based on OSPAR Coordinated Environmental Monitoring Programme Assessment (2019).
Introduction / Objective	Monitoring for hazardous substances is risk based and primarily focussed on coastal waters as most sources are terrestrial and marine sources are generally more concentrated in coastal waters (e.g. shipping concentrated around ports). If problems are not detected in inshore waters, monitoring is not widely extended beyond Irish coastal waters (which in themselves can reach near full ocean salinity) unless there is a specific risk factor, such as specific offshore sources. Polybrominated diphenyl ethers (PBDEs) are ubiquitous manmade substances that are persistent, toxic and can bioaccumulate. As part of the OSPAR Coordinated Environmental Monitoring Programme concentrations of PBDEs are measured in shellfish (mussels and oysters) and data are reported to ICES and assessed according to OSPAR methodology. OSPAR utilise two assessment criteria to assess the status of organo-bromine concentrations in shellfish: • Background Assessment Concentration (BAC) • Federal Environmental Quality Guideline (FEQG). FEQGs were developed under the Canadian Environmental Protection Act, 1999. Concentrations below the FEQG should not cause any chronic effects on marine organisms.

<table>
<tr><td></td><td>The BACs and FEQGs are currently being used on a trial basis following deliberations at OSPAR Working Groups on Monitoring and on Trends and Effects of Substances in the Marine Environment (MIME) 2017 and 2018.

Monitoring of PBDEs in shellfish from Irish waters began in approximately 2004.</td></tr>
<tr><td>Drivers</td><td>Commission Directive 2017/845 activity themes - Urban and industrial uses

Their main use is as flame retardants in different types of material including plastics, textiles and electronic products.</td></tr>
<tr><td>Pressures</td><td>MSFD qualitative descriptors are linked to their key pressure elements via Commission Directive 2017/845 (amending Directive 2008/56/EC). Pressure via anthropogenic input of substances, litter and/or energy and specifically those from synthetic and non-synthetic substances via diffuse and point sources, atmospheric deposition and acute events are specifically identified as key pressures for GES descriptors 8 and 9.

Pathways to the marine environment are via riverine, atmospheric transport (including long range transport) and direct inputs.
PAH’s are ubiquitous and persistent synthetic contaminants.</td></tr>
<tr><td>State</td><td>PBDE in shellfish status
Concentrations of PBDEs in shellfish were monitored at 33 stations and with 198 individual PBDE parameter assessments completed in accordance with OSPAR Coordinated Environment Monitoring Programme (CEMP) methodologies. While PBDE concentrations are above OSPAR background thresholds, 98.5% of datasets were lower than the Canadian Federal Environmental Quality Guideline (FEQG) as currently adopted by OSPAR.

Figure 1: Summary assessment of PBDE concentrations in shellfish from Irish waters in accordance with OSPAR Coordinated Environment Monitoring Programme (CEMP) methodologies.

<table>
<tr><th><BAC</th><th>>BAC <EAC</th><th>>EAC/FEQG</th></tr>
<tr><td>0</td><td>195</td><td>3</td></tr>
<tr><td>0%</td><td>98.5%</td><td>1.5%</td></tr>
</table>
</td></tr>
</table>

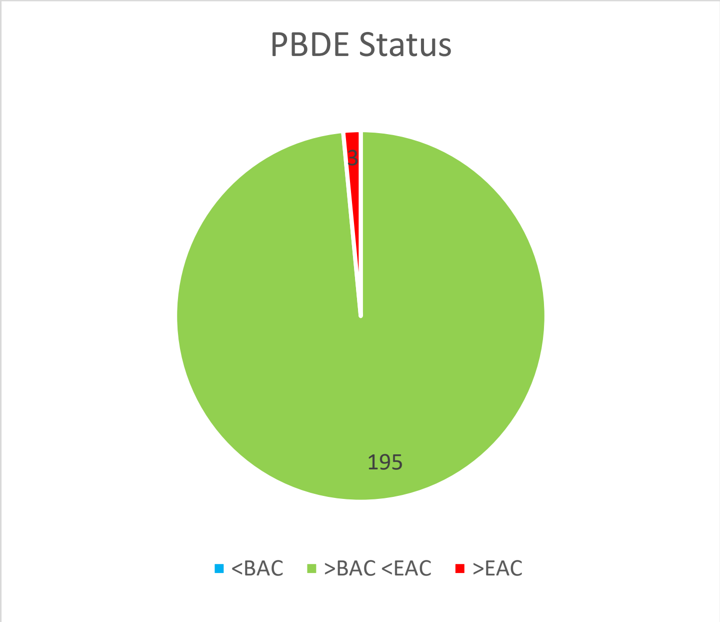


Table 1: Contaminant trend directions: individual parameters.

	Downward Trend	No measurable trend	Upward Trend	#Locations
BD100	6	27		33
BD153	2	31		33
BD154	3	30		33
BDE28	1	32		33
BDE47	7	26		33
BDE99	6	27		33

Table 2: Summary Parameter Groups trend direction. Number of occurrences and percentage in parenthesis.

	Downward Trend ↓	**No trend↔**	**Upward Trend↑**
PBDE	25 (12.6)	173 (87.4)	None

Note: OSPAR temporal trend assessments can often be completed where sufficient monitoring data exist irrespective of the number of threshold values available. Full status assessments require both BAC and EAC (or equivalent) to be available. Consequently, this may result in a different number of individual parameter temporal and status assessments being available.

Impact	This is a state variable.

Conclusion	OSPAR assessments indicate that PBDE in shellfish from Irish coastal waters are generally above background concentrations (OSPAR BAC) but predominantly within the FEQG thresholds applied in the OSPAR assessment. These assessments imply adverse effects on marine life would not be expected. However, lower WFD EQS_{HH} for finfish are adopted by Directive 2013/39/EC. For the most part trends are not detected but where they occur, they are typically in a downward direction. An assessment of Good Environmental Status cannot be made as assessment criteria for concentrations of PBDEs in shellfish at which adverse effects are likely to occur for the marine environment are not agreed.
Assessment Result	Monitoring data in this assessment is referenced against the two assessment criteria currently utilised in OSPAR assessments, namely; • Background Assessment Concentration (BAC) • Federal Environmental Quality Guideline (FEQG) BACs were developed within the OSPAR framework with scientific advice from the International Council for the Exploration of the Sea. Mean concentrations significantly below the BAC are near background. FEQGs were developed under the Canadian Environmental Protection Act, 1999. Concentrations below the FEQG should not cause any chronic effects on marine organisms. The BACs and FEQGs are currently being used on a trial basis following deliberations at OSPAR MIME 2017 and 2018. https://ocean.ices.dk/ohat/trDocuments/2019/help_ac_biota_organo-bromines.html PBDE concentrations measured in shellfish are generally above background (i.e. not close to zero for this synthetic pollutant) but below the threshold applied by OSPAR (FEQG) in lieu of an EAC in all assessed sub-regions (Irish Sea, Celtic Seas and West Coast). However, with the exception of one location concentrations were below the FEQG threshold and therefore are unlikely to cause adverse effects in marine organisms. Overall PBDE concentrations in shellfish were either stable or decreasing in all other locations assessed. No upwards trends were observed for PBDEs

Knowledge gaps	Where there is no OSPAR EAC a Canadian FEQG is utilised in lieu of this. There is an inconsistency with the WFD EQS_{biota} for PBDEs in fish which needs to be resolved. The WFD EQS_{biota} is very conservative and presents analytical challenges. This is not currently applied in OSPAR assessment. The potential impact of cumulative effects of combinations of contaminants is unknown.
Background	Polybrominated diphenyl ethers (PBDEs) are a group of 209 different congeners. Their main use is as flame retardants in different types of material including plastics, textiles and electronic products. The three major commercial PBDE products that have been produced are pentaBDE, octaBDE and decaBDE, containing mixtures of different PBDEs relating to the number of bromines attached to the compound. Globally, decaBDE is the most widely used. PBDEs are flame retardants of the additive type, which means that they are physically combined with the material being treated rather than chemically combined (as in reactive flame-retardants) and are more likely to diffuse out of the products (European Commission, 2001, 2003; Hutzinger and Alaee et al., 2003). Leakage of PBDEs occurs during production, use, or disposal of such products, and PBDEs are mainly transferred to the ocean via rivers and through diffuse distribution in the atmosphere (OSPAR, 2009). The presence of PBDEs in air samples from Arctic Canada, for example, provides evidence of their long-range transport (de Wit, 2002). The advantage of these compounds for industry is their high resistance to acids, bases, heat, light, and reducing and oxidising compounds. However, this becomes a great disadvantage in the environment where they persist for very long periods. Increased concentrations of these compounds have been measured in environmental samples since the 1970s (de Wit, 2002). PBDEs are toxic, persist in the environment, and can bioaccumulate. As a result, the PBDE substances included in the commercial pentaBDE- and octaBDE-mixtures were banned in the European Union in 2004, and since 2009 have been listed under the Stockholm Convention (2009), meaning that a majority of countries worldwide have agreed to phase out these compounds.

	PBDE has been reported as neurotoxic, immunotoxic and to affect thyroid hormone receptors in sensitive human populations (de Wit, 2002). Effects on behaviour and learning (Eriksson et al., 2006a,b) and hormonal function (Legler, 2008) have been reported in mammals, while reduced reproductive success has been documented in birds (Fernie et al., 2009). The use of substance groups pentaBDE and octaBDE has been banned in the European Union since 2004 (Commission Regulation (EC) No 552/2009). At present the use of decaBDE is only restricted in electrical and electronic products (European Court of Justice, 2008). However, decaBDE is no longer produced within the EU (UNEP, 2014). Although there is no production within the European Union, existing stocks of PBDE-containing products may still act as a diffuse source. In 2009, tetraBDE, pentaBDE, hexaBDE and heptaBDE were listed under the Stockholm Convention (2009). As a result, Parties to the Convention must take action to eliminate the production and use of these compounds. The European Food Safety Authority recommended these eight substances of interest to monitor: triBDE-28, tetraBDE-47, pentaBDE-99, pentaBDE-100, hexaBDE-153, hexaBDE-154, heptaBDE-183 and decaBDE-209 (EFSA, 2006). These were selected on the basis of analytical feasibility for their measurement, production volumes (as registered in 2006), their occurrence in food and feed, their persistence in the environment and their toxicity. For environmental monitoring within the European Union, environmental quality standards have been derived for these congeners excluding BDE-183 and BDE-209 (European Commission, 2011).
Objective	Assess the spatial distribution, temporal trends and status of PBDEs in shellfish (bivalve molluscs) from Irish marine waters according to OSPAR methodology and standards.
Drivers	Polybrominated diphenyl ethers (PBDEs) constitute a group of additive flame retardants predominately found in electrical equipment, textiles, and furniture. PBDEs are used as additives to polymers and resins. PBDEs consist of two phenyl rings, connected by an ether bridge, each ring containing up to five bromine atoms. There are a possible 209 PBDE congeners, depending on the position and number of bromines, with molecular weights ranging from 249 to 960

	Da. However, PBDE technical mixtures used as flame retardants contain only a limited number, approximately 20, of these congeners. Commercial PBDE mixtures are classified according to the degree of bromination. The penta- mix contains mainly tetra- to hexa- BDEs, the octa- mix mainly hexa- to octa- BDEs, and the deca- mix contains mainly deca- BDE. Penta- BDE is primarily used in furniture and upholstery, octa- BDE in plastics, and deca- BDEs in textiles and polymers. PBDEs are now heavily regulated.
Pressures	Within the Irish MSFD area the pressures relating to Descriptor 8 come from the following activities: • Input of other substances (e.g. synthetic substances, non-synthetic substances) - diffuse sources, point sources, atmospheric depositions; • Inputs may be from land-based sources (riverine, direct discharge or atmospherically transported) or sea-based sources; • PBDEs are globally ubiquitous due to long-range transport.
State	See assessment
Impact (extended)	This assessment sheet is focused on concentrations of contaminants in shellfish and compliance with OSPAR BACs and EACs.
Assessment Method	This assessment of data reported to OSPAR describes the trends and status of contaminant concentrations at biota monitoring stations around Irish waters and includes both temporal trend and status assessments using a total of up to 6 PBDEs, for which assessment criteria were available. In accordance with OSPAR methodologies individual time series of PBDEs was assessed for status where: • there is at least one year with data in the period 2010 to 2015 • there are at least 3 years of data over the whole time-series • a parametric model can be fitted to the data and used to estimate the mean concentration in the final monitoring year (or, occasionally, if a non-parametric test of status is applied).

	The time series was assessed for trends where: • there are at least 5 years of data over the whole time-series • a parametric model can be fitted to the data and used to estimate the trend in mean concentrations • Information on how the individual time series are assessed for status and trends is available. For regional assessment, data from individual time series were combined and a summary measure of status or trend was obtained from each time series. Larger scale regional assessment only considers coastal and offshore stations and excludes estuarine stations. Full details of the individual methodologies are available at. https://ocean.ices.dk/ohat/trDocuments/2019/help_methods_biota_organo-bromines.html Assessment criteria for contaminants in biota are available https://ocean.ices.dk/ohat/trDocuments/2019/help_ac_biota_organo-bromines.html Monitoring follows OSPAR Guidelines for monitoring contaminants in biota which are available: https://www.ospar.org/work-areas/cross-cutting-issues/cemp **Table 3:** OSPAR BAC, OSPAR adopted FEQG and WFD (Directive 2013/39/EU) thresholds for PBDEs.

Compounds	**BAC ($\mu g\ kg^{-1}$ ww)**	**FEQG[A] ($\mu g\ kg^{-1}$ww)**	**WFD EQS_{biota} $\mu g\ kg^{-1}$ ww**
BDE28		120	
BDE47	0.011	44	
BDE99		1	
BDE100		1	
BDE153		4	
BDE154		4	
Sum of 6 BDEs[B]			0.0085 [c]

A. OSPAR apply Canadian Federal Environmental Quality Guideline (FECG) in lieu of OSPAR EAC
B. BDE congeners 28, 47, 99, 100, 153, 154

C. EQS biota for PBDEs applies to fish filet as it is based on a human consumption risk

Assessment Result

PBDE's congeners measured in mussels and oysters from Irish coastal waters are present above the OSPAR Background Assessment Concentrations, though generally below the Canadian FECG guidelines used in lieu of an OSPAR EAC, considered to represent a concentration threshold of a given chemical below which there is a low likelihood of direct adverse effects from the chemical on aquatic life exposed via the water or sediment, or where chemicals may bioaccumulate, in wildlife (birds and mammals) that consume aquatic life.

Where significant temporal trends were detected they were downwards.
Note WFD EQS for fish have not been applied in OSPAR assessments to date, though it is clear that levels of PBDEs, a ubiquitous and persistent synthetic polllutant, in fish in marine waters are widely well above the very low WFD EQS biota

Results

Table 4: Status assessment and temporal trend direction for individual PBDEs in shellfish from Irish waters.
Key: Number in brackets is number of years for which data points are available.
Green final year within OSPAR EAC (FECG), Red final year does not meet OSPAR EAC (FECG)
↑/↓Arrows indicate upward/downward significant trend. No arrow means no significant trend or trend not assessed (<5 year's data)

Station	BD100	BD153	BD154	BDE28	BDE47	BDE99
Cork Harbour North Channel	(3)	(2)	(3)	(3)	(3)	(3)
Cromane	(3)	(3)	(3)	(3)	(3)	(3)
Glengariff	(2)	(2)	(2)	(2)	(2)	(2)
Kilmakillogue	(3)	(2)	(2)	(3)	(3)	(3)
Ringaskiddy	(13) ↓	(13) ↓	(13) ↓	(12)	(13) ↓	(13) ↓
Roaringwater Bay Inner	(2)	(2)	(2)	(2)	(2)	(2)
Aughinish Bay	(2)	(2)	(2)	(2)	(2)	(2)
Ballysadare Bay	(2)	(2)	(6)	(7)	(7) ↓	(7) ↓
Bruckless	(2)	(2)	(2)	(2)	(2)	(2)
Clarenbridge	(3)	(3)	(2)	(3)	(3)	(3)
Clew Bay South	(2)	(2)	(2)	(2)	(2)	(2)
Clew Bay South	(2)	(2)	(2)	(2)	(2)	(2)
Drumcliff	(2)	(2)	(2)	(2)	(2)	(2)
Fenit	(2)	(2)	(2)	(2)	(2)	(2)
Killary Harbour Inner	(2)	(2)	(2)	(2)	(2)	(2)

Maharees	(2)	(2)	(2)	(2)	(2)	(2)
Maharees	(3)	(2)	(2)	(3)	(3)	(3)
Mulroy Bay - Broadwater	(3)	(3)	(2)	(3)	(3)	(3)
Quigleys Point	(6)	(2)	(2)	(6)	(6)	(6)
Quigleys Point	(2)	(2)	(2)	(2)	(2)	(2)
Rosses Point	(9) ↓	(2)	(4)	(9)	(9)	(9)
Shannon Estuary - Aughinish	(11)	(11)	(11) ↓	(10)	(11) ↓	(11) ↓
Tralee Bay Inner	(3)	(3)	(3)	(3)	(3)	(3)
Tralee Bay Inner	(5)	(2)	(2)	(5)	(5)	(5)
Arthurstown	(10) ↓	(10)	(10)	(9)	(10) ↓	(10) ↓
Cheekpoint	(6) ↓	(2)	(6)	(6) ↓	(6) ↓	(6)
Duncannon	(2)	(2)	(2)	(2)	(2)	(2)
Dundalk Bay Inner	(1)	(1)	(1)	(1)	(1)	(1)
Dungarvan Bay	(3)	(2)	(3)	(3)	(3)	(3)
Rogerstown Estuary	(9) ↓	(2)	(8)	(8)	(9) ↓	(9) ↓
Sea Point	(6)	(6)	(6)	(6)	(6)	(6)
Sutton	(13) ↓	(13) ↓	(13) ↓	(13)	(13) ↓	(13) ↓
Wexford Harbour Outer	(2)	(2)	(2)	(2)	(2)	(2)

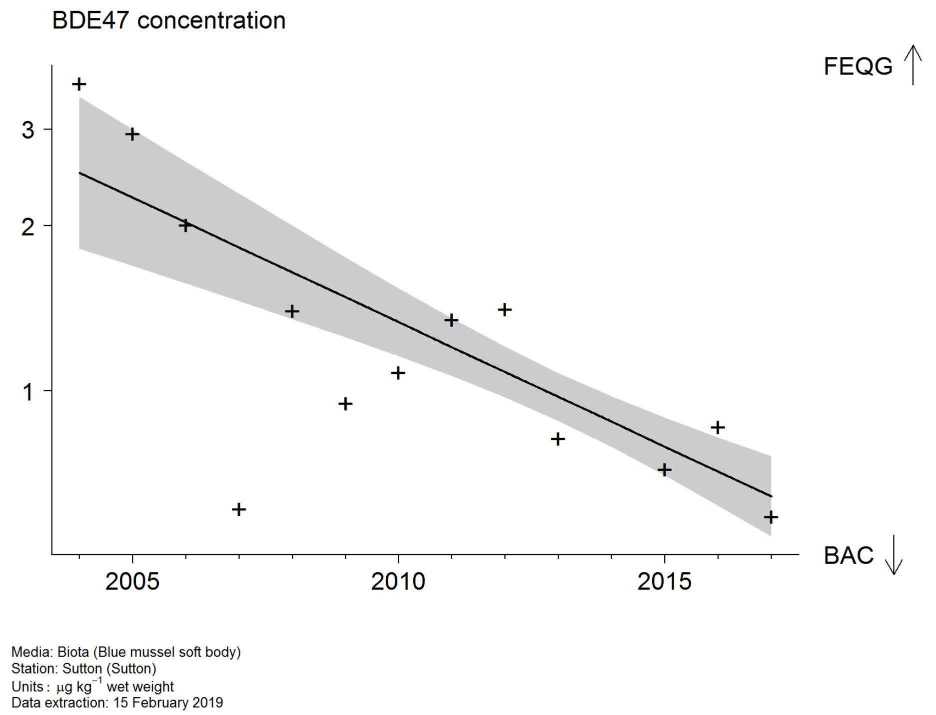


Figure 1: Temporal trend direction for PBDE 47 in mussels from Sutton

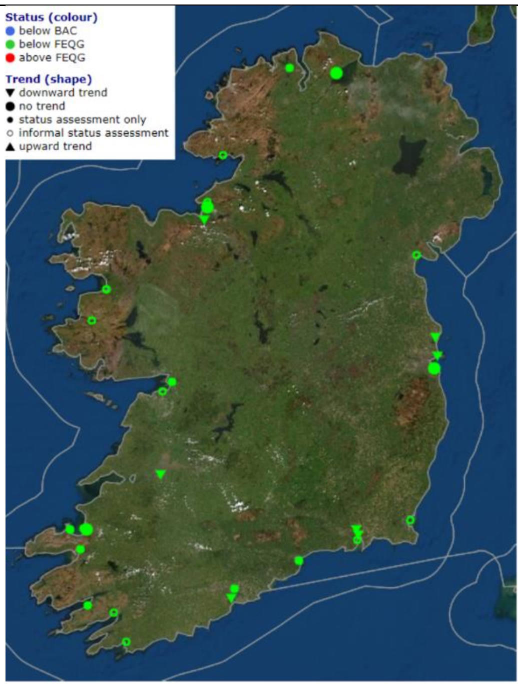


Figure 2: Example of OSPAR status for PBDE 47 in shellfish from Irish waters. https://ocean.ices.dk/ohat/

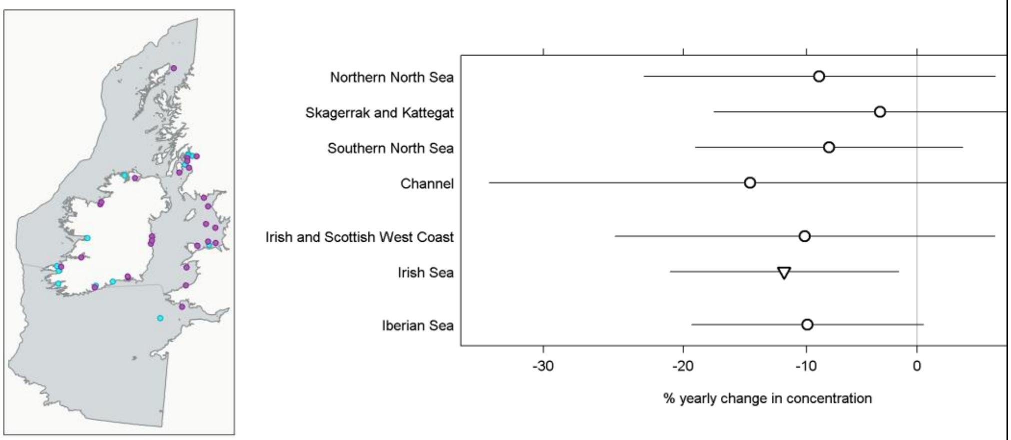


Figure 3: Regional trend monitoring stations and estimates detailing the percentage yearly change in averaged PBDE concentrations in shellfish (95% confidence intervals). Monitoring stations (purple = temporal trend. blue = status only).

Note: Downward triangles= the mean concentration is significantly decreasing ($p < 0.05$)
Circle = No significant change in mean concentration ($p > 0.05$)

Conclusion	OSPAR assessments indicate that PBDE in shellfish from Irish coastal waters are generally above background concentrations (OSPAR BAC) but predominantly within the OSPAR adopted FEQG thresholds. These assessments imply adverse effects on marine life would not be expected. For the most part trends are not detected but where they do occur, they are typically in a downward direction. Good Environmental Status has been achieved for PBDE concentration is biota in the Irish maritime area.
Knowledge gaps	Where there is no OSPAR EAC a Canadian FEQG is utilised in lieu of this. There is an inconsistency with the WFD EQS_{biota} for PBDEs in fish which needs to be resolved. The WFD EQS_{biota} is very conservative and presents analytical challenges. This is not currently applied in OSPAR assessments. The potential impact of cumulative effects of combinations of contaminants is unknown.
	Assessment Data
Data Sources	Monitoring is undertaken by the Marine Institute and reported to ICES database where it is used for OSPAR Joint assessment https://ocean.ices.dk/ohat/ OSPAR Assessment https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/contaminants/pbde-fish-shellfish/ OSPAR Intermediate assessment 2017 PBDES in biota References utilised in this assessment Alaee, M, Arias P, Sjödin A, Bergman, Å (2003) 'An overview of commercially used brominated flame-retardants, their applications, their use patterns in different countries/regions and possible modes of release' Environment International, 29(6): 683–689 de Wilt CA (2002) 'An overview of brominated flame retardants in the environment' Chemosphere 4(5): 583-624. European Food Safety Authority (2006) 'EFSA/WHO International Conference with support of ILSI Europe on Risk Assessment of

	Compounds that are both Genotoxic and Carcinogenic' Meeting Summary Report, 16-18 November 2005, Brussels, Belgium European Food Safety Authority (2011) 'Scientific Opinion on Polybrominated Diphenyl Ethers (PBDEs) in Food' Panel on Contaminants in the Food Chain (CONTAM), EFSA Journal 9(5):2156 Eriksson P, Fischer C, Fredriksson A (2006a) 'Polybrominated diphenyl ethers, a group of brominated flame-retardants, can interact with polychlorinated biphenyls in enhancing developmental neurobehavioral defects' Toxicological Sciences 94: 302-309 Eriksson P, Fischer C, Wallin M, Jakobsson E, Fredriksson A (2006b) 'Impaired behaviour, learning and memory, in adult mice neonatally exposed to hexabromocyclododecane (HBCDD)' Environmental Toxicology and Pharmacology, 21: 317-322 European Commission (2001a) 'Opinion of the Economic and Social Committee on the "Proposal for a Directive of the European Parliament and of the Council amending for the 24th time Council Directive 76/769/EEC relating to restrictions on the marketing and use of certain dangerous substances and preparations (pentabromodiphenyl ether)"'Official Journal of the European Union C 193, 10.7.2001, pages 27–28 European Commission (2001b) 'European Union Risk Assessment Report for diphenyl ether, pentabromo derivative (CAS-No.:32534-81-9; EINECS-No.: 251-084-2) European Commission (2003a) 'Directive 2003/11/EC of the European Parliament and of the Council of 6 February 2003 amending for the 24th time Council Directive 76/769/EEC relating to restrictions on the marketing and use of certain dangerous substances and preparations (pentabromodiphenyl ether, octabromodiphenyl ether)' Official Journal of the European Union L 42, 15.2.2003, pages 45–46 European Commission (2003b) 'European Union Risk Assessment Report for diphenyl ether, octabromo derivative (CAS-No.:32536-52-0, EINECS-No.: 251-087-9)' (Final approved version). Institute for Health and Consumer Protection- European Chemicals Bureau 2003 European Commission (2008a) 'Designation of the Chamber responsible for cases of the kind referred to in Article 104b of the

	rules of procedure of the Court of Justice' Official Journal of the European Union C116, 09.5.2008, Pages 2-2 European Commission (2008b) 'Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive)' Official Journal of the European Union L 164, 25.6.2008, pages 19-40 European Commission (2008c) 'Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC of the European Parliament and of the Council' European Commission (2009) 'Commission Regulation (EC) No 552/2009 of 22 June 2009 amending Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards Annex XVII (Text with EEA relevance)' Official Journal of the European Union L164, 26.2.2019, Pages 7-31 Fernie KJ, Shutt JL, Letcher RJ, Ritchie IJ, Bird DM (2009) 'Environmentally relevant concentrations of DE-71 and HBCD alter eggshell thickness and reproductive success of American kestrels' Environmental Science and Technology 43: 2124-30 Hutzinger O, Thoma H (1987) 'Polybrominated dibenzo-p-dioxins and dibenzofurans: the flame-retardant issue' Chemosphere 16: 1877–1880 Legler J (2008) 'New insights into the endocrine disrupting effects of brominated flame-retardants. Chemosphere' 73: 216-222 OSPAR Commission (2008) 'CEMP Assessment Manual. Co-ordinated Environmental Monitoring Programme Assessment Manual for contaminants in sediment and biota' OSPAR Publication 379/2008 ISBN 978-1-906840-20-4 OSPAR Commission (2009) 'Background Document on CEMP Assessment Criteria for QSR 2010' OSPAR Publication 461/2009. ISBN 978-1-907390-08-1

	OSPAR Commission (2017) 'Intermediate Assessment 2017'			
Data Locations (URL)	OSPAR assessment site (most recent) https://ocean.ices.dk/ohat/ OSPAR Assessment output 2019 https://ocean.ices.dk/ohat/?assessmentperiod=2019			
Data Time Line	Start Date:	2005	End Date:	2017
Point of Contact	Brendan McHugh/ Evin McGovern, Marine Institute			
Email	Brendan.mchugh@marine.ie; evin.mcgovern@marine.ie			

D8 C1 PCBs in Shellfish

Ref D8C1 a Rev 1	**Assessment Sheet: Status and Trends in the Concentrations of Polychlorinated Biphenyls (PCBs) in Shellfish** **MSFD Cycle 1: D8.1 - Concentration of contaminants** **MSFD Cycle 2: D8C1 (Element - PCB Concentrations in Biota)**
Key message	Concentrations of Polychlorinated Biphenyls (PCBs) in shellfish, sampled in Irish waters, are low. The concentrations encountered are below levels likely to harm marine species. Where significant trends are detected they are predominantly in a downward direction. This indicator is based on OSPAR Coordinated Environmental Monitoring Programme Assessment (2019).
Introduction / Objective	Monitoring for hazardous substances is risk based and primarily focused on coastal waters as most sources are terrestrial and marine sources are generally more concentrated in coastal waters (e.g. shipping concentrated around ports). If problems are not detected in inshore waters, monitoring is not widely extended beyond Irish coastal waters (which in themselves can reach near full ocean salinity) unless there is a specific risk factor (such as specific offshore sources). Polychlorinated Biphenyls are ubiquitous manmade substances that are persistent, toxic and can bioaccumulate. As part of the OSPAR Coordinated Environmental Monitoring Programme concentrations of PCBs are measured in shellfish (mussels and oysters) and data are reported to ICES and assessed according to OSPAR methodology. Concentrations were compared against relevant assessment criteria: the OSPAR Background Assessment Concentrations (BACs) and Environmental Assessment Criteria (EACs). EACs are assessment tools intended to represent the contaminant concentration in sediment and biota below which no chronic effects are expected to occur in marine species, including the most sensitive species. BACs are used to assess whether concentrations are near background values for naturally occurring substances. The OSPAR Hazardous Substances Strategy has the ultimate aim of achieving concentrations in the marine environment near background and close to zero for PCBs. Due to their persistence in the marine environment, their potential to bioaccumulate and their toxicity,

<table>
<tr><td></td><td>concentrations of PCBs in shellfish are reported in the OSPAR Coordinated Environment Monitoring Programme (CEMP).
Monitoring of PCBs in shellfish from Irish waters began in approximately 1995.</td></tr>
<tr><td>Drivers</td><td>See Pressures below for Anthropogenic and Natural pressures
Commission Directive 2017/845 activity themes: Urban and industrial uses.</td></tr>
<tr><td>Pressures</td><td>MSFD qualitative descriptors are linked to their key pressure elements via Commission Directive 2017/845 (amending Directive 2008/56/EC). Pressure via anthropogenic input of substances, litter and/or energy and specifically those from synthetic and non-synthetic substances via diffuse and point sources, atmospheric deposition and acute events are specifically identified as key pressures for GES descriptors 8 and 9.

Pathways to the marine environment are via riverine, atmospheric transport (including long range transport) and direct inputs.
PAH's are ubiquitous and persistent synthetic contaminants.</td></tr>
<tr><td>State</td><td>PCB in shellfish status
Concentrations of PCBs in shellfish were monitored at 33 stations with 309 individual PCB parameter assessments completed in accordance with OSPAR Coordinated Environment Monitoring Programme (CEMP) methodologies.
While PCB concentrations are above OSPAR background thresholds, 98.3% of datasets were lower than OSPAR EACs.

Figure 1: Summary assessment of PCB concentrations in shellfish from Irish waters in accordance with OSPAR Coordinated Environment Monitoring Programme (CEMP) methodologies.
<table>
<tr><th><BAC</th><th>>BAC <EAC</th><th>>EAC</th></tr>
<tr><td>146</td><td>135</td><td>5</td></tr>
<tr><td>51.0%</td><td>47.2%</td><td>1.7%</td></tr>
</table>
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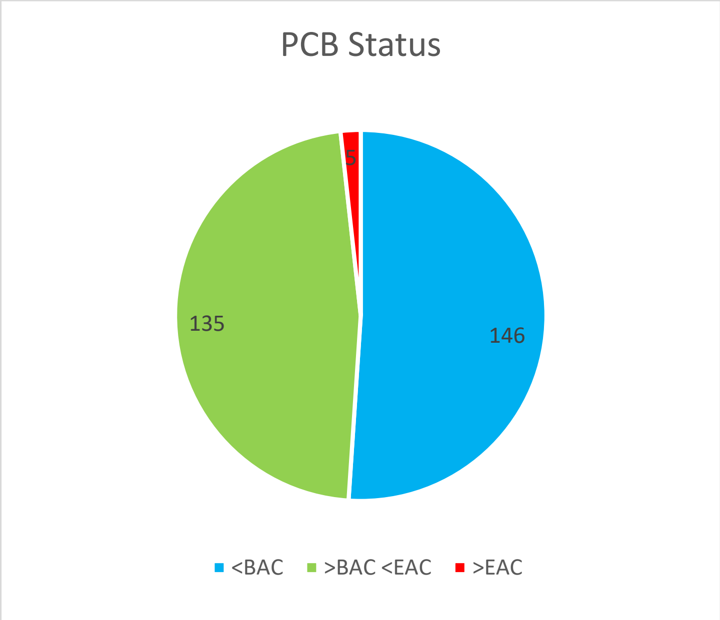

Table 1: Contaminant trend directions: individual parameters.

	Downward Trend	No measurable trend	Upward Trend	#Locations
CB101	14	19		33
CB105	8	25		33
CB118	9	24		33
CB126		6		6
CB138	12	21		33
CB153	8	25		33
CB156	1	32		33
CB169		6		6
CB180	3	29	1	33
CB28	8	25		33
CB52	9	24		33

Table 2: Summary Parameter Groups Trend direction. Number of occurrences and percentage in parenthesis.

	Downward Trend ↓	**No trend↔**	**Upward Trend↑**
CBs	72 (23.3)	236 (76.4)	1 (0.32)

Note: OSPAR temporal trend assessments can often be completed where sufficient monitoring data exist irrespective of the number of

	threshold values available. Full status assessments require both BAC and EAC (or equivalent) to be available. Consequently, this may result in a different number of individual parameter temporal and status assessments being available.
Impact	This is a state variable.
Conclusion	Concentrations of Polychlorinated Biphenyls (PCBs) in shellfish, sampled in Irish waters, are generally low. The concentrations encountered are below levels likely to harm marine species. Where significant trends are detected they are predominantly in a downward direction.
Assessment Result	PCB concentrations measured in shellfish are generally above background in all assessed sub-regions (Irish Sea, Celtic Seas and West Coast). With the exception of one location concentrations were below the EAC and therefore are unlikely to cause adverse effects in marine organisms. Overall PCB concentrations in shellfish were either stable or decreasing, with one single upward trend noted for PCB 180 noted from all locations assessed.
Knowledge gaps	Continued collaborative efforts are required to further develop threshold values for contaminants and their effects. The potential impact of cumulative effects of combinations of contaminants is unknown.
Background	Polychlorinated biphenyls (PCBs) are man-made chemical compounds that were banned in the mid-1980s owing to concerns about their toxicity, persistence, and potential to bioaccumulate in the environment. Since the 1980s, global action has resulted in big reductions in releases and remaining stocks have been phased out. However, despite European and global action, releases continue through diffuse emissions to air and water from building sites and industrial materials. Remaining sources include electrical and hydraulic equipment containing PCBs, waste disposal, redistribution

	of historically contaminated marine sediments and by-products of thermal and chemical industrial processes. PCBs do not break down easily in the environment and are not readily metabolised by humans or animals. PCBs accumulate in marine animals with greater concentrations found at higher trophic levels. PCB compounds are extremely toxic to animals and humans, causing reproductive and developmental problems, damage to the immune system, interference with hormones, and may also cause cancer. A sub-group of PCBs is 'dioxin-like', meaning they are more toxic than other PCB congeners. PCBs are included in the Stockholm Convention (UNEP, 2009) due to their persistence, bioaccumulation, and toxicity (PBT). The seven ICES (International Council for the Exploration of the Sea) PCBs (CB28, 52, 101, 118, 153, 138, and 180) were recommended for monitoring by the European Union Community Bureau of Reference; these are now recognised as ICES PCB indicator compounds. Levels and temporal trends of these seven PCB congeners are recognised indicators of wider PCB contamination due to their relatively high concentrations and toxic effects. The ICES-7 PCBs have been part of the OSPAR Coordinated Environmental Monitoring Programme (CEMP) since 1998.
Objective	Assess the spatial distribution, temporal trends and status of PCBs in shellfish (bivalve molluscs) from Irish marine waters according to OSPAR methodology and standards.
Drivers	See Brief Section
Pressures	Within the Irish MSFD area the pressures relating to Descriptor 8 come from the following activities: • Input of other substances (e.g. synthetic substances, non-synthetic substances) - diffuse sources, point sources, atmospheric depositions; • Inputs may be from land-based sources (riverine, direct discharge or atmospherically transported) or sea-based sources; • PCBs are globally ubiquitous due to long-range transport.

State	See Brief Section
Impact	See Brief Section
Assessment Method	This assessment was completed in accordance with OSPAR methodology. https://ocean.ices.dk/ohat/trDocuments/2019/help_methods_biota_chlorobiphenyls.html This assessment of data reported to OSPAR describes the trends and status of contaminant concentrations at biota monitoring stations around Irish waters and includes both temporal trend and status assessments using PCBs28, 52, 101, 118, 138, 153 and PCB180. In accordance with OSPAR methodologies individual time series of PCBs were assessed for status where: • there is at least one year with data in the period • there are at least 3 years of data over the whole time-series • a parametric model can be fitted to the data and used to estimate the mean concentration in the final monitoring year (or, occasionally, if a non-parametric test of status is applied). The time series was assessed for trends where: • there are at least 5 years of data over the whole time-series • a parametric model can be fitted to the data and used to estimate the trend in mean concentrations. • Information on how the individual time series are assessed for status and trends is available. For regional assessment, data from individual time series were combined and a summary measure of status or trend was obtained from each time series. Larger scale regional assessment only consider coastal and offshore stations and excludes estuarine stations. Full details of the individual methodologies are available at. https://ocean.ices.dk/ohat/trDocuments/2019/help_methods_biota_chlorobiphenyls.html

	https://www.ices.dk/sites/pub/Publication%20Reports/Techniques%20in%20Marine%20Environmental%20Sciences%20(TIMES)/TIMES53.pdf Assessment Criteria: Monitoring follows OSPAR Guidelines for monitoring contaminants in biota are available: https://www.ospar.org/work-areas/cross-cutting-issues/cemp The Initial Assessment (2013) target for contaminants states that ***"*Concentrations of substances identified within relevant legislation and international obligations are below the concentrations at which adverse effects are likely to occur (e.g. are less than Environmental Quality Standards applied within the Water Framework Directive (European Commission, 2000) and Environmental Assessment Criteria applied within OSPAR)**". Two assessment criteria, Background Assessment Concentration (BAC) and Environmental Assessment Criteria (EAC) have been used by OSPAR to assess PCB concentrations in biota (OSPAR Commission, 2008 and 2009b). Background Assessment Concentrations were developed by OSPAR for testing whether concentrations are near background levels. Mean concentrations significantly below the Background Assessment Concentration are said to be near background. Concentrations below the EAC should not cause any chronic effects on marine organisms. **Table 3.** Background Assessment Concentrations and Environmental Assessment Criteria available for chlorobiphenyls.

	BAC	**EAC**
	mussels and oysters	**all species**
CB28	0.75	67
CB52	0.75	108
CB101	0.70	121
CB105	0.75	NO EAC
CB118	0.60	25
CB138	0.60	317
CB153	0.60	1585
CB156	0.60	NO EAC
CB180	0.60	469

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- BAC units are in μg kg^{-1} dw for mussels and oysters, EAC units are μg kg^{-1} lw
- BACs and EACs are converted to other bases (wet, dry or lipid weight) using species-specific conversion factors. https://ocean.ices.dk/ohat/trDocuments/2019/help_ac_basis_conversion.html
- the EACs are based on partitioning theory and are sometimes known as EAC passive BACs and EACs are converted to other bases (wet, dry or lipid weight) using species-specific conversion factors in accordance with OSPAR methodologies.

Assessment criteria for PCBs in biota are available at:

https://ocean.ices.dk/ohat/trDocuments/2019/help_ac_biota_chlorobiphenyls.html
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<tr>
<td>Assessment Result (extended)</td>
<td>
PCB concentrations measured in shellfish are generally above background in all assessed sub-regions (Irish Sea, Celtic Seas and West Coast).

With the exception of one location, concentrations were below the EAC and therefore are unlikely to cause adverse effects in marine organisms.

Overall PCB concentrations in shellfish were either stable or decreasing, with one single upward trend noted for PCB 180 noted from all locations assessed.
</td>
</tr>
<tr>
<td>Results</td>
<td>
Table 4: Status assessment and temporal trend direction for individual PCBs in shellfish (mussel and oysters) from Irish waters. Key: Number in brackets is number of years for which data points are available.
Blue = final year “at background” (<BAC), Green final year within OSPAR EAC (>BAC <EAC), Red final year does not meet OSPAR EAC
↑/↓. Arrows indicate upward/downward significant trend. No arrow means no significant trend or trend not assessed (<5 year’s data).
<table>
<tr><td><BAC</td><td>>BAC <EAC</td><td>>EAC</td><td>NO EAC</td></tr>
</table>
</td>
</tr>
</table>

Station	CB101	CB105	CB118	CB138	CB153	CB156	CB180	CB28	CB52
Cork Harbour North Channel	(4)	(4)	(5)	(5)	(5)	(4)	(5) ↑	(5)	(5)
Cromane	(11)	(10)	(11)	(10)	(11)	(7)	(10)	(10)	(9)
Glengariff	(9) ↓	(8) ↓	(9)	(8) ↓	(9) ↓	(8)	(9)	(8)	(7)
Kilmakillogue	(12) ↓	(11) ↓	(12) ↓	(11) ↓	(12) ↓	(8)	(10)	(11)	(10)
Ringaskiddy	(21) ↓	(20) ↓	(22) ↓	(21) ↓	(21) ↓	(19) ↓	(20) ↓	(21) ↓	(21) ↓
Roaringwater Bay Inner	(7)	(8)	(8)	(8)	(9)	(8)	(6)	(9)	(9)
Aughinish Bay	(11) ↓	(10)	(11) ↓	(10) ↓	(11) ↓	(4)	(11)	(10)	(10)
Ballysadare Bay	(6)	(6)	(8)	(8)	(8)	(7)	(6)	(8)	(6)
Bruckless	(8) ↓	(7) ↓	(8)	(7)	(8)	(6)	(8)	(8) ↓	(8) ↓
Clarenbridge	(4)	(3)	(4)	(4)	(4)	(2)	(3)	(3)	(4)
Clew Bay South	(4)	(3)	(4)	(4)	(4)	(4)	(4)	(4)	(3)
Clew Bay South	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Drumcliff	(4)	(4)	(4)	(3)	(4)	(2)	(4)	(4)	(4)
Fenit	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Killary Harbour Inner	(10) ↓	(9) ↓	(10) ↓	(10) ↓	(10) ↓	(2)	(10) ↓	(9)	(8) ↓
Maharees	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Maharees	(7) ↓	(7)	(5) ↓	(6)	(7)	(4)	(6)	(6) ↓	(6)
Mulroy Bay - Broadwater	(8)	(6) ↓	(8)	(8)	(8)	(7)	(8)	(8) ↓	(8) ↓
Quigleys Point	(14) ↓	(11) ↓	(14) ↓	(14)	(14)	(11)	(13)	(13) ↓	(13) ↓
Quigleys Point	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Rosses Point	(8) ↓	(9)	(9)	(8) ↓	(8)	(9)	(8) ↓	(8)	(8)
Shannon Estuary - Aughinish South	(15) ↓	(14)	(16)	(15) ↓	(15)	(14)	(15)	(13)	(15)
Tralee Bay Inner	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Tralee Bay Inner	(11) ↓	(12) ↓	(12) ↓	(11) ↓	(12) ↓	(8)	(12)	(11)	(10)
Arthurstown	(18)	(17)	(19)	(18) ↓	(18)	(17)	(18)	(17)	(18) ↓

Cheekpoint	(8)	(7)	(8)	(8)	(8)	(7)	(8)	(8)	(8)
Duncannon	(2)	(4)	(4)	(3)	(4)	(4)	(4)	(4)	(4)
Dundalk Bay Inner	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Dungarvan Bay	(11) ↓	(9)	(12) ↓	(11) ↓	(12)	(8)	(12)	(12) ↓	(12) ↓
Rogerstown Estuary	(10)	(10)	(11)	(10)	(10)	(10)	(10)	(10)	(9)
Sea Point	(6)	(3)	(6)	(6)	(6) ↓	(3)	(6)	(6)	(6)
Sutton	(19) ↓	(18)	(20)	(19) ↓	(19) ↓	(18)	(19)	(18) ↓	(19) ↓
Wexford Harbour Outer	(15) ↓	(15)	(15) ↓	(14) ↓	(15)	(15)	(15)	(14) ↓	(12) ↓

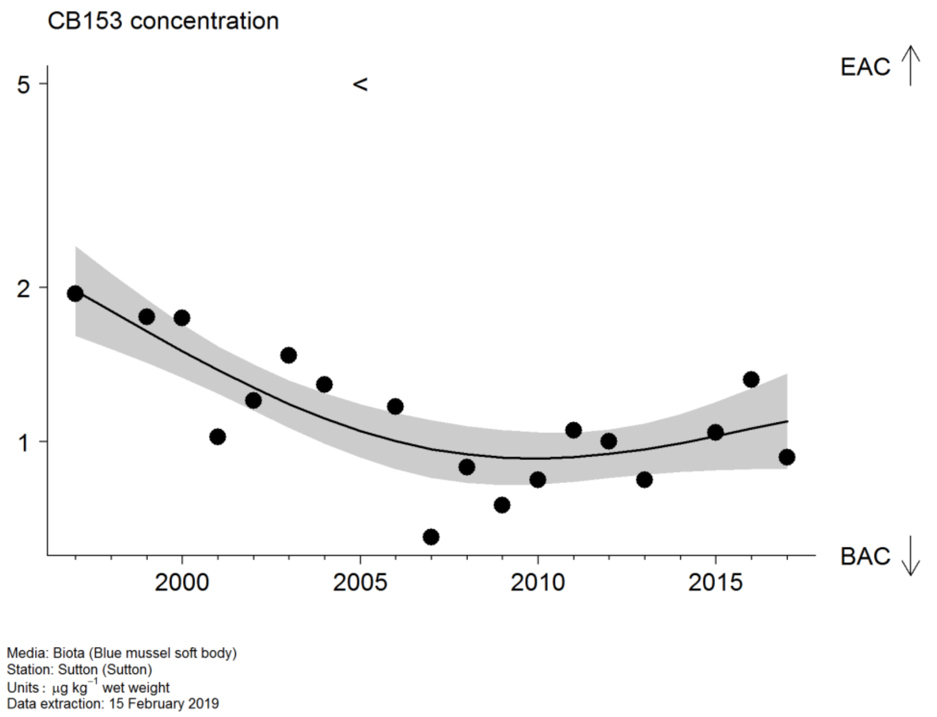

Figure 2: Example of temporal trend assessment plot of PCB153 in mussels from Sutton

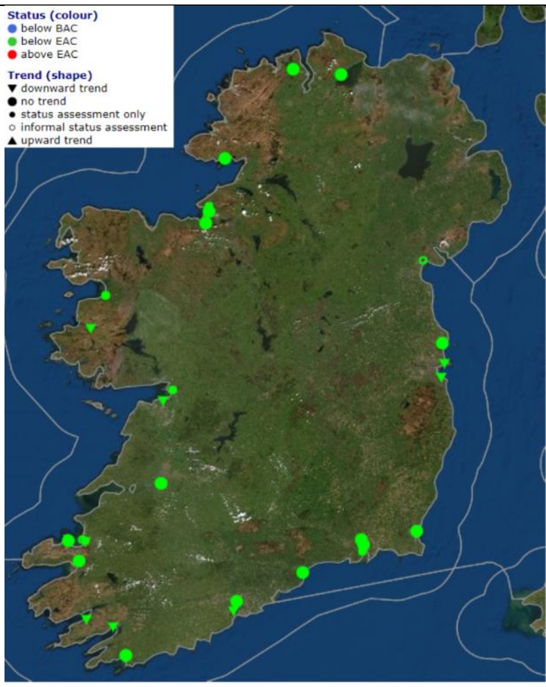

Figure 3: Example of OSPAR status for PCB153 in shellfish from Irish waters.

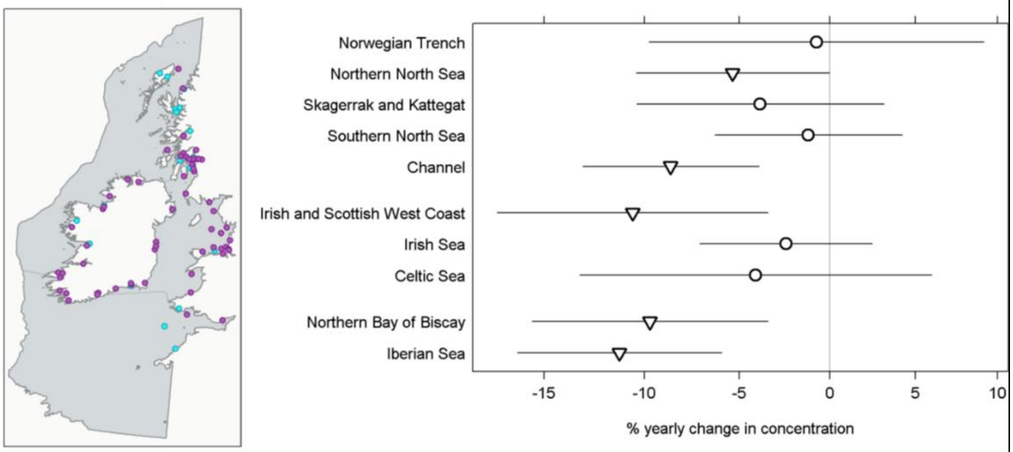

Figure 4: Regional trends for monitoring stations and estimates detailing the percentage yearly change in averaged PCB concentrations in shellfish (95% confidence intervals). Monitoring stations (purple = temporal trend. blue = status only).

Note: Downward triangles= the mean concentration is significantly decreasing ($p < 0.05$)
Circle = No significant change in mean concentration ($p > 0.05$)

Conclusion	More than 25 years after PCBs were banned the majority of PCB concentrations in shellfish from around the Irish coastline have

	decreased to acceptable ecological concentrations. With the exception of the most toxic PCB congener (CB118) at a few stations, concentrations of PCBs in shellfish are below the level at which they are expected to present an unacceptable risk to the environment. While concentrations of CB118 in biota are above this level, temporal trends are generally in a downward direction. Adverse effects on marine organisms may still be possible in these areas.			
Knowledge gaps	While PCB use has been discontinued, they are likely to continue to enter the marine environment through secondary sources. Further research is required to define and quantify inputs and their potential for deleterious effects, particularly in higher trophic level species. Continued collaborative efforts are required to further develop threshold values for contaminants and their effects. The potential impact of cumulative effects of combinations of contaminants is unknown.			
	Assessment Data			
Data Sources	Monitoring is undertaken by the Marine Institute and reported to ICES database where it is used for OSPAR Joint assessment https://ocean.ices.dk/ohat/ OSPAR Assessment https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/contaminants/pcb-fish-shellfish/ OSPAR Intermediate Assessment 2017 PCBs in biota			
Data Locations (URL)	OSPAR assessment site (most recent) https://ocean.ices.dk/ohat/ OSPAR Assessment output 2019 https://ocean.ices.dk/ohat/?assessmentperiod=2019			
Data Time Line	Start Date:	1995	End Date:	2017
Point of Contact	Brendan McHugh/ Evin McGovern, Marine Institute			
Email	Brendan.mchugh@marine.ie; evin.mcgovern@marine.ie			

D8 C1 WFD

Ref D8C1 Rev 1	Assessment Sheet: Concentrations of Priority Substances and other Specific Pollutants for Transitional and Coastal (TraC) Waters for the monitoring cycle 2011 to 2015 MSFD Cycle 1: D8.1 - Concentration of contaminants
Key message	WFD chemical status was assessed for 12 coastal and 30 transitional water bodies. Specifically, compliance with Environmental Quality Standards for priority substances and priority hazardous substances that are listed in the WFD (Annex X) and the Environmental Quality Standards (EQS) Directive (2008/105/EC). Of the 42 water bodies assessed in 2010–2015 only the Avoca estuary was deemed to have failed to meet the Good Status Objective under the WFD.
Drivers	The drivers of contaminant inputs to the marine environment as described in Commission Directive 2017/845 include: • Urban and industrial uses, include waste treatment and disposal; • Production of energy; • Extraction of non-living resources; • Transport.
Pressures	Within the Irish maritime area the pressures relating to Descriptor 8 come from the following activities: • Input of other substances (e.g. synthetic substances, non-synthetic substances) - diffuse sources, point sources, atmospheric depositions; • Inputs may be from land-based sources (riverine, direct discharge or atmospherically transported) or sea-based sources. Some pollutants of concern such as many synthetic Persistent Organic Pollutants (POPs) are globally ubiquitous due to long-range transport.

<table>
<tr><td>State</td><td>Of the 42 water bodies assessed in 2010–2015 only the Avoca estuary was deemed to have failed to meet the Good Status Objective under the WFD (i.e. not comply with EQS_{water} as set in Directive 2008/56/EC). This indicates that, in absence of significant sea-based sources or transboundary sources, the offshore Irish maritime area is compliant with EQS assessed.

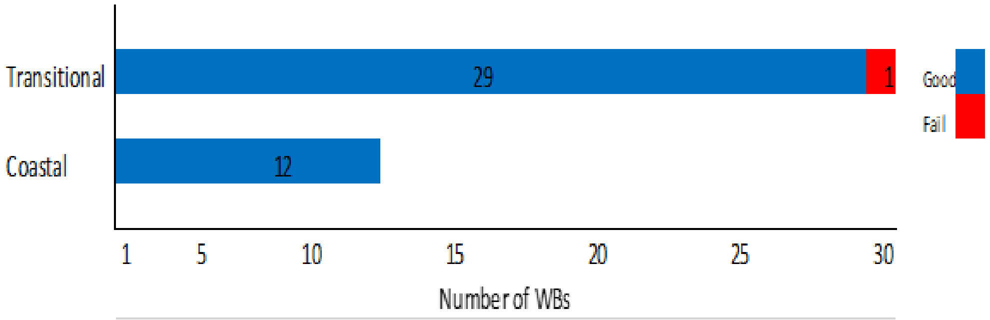

Figure 1: Summary of chemical status assessment in 42 coastal and transitional waterbodies between 2010 and 2015.</td></tr>
<tr><td>Conclusion</td><td>Of the 42 water bodies assessed in 2010–2015 only the Avoca estuary was deemed to have failed to meet at least good status objective.

Concentrations of priority substances otherwise meet agreed target thresholds (EQS).

Highly persistent ubiquitous legacy chemicals are detected, mainly in coastal waters close to polluted sources.</td></tr>
<tr><td>Assessment Result</td><td>Only one of the 42 water bodies assessed in 2010–2015 failed for parameters that aren't ubiquitous, and this was the Avoca estuary which saw breaches of the EQS for copper, zinc and cadmium, which is unsurprising given its mining history and the naturally elevated concentrations of these metals in the catchment to this estuary.</td></tr>
<tr><td>Knowledge gaps (brief)</td><td>The potential impact of cumulative effects of combinations of contaminants is unknown and not considered as part of individual EQS assessments.

For some substances the available analytical capability is not sufficiently sensitive to enable assessment of compliance.

Revised EQS and additional EQS including new EQS_{biota} will be applied for assessment of 2016-2021 cycle (Directive 2013/39). Some of these EQS are lower than those in Directive 2008/105/EC.</td></tr>
</table>

Background	The European Water Framework Directive (WFD Directive 2000/60/EC) requires Member States to achieve good surface water quality status for inland, transitional and coastal (TrAC) waters by the year 2015 and to prevent deterioration of water body status. This requires monitoring to assess Ecological Status of the water bodies, i.e. status of certain biological elements and physico-chemical elements, reflecting general conditions and also pollution by specific substances. Member States must report on Chemical Status which requires assessing compliance with Environmental Quality Standards (EQS) set in Directive 2008/105/EC (WFD Annex X substances – Priority Substances (PS), some of which are designated as Priority Hazardous Substances (PHS)). This chemical status assessment covers the monitoring cycle for the Water Framework Directive in the period 2010 to 2015 was undertaken in cooperation with/on behalf of the Environmental Protection Agency (EPA) and the then Department of the Environment, Community and Local Government (DECLG). **Chemical Status**: For each of the priority substances (Annex X) and certain other pollutants (Annex IX) the WFD requires **an Environmental Quality Standard (EQS)** for each priority substance that will separate the two chemical status classes 'good' and 'failing to achieve good' set out in the Directive. Failure **to achieve one of these standards** will mean failure to achieve good chemical status. Water EQS are set as Annual Average concentrations (AA-EQS) and/or Maximum Allowable Concentrations(MAC-EQS). Note the MSFD does not operate a 'one out all out' basis like the WFD. Note additional priority substances and revised EQS (Directive 2013/39/EC) were not in force for the WFD 2009 – 2015 monitoring cycle. The assessment of WFD for priority substances and other pollutants contributes to the MSFD assessment and provides a key element in a risk based monitoring programme under Descriptor 8. As the primary sources for priority substances is terrestrial, and in the absence of significant specific offshore or transboundary sources, there is no requirement to assess EQS compliance for offshore marine waters if coastal waters are determined to be compliant.

Objective	Assess chemical status for contaminants in water samples from transitional and coastal water bodies according to the WFD methodology and standards set in EC Directive 2008/105.
Drivers (Activities)	The drivers of contaminants inputs to the marine environment as described in Commission Directive 2017/845 include: • Urban and industrial uses, include waste treatment and disposal; • Production of energy; • Extraction of non-living resources; • Transport.
Pressures	Within the Irish maritime area the pressures relating to Descriptor 8 come from the following activities: • Input of other substances (e.g. synthetic substances, non-synthetic substances) - diffuse sources, point sources, atmospheric depositions; • Inputs may be from land-based sources (riverine, direct discharge or atmospherically transported) or sea-based sources. Some pollutants of concern such as many synthetic Persistent Organic Pollutants (POPs) are globally ubiquitous due to long-range transport.
State	Of the 42 water bodies assessed in 2010–2015 only the Avoca estuary was deemed to have failed to meet the Good Status Objective under the WFD (i.e. not comply with EQS_{water} as set in Directive 2008/56/EC). This indicates that, in absence of significant sea-based sources or transboundary sources, the offshore Irish maritime area is compliant with the EQS assessed.
Impact	This indicator sheet is focused on concentrations of contaminants and compliance to the standards and WFD methodology set in EC Directive 2008/105.
Assessment Method	**Priority substances and other specific pollutants - 2011 – 2015** Sites monitored during the 2010 to 2015 cycle are presented in Table 1 and Figure 2. The sampling schedules were in accordance with the

	monitoring plan agreed with the EPA and the DECLG in 2010. Sampling was divided over a three-year period (see Table 1 and Figure 2). A comprehensive quality assurance programme in place at the MI covered all aspects including sampling, field data collection, laboratory testing and data management. **Water Bodies and Sites**: The Marine Institute (MI) program was designed to combine the overall sampling requirements for WFD PS/RP, SWD and phytoplankton monitoring. WFD operational and surveillance monitoring for PS/RPs targeted the transitional and coastal water bodies listed in Table 1. These water bodies show widely varied characteristics, with salinity ranging from essentially freshwater in upper tidal reaches (S~ 0.1) to oceanic (S > 35) in large exposed coastal water bodies. Given the high cost of sampling and testing only one PS/RP sampling station is selected for each water body regardless of the water body characteristics. Sampling programme locations are reported in Table1 and Figure 1. **Frequency:** For PS surveillance monitoring (water), annex V of the WFD requires sampling 12 times a year to identify seasonal inputs, during one year of the monitoring cycle, unless a lower frequency can be justified. **Sample Analysis:** The monitoring plan combined analysis carried out at the MI where the methods are available, and those subcontracted using external support for other tests. Directive 2009/90 requires that method LoQ should be at least 0.3 x EQS with an uncertainty of <50% at the EQS. For many of the EQS in TCW, best standard methods available are unlikely to achieve this requirement.

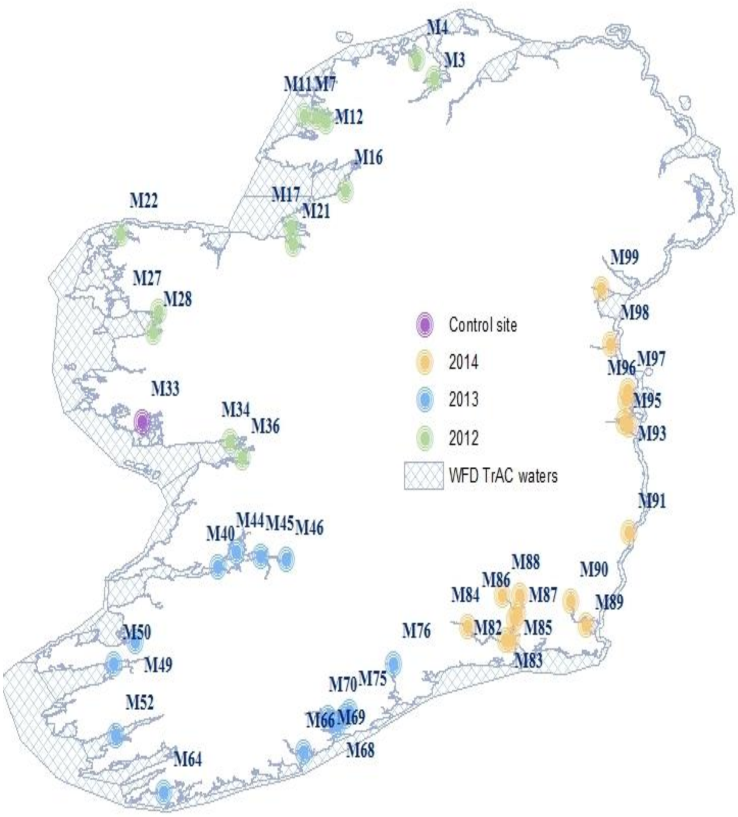

Figure 2: WFD sampling stations. The colour code indicates target year for annual water sampling for Priority Substances and other Specific Pollutants on a monthly basis.

Table 1: WFD Monitoring station locations for priority substances and other specific pollutants, and matrices sampled per station 2011-2014.

MI Code	County	Latitude	Longitude	WFD Water body	Water Samples collected [1]
M3	Donegal	55.0591	-7.5579	**Swilly Estuary**	**12**
M4	Donegal	55.1535	-7.6835	**Mulroy Bay Broadwater**	**12**
M7	Donegal	54.8709	-8.5007	**Northwestern Atlantic Seaboard**	**12**
M11	Donegal	54.8691	-8.417	**Gweebarra Bay**	**12**
M12	Donegal	54.84	-8.35	**Gweebarra Estuary**	**12**
M16	Donegal	54.5044	-8.2087	**Erne Estuary**	**12**
M17	Sligo	54.3189	-8.6044	**Sligo Bay**	**12**
M21	Sligo	54.2355	-8.5889	**Ballysadare Bay**	**12**
M22	Mayo	54.2866	-9.8464	**Broadhaven Bay**	**12**
M27	Mayo	53.9025	-9.572	**Furnace Lough**	**12**
M28	Mayo	53.7955	-9.6017	**Westport Bay**	**12**
M33	Galway	53.351	-9.6892	**Kilkeiran Bay**	**36**
M34	Galway	53.2506	-9.0495	**Corrib Estuary**	**12***
M36	Galway	53.1666	-8.9565	**Kinvarra Bay**	**12**
M40	Limerick	52.6268	-9.1349	**Shannon Estuary Lower**	**12**
M44	Clare	52.6999	-9.0011	**Fergus Estuary**	**12**
M45	Limerick	52.6808	-8.8203	**Upper Shannon Estuary**	**12**
M46	Limerick	52.6619	-8.6351	**Limerick Dock**	**12**
M49	Kerry	52.2564	-9.7392	**Lee K Estuary**	**12**
M50	Kerry	52.1402	-9.8991	**Cromane**	**12**
M52	Kerry	51.7888	-9.8771	**Kenmare River Outer Stn 1**	**12**
M57	Kerry	51.8141	-9.841	**Drongawn Lough, Sneem**	**3***
M64	Cork	51.5037	-9.5278	**Roaringwater Bay Outer Stn 1**	**12**
M66	Cork	51.7023	-8.5142	**Lower Bandon Estuary**	**12**
M68	Cork	51.8366	-8.2633	**Cork Harbour**	**12**
M69	Cork	51.8778	-8.3361	**Lough Mahon**	**12**
M70	Cork	51.8817	-8.204	**North Channel Great Island**	**12**
M75	Cork	51.9056	-8.1758	**Owenacurra Estuary**	**12**
M76	Cork	52.146	-7.854	**Upper Blackwater M Estuary**	**12**
M78	Waterford	52.1522	-69488	**Waterford Harbour Stn 1**	**12**
M82	Waterford	52.2584	-6.9916	**Barrow Suir Nore Estuary**	**12**
M83	Waterford	52.258	-7.0364	**Lower Suir Est Cheekpoint**	**12**

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M84	Waterford	52.328	-7.316	**Upper Suir Estuary**	**12**
M85	Wexford	52.3674	-6.972	**New Ross Port**	**12**
M87	Wexford	52.4881	-6.948	**Upper Barrow Estuary**	**12**
M88	Kilkenny	52.4865	-7.063	**Nore Estuary**	**12**
M89	Wexford	52.3354	-6.4487	**Lower Slaney Estuary**	**12**
M90	Wexford	52.454	-6.561	**Upper Slaney Estuary**	**12**
M91	Wicklow	52.7932	-6.1407	**Avoca Estuary**	**12**
M93	Dublin	53.3333	-6.137	**Dublin Bay Stn 2**	**12**
M95	Dublin	53.3448	-6.1764	**Liffey Estuary Lower**	**12**
M96	Dublin	53.4593	-6.1581	**Broadmeadow Water**	**12**
M97	Dublin	53.5025	-6.1444	**Rogerstown Estuary**	**12**
M98	Louth	53.7318	-6.2688	**Boyne Estuary**	**12**
M99	Louth	54.0086	-6.3411	**Inner Dundalk Bay**	**12**

Colour code sampling year Green = 2011, Blue = 2012 and Orange =2014. Kilkieran Bay sampled as a reference location 2011 to 2014. WFD monitoring is completed on a geographically based sampling program with coverage of all designated sampling points within the monitoring cycle. Kilkieran Bay has been designated as a reference location and is sampled monthly throughout the full extent of this program.
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Assessment Result	**Trace Metals in water** Mercury is a ubiquitous pollutant occurring naturally in the environment. Annual average dissolved total mercury (PHS) concentrations in seawater were compliant with the AA-EQS (0.05µg/L) at all stations sampled for water between 2012 - 2014. MAC-EQS were exceeded on only a total of 3 individual occasions, namely at stations in Mulroy Bay Broadwater (Station M4 June 2012: 0.22 µg L^{-1}), Broadhaven Bay (Station M22 Dec. 2012: 0.078 µg $L^{-1)}$ and one station in 2013 at Roaringwater Bay (Station M64 March 2013: 0.276 µg L^{-1}). While these three results exceed the MAC-EQS the exceedances were categorised as being of lower confidence and thus the three locations were consequently assessed as being compliant. In 2014, Station M91 Avoca Estuary, failed the AA- EQS for cadmium (PHS). Average cadmium concentrations of 11 results available (0.232 µg/L), exceed the AA-EQS of 0.2 µg/L. No exceedances of the MAC-EQS (0.45 µg/L) were observed- however average values have

	deemed it non-compliant. Recorded concentrations were considerably high relative to all other WFD sites sampled on the east coast. No other sample across all 45 WFD stations exceeded the MAC or AA set for cadmium. Other PS, nickel and lead concentrations did not exceed the AA-EQS set (20 µg/L and 7.2 µg/L respectively) at any of the 45 WFD stations sampled over the period of 2012 to 2014. Concentrations were deemed to be compliant with the reduced EQS for nickel and lead introduced by Directive 39/2013. However, LOQs were insufficiently low to enable an assessment of PAH EQS as established in that directive. **Organic substances in water** There were trace detections for some polyaromatic hydrocarbons (PAH) measured in water {PHS: –anthracene, benzo(*a*)pyrene, benzo(*b*+*k*) fluoranthene; and PS:- fluoranthene, naphthalene} in 2012 from water sampled in the North to West. Benzo(*a*)pyrene and fluoranthene were detected in samples mainly Upper Shannon Estuary and Fergus Estuary, Owenacurra Estuary, North Channel Island and Lough Mahon, from the Upper to Lower Suir Estuary, Upper to Lower Slaney Estuary, and Rogerstown Estuary. Detection of PAHs is not unexpected due to the relatively impacted nature of these sites (port, ships, anthropogenic effects, close to population agglomerations. However these monitoring results all complied with statutory AA-EQS and where available MAC-EQS. In the case of the sum of benzo(*ghi*)perylene + indeno (*1,2,3 cd*)-pyrene the reported LOQ (0.005 µg/L) exceeded the very low AA-EQS (0.002 µg/L), thus could not be assessed relative to the relevant EQS threshold. Volatile Organic Compounds in water {Benzene, trichlorobenzenes, dichloroethane, dichloromethane (all PS)} were generally < LOQ with only <2% detections returned for dichloromethane, and only one single detection in 12 samples at (Station M97 Rogerstown Sept 2014 0.1 µg/L) for benzene. It should be noted that this detection was extremely low relative to the MAC-EQS of 50 µg/L. All reported values were deemed compliant with AA-EQS. Alkylphenols {4-nonylphenol (PHS) and 4 octylphenol (PS)} were not detected (< 0.01 µg/L) across all WFD sites sampled 2012-2014

	showing compliance with their set AA - EQS of 0.3 and 0.01 µg/L, respectively. DEHP (PS) was detected in approximately 7% of samples but with annual averages below AA-EQS. DEHP is a substance present in many materials and difficult to fully control for in environmental sampling and testing. It is possible that some of the reported values relate to sampling or testing artefacts. The PS pesticides diuron, atrazine and simazine were not detected in any of the water samples and, as the detection capabilities for the methods are well below the AA-EQS, these are reported as compliant for all WFD water bodies sampled.
Conclusion	Chemical status for Irish coastal and transitional waters (2011-2015) was assessed by evaluating compliance of contaminants measured in water with Environmental Quality Standards (Directive 2008/105/EC) for priority substances and priority hazardous substances that are listed in the WFD (Annex X). These priority substances and priority hazardous substances include metals, pesticides and various industrial chemicals. The monitoring of these is undertaken by the Marine Institute on behalf of the EPA, and is in line with WFD methodology. In the current assessment period, 12 coastal and 30 transitional water bodies were assessed for compliance. Sampling is undertaken monthly on a rolling cycle so that each water body has at least one year's monthly data for assessment over the six-year period. Consequently, **only one of the 42 water bodies assessed in 2010–2015 failed for parameters that aren't ubiquitous,** and this was the **Avoca estuary** which saw breaches of the EQS for copper, zinc and cadmium, which is unsurprising given its mining history and the naturally elevated concentrations of these metals in the catchment to this estuary. This indicates that, in absence of significant sea-based sources or transboundary sources, the offshore Irish marine area is compliant with EQS assessed
Knowledge gaps	The potential impact of cumulative effects of combinations of contaminants is unknown and not considered as part of individual EQS assessments.

	For some substances the available analytical capability is not sufficiently sensitive to enable assessment of compliance. Revised EQS and additional EQS including new EQS biota will be applied for assessment of 2016-2021 cycle (Directive 2013/39). Some of these EQS are lower than those in Directive 2008/105/EC.			
	Assessment Data			
Data Sources	Monitoring is undertaken by the Marine Institute and reported to the ICES database https://www.epa.ie/pubs/reports/water/waterqua/waterqualityinireland2010-2015.html			
Data Locations (URL)	http://doi.org/dst5			
Data Time Line	Start Date:	2011	End Date:	2015
Point of Contact	Brendan McHugh/ Evin McGovern. Marine Institute			
Email	Brendan.mchugh@marine.ie; evin.mcgovern@marine.ie			

D8 C2

Ref D8C2	Assessment Sheet: Status and trends on the levels of imposex in marine gastropods. MSFD Cycle 1: D8.1 - Concentration of contaminants MSFD Cycle 2: D8C2 (Effects on biota: Imposex in marine gastropods.)
Key message	Historic application of tributyltin (TBT) containing antifouling paints to prevent biological growth on marine vessels and structures is now unequivocally linked in bringing about reproductive impairment (i.e. the superimposition of male genitalia) in female dogwhelks (*Nucella lapillus L*.), via the condition of imposex. A 2018 imposex status assessment concluded that levels of imposex in dogwhelks, associated with TBT contamination, have decreased dramatically in recent years following the banning of TBT and are for the most part now within background range, with only very few indications of problems remaining (>OSPAR Ecological Quality Objectives (EcoQO)). The improvement in reproductive condition in dogwhelks following the banning of TBT as a marine antifoulant demonstrates that measures taken nationally and internationally to phase out known toxic substances can be very effective in reducing marine pollution. Good Environmental Status has been achieved for the Effects on biota: Imposex in marine gastropods.
Introduction / Objective	Antifouling paints have been extensively used to prevent biological growth on marine vessels and structures (Dafforn et al., 2011). By the 1980s it was realised that paints containing tributyltin (TBT) were affecting certain non-target organisms (Alzieu 1982) with TBT now recognized as being extremely toxic to many marine organisms, and in particular has been unequivocally linked to being a cause of the masculinisation of female gastropods. Dogwhelks (*Nucella lapillus* see Figure 1) are particularly sensitive to TBT even at very low levels of exposure, developing a condition known as imposex, whereby the females develop male sex organs and ultimately become sterile. Over a number of decades, national, EU and International Maritime Organisation (IMO) measures have resulted in the phasing out of paints containing TBT in the OSPAR Maritime Area with a global ban on TBT in antifouling systems on large vessels coming into effect in 2008. Imposex is presently the only “biological effect” target and

	associated indicator (8.2.1) currently used by Ireland under MSFD (http://cdr.eionet.europa.eu/ie/eu/msfd8910/acsie/envuwsbg). TBT is also on the OSPAR Convention's list of Substances for Priority Action (OSPAR, 2011) and monitoring in relation to TBT- specific biological effects have been carried out for a number of decades throughout the OSPAR maritime area. The objective of this indicator is to demonstrate continued reduction of levels of TBT in the marine environment, so that the exposure of marine gastropods and adverse imposex effects remain below agreed OSPAR Environmental Assessment Criteria (EAC) and ultimately reduction to 'close to zero' levels.  **Figure 1:** The dog whelk Nucella lapillus in its natural environment.
Drivers	Human related activities are the most relevant in terms of TBT/organotin in the marine environment, including; • Leaching from antifouling from ships, and sea based structures, diffuse sources. • Remobilisation of historically contaminated sediments and dumped dredged materials from harbours. • OSPAR riverine inputs No emissions of organotins to ambient air, consequently atmospheric deposition of organotins is not considered relevant. Organotins are not part of OSPAR Common Atmospheric Monitoring Programme CAMP.

Pressures	• Antifouling (tributyltin and triphenyltin): leaching/eroding from antifouling used on underwater structures and ships and discharges from docking activities; • Shipbuilding and ship repair yards can constitute a major point source of tributyltin in coastal areas; • disposal of harbour sediments contaminated with organic tin compounds industrial discharges from production/formulation of all organic tin compounds; • potential for agricultural releases from the use of triphenyltin in potato growing; • tributyltin compounds used for wood conservation: application, leaching, dumping of conserved wood as waste; • antiseptic or disinfecting use of tributyltin compounds e.g. textiles • dibutyltin compounds as stabiliser in plastics and as catalytic agents in soft foam production; • atmospheric deposition of organic tin compounds; Not considered to be a major source.
State	Temporal trend assessment completed using over 20 years of imposex data revealed that while little change in imposex was evident up to 2005, there was a substantial and significant improvement noted thereafter, this generally reflecting the findings of similar recent studies throughout Europe. The absence of upward trends indicates that only a limited input still remains linked to very local situations While some “hot-spots” still exist the survey notes that over 95% of the sites were deemed to meet the EcoQO (Vas Deferens Sequence Index (VDSI) < 2) threshold with the majority of sites assessed as being at “background” in accordance with OSPAR’s criteria indicating that the majority of individual sampling sites do not indicate significant TBT contamination. This current status exhibits a marked improvement in imposex over the last decade with almost all locations found to be at or close to background exhibiting little evidence of imposex. While a few locations still exhibit some problem levels of imposex, it is clear that improvement is also evident at these locations.

	The improvement in reproductive condition in dogwhelks following the banning of TBT as a marine antifoulant demonstrates that measures taken nationally and internationally to phase out known toxic substances can be very effective in reducing marine pollution.
Impact	Tributyltin compounds are considered to be the most hazardous of all tin compounds, evidence to show; shell malformations of oysters, imposex in marine snails, reduced resistance to infection (e.g. in flounder), effects on the human immune system. At a local level organotin compounds cause most concern in marine environments (where they are most widely used). Some organotins are very toxic to algae, molluscs, crustacean, fish and some marine mammals. The effects include damage to the immune system and, for marine mammals, the hormone system (which is essential for the proper function of the body). Organotins can accumulate in fish, animals and plants and can concentrate up the food chain. Marine snails are extremely sensitive to harmful effects of TBT, developing non-functional male characteristics (termed imposex). These can be used as an indicator of the extent of impact on the marine ecosystem.
Response	**The actions taken and / or proposed to minimise Impact and improve State (management response)** Releases of organotins to the environment are controlled through a number of legislative instruments. An Irish Bye-law (Anon 1987) was passed in April 1987, prohibiting, except under special circumstances, the use of TBT on all vessels under 25 metres and on all aquaculture netting and marine structures in Irish waters. The International Convention on the Control of Harmful Anti-fouling Systems on Ships (International Maritime Organisation, 2001) which prohibited use of TBT in all shipping, entered into force in 2008 and this was also transposed into EC legislation (EC 2003, EC 2008). Any EU ship, or any ship entering EU ports, must either not bear TBT antifoulant, or else must have a hull coating that prevents leaching of TBT. TBT is also on the OSPAR Convention's list of Substances for Priority Action (OSPAR, 2011) with releases of organotins controlled through

	the OSPAR and Helsinki conventions which protect the marine environments of the north-east Atlantic and Baltic seas respectively. TBT is listed as a Priority Hazardous Substance by the EU Directive 2008/105/EC under the Water Framework Directive. The Water Framework Directive requires Member States to achieve good ecological and chemical status in water bodies by 2015 (EC, 2000) and is based on compliance of water concentrations with environmental quality standards (EQS). However, the EQS is lower than the levels that can be readily be measured with current analytical methodologies. Together, these measures address the main TBT related pressures on the marine environment.
Conclusion	Concentrations of the antifouling agent tributyltin (TBT) and biological effects in marine gastropods resulting from its use have decreased following the ban on the use of TBT on small craft in 1987 and on all ships in 2008. Overall, the current status indicates that with a small number of exceptions, there has been a dramatic reduction of TBT contamination around the Irish coast. This demonstrates that measures taken nationally and internationally to phase out known toxic substances can be very effective in reducing marine pollution. While some “hot-spots” still exist the survey notes that over 95% of the sites were deemed to meet the EcoQO (VDSI< 2) threshold with the majority of sites assessed as being at “background” in accordance with OSPAR’s criteria. Temporal trend assessment completed using over 20 years of imposex data revealed that while little change in imposex was evident up to 2005, there was a substantial and significant improvement noted thereafter, this generally reflecting the findings of similar recent studies throughout Europe.
Assessment Result	The CEMP assessment measures progress towards the OSPAR objective of having concentrations of hazardous substances at background levels, or close to zero, by 2020. The degree of imposex in female dogwhelks was measured at 59 sites from 12 locations around the coasts of Ireland, from Carlingford Lough (Co. Louth) to Mulroy Bay (Co. Donegal) and compared to previous

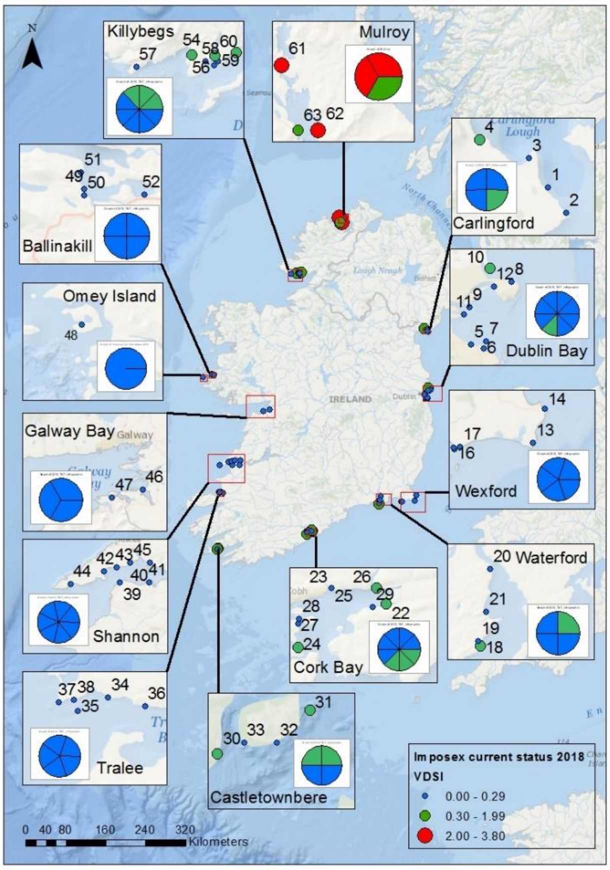
	surveys (see figure 2). Target locations included areas around ports where TBT contamination might be most likely encountered. While small numbers of sterile females were found and reduced numbers of young individuals were noted at three sites (North and South wall at Dublin Bay and Ahanesk Pier in Cork harbour), the majority of individual sampling sites did not indicate significant TBT contamination. This current status exhibits a remarkable improvement in imposex over the last decade. Trend assessments show that until the mid-2000s, levels of imposex at many sites remained consistently elevated. However, the 2010/2011 survey showed a notable improvement at many sites, and in 2018 almost all locations were found to be at or close to background exhibiting little evidence of imposex (see figure 3). While a few locations still exhibit some problem levels of imposex it is clear that improvement is also evident at these locations.
Knowledge gaps	There is potential concern about the potential for environmental harm associated with the substitute chemicals used to replace tributyltin (TBT) in antifouling paints. The use of copper-based paints, may require monitoring to avoid adverse consequences of use of substitute chemicals TBT present in historically contaminated sediments could be remobilised and enter the water column, representing a potentially long-term issue. Impacts of illegal use of TBT should not be discounted.
Background (extended) (figures & tables)	The growth of barnacles and other organisms on ship hulls, a process known as biofouling, has always been a problem for mariners, with the resultant increase in friction drag reducing vessel speeds and greatly increasing fuel costs. Antifouling paints have been extensively used to prevent biological growth on marine vessels and structures (Dafforn et al., 2011). By the 1980s it was realised that many of these paints were affecting certain non-target organisms (Alzieu 1982). The first indication of TBT contamination in Irish waters was reported in 1985, (Minchin and Duggan., 1986), who detected poor growth in oysters from Cork Harbour and Baltimore in County Cork (and subsequently possible effects on the scallop population in Mulroy Bay in County Donegal (Minchin et al., 1987). Dogwhelks (*Nucella lapillus* see Figure 1) are particularly sensitive to TBT even at very low levels of exposure, developing a condition known as imposex, whereby the females develop male sex organs and

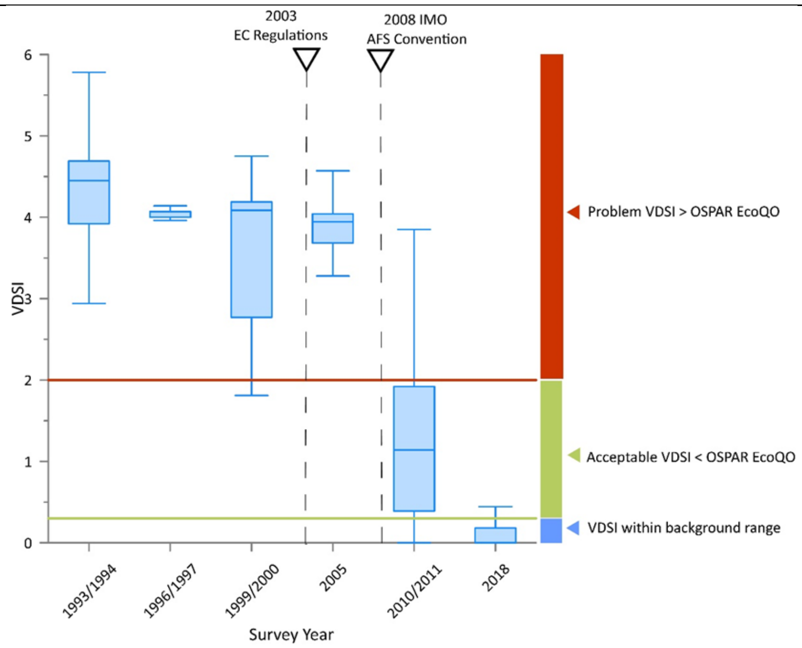
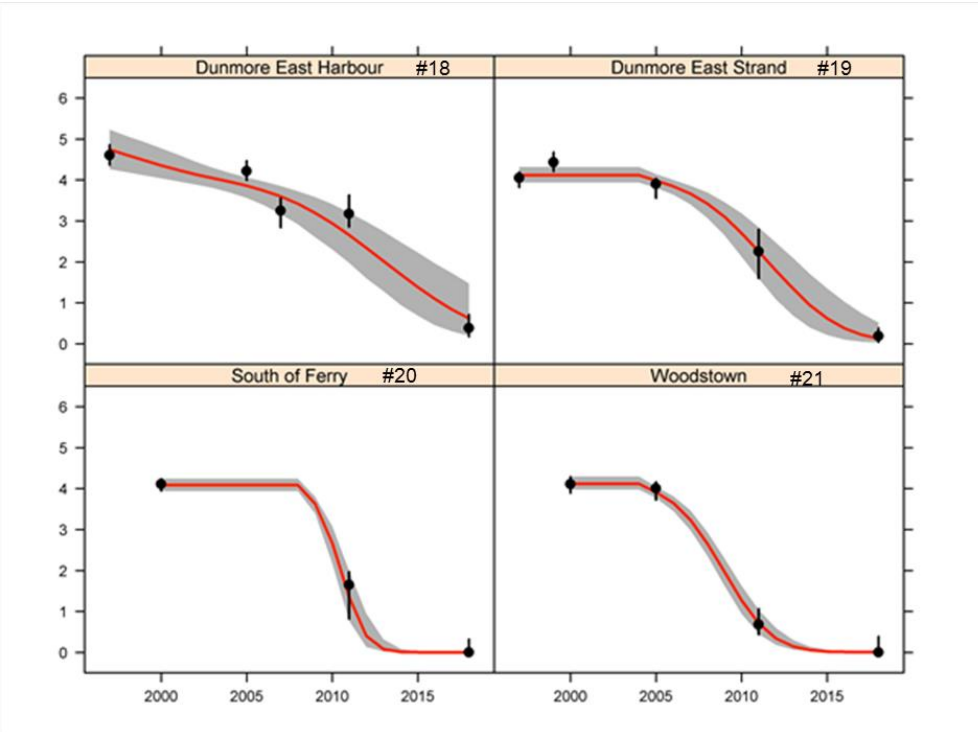
	ultimately become sterile. While TBT ultimately affects many organisms, the particular sensitivity of marine gastropods makes them an important indicator species, and changes in their levels of imposex can provide an early warning of changes as a result of TBT in the marine ecosystem.  **Figure 2:** Nucella lapillus (dogwhelk) in natural environment feeding on mussels To address this, an Irish Bye-law (Anon 1987) was passed in April 1987, prohibiting, except under special circumstances, the use of TBT on vessels under 25 metres, and on aquaculture netting and marine structures in Irish waters. The International Convention on the Control of Harmful Anti-fouling Systems on Ships (IMO, 2001) which prohibited use of TBT in all shipping, entered into force in 2008 and this was also transposed into EC legislation (EC 2003, EC 2008). Any EU ship, or any ship entering EU ports, must either not bear TBT antifoulant, or else must have a hull coating that prevents leaching of TBT. TBT is listed as a Priority Hazardous Substance by the EU Directive 2008/105/EC under the Water Framework Directive. Imposex is presently the only “biological effect” target and associated indicator (8.2.1) currently used by Ireland under MSFD (http://cdr.eionet.europa.eu/ie/eu/msfd8910/acsie/envuwsbg). Together, these measures address the main TBT related pressures on the marine environment.

	TBT is on the OSPAR Convention's list of Substances for Priority Action (OSPAR, 2011) and Imposex has been adopted as a biomarker of TBT pollution under OSPAR's Coordinated Environmental Monitoring Programme (CEMP) and monitoring in relation to TBT-specific biological effects have been carried out for a number of decades throughout the OSPAR maritime area. The OSPAR objective is continued reduction of levels of TBT in the marine environment, so that the exposure of marine gastropods and adverse imposex effects remain below agreed OSPAR Environmental Assessment Criteria (EAC) and ultimately reduction to 'close to zero' levels. OSPAR (OSPAR 2008-2009) established a North Sea Ecological Quality Objective (EcoQO) for TBT-specific effects (OSPAR 2005) in Nucella lapillus and these are used as assessment criteria in the form of background assessment criteria (BAC) and environmental assessment criteria (EAC) to support the OSPAR objective of continued reduction of levels of TBT in the marine environment, so that the exposure of marine gastropods and adverse imposex effects remain below agreed OSPAR Environmental Assessment Criteria (EAC) and ultimately reduction to 'close to zero' levels. Since 1987, the extent of imposex in dogwhelks around the Irish coast has been monitored by various research initiatives (e.g. Wilson et al 2015) and by Marine Institute (formerly, Fisheries Research Centre) surveillance surveys at approximately 6 yearly intervals. The surveys put a particular emphasis on ports and their approaches. The most recent survey in 2018 (Giltrap at al. in prep) measured the degree of imposex in female dogwhelks at 59 sites from 13 locations around the coasts of Ireland, from Carlingford Lough (Co. Louth) to Mulroy Bay (Co. Donegal). In addition to lowly impacted sites, the survey targeted locations, including areas around ports, where TBT contamination might be most likely encountered. While small numbers of sterile females were found the majority of individual sampling sites did not indicate significant TBT contamination. This current status exhibits a remarkable improvement in imposex over the last decade. Temporal trend assessments show that until the mid-2000s, levels of imposex at many sites remained consistently elevated. However, the 2010/2011 survey showed a notable improvement at many sites, and in 2018 almost all locations were found to be at or close to background exhibiting little evidence of imposex. While a few locations still exhibit some problem levels of imposex (e.g. Mulroy Bay), it is clear that improvement is also evident at these locations.

	Following bans on tributyltin the assessment shows there has been a decrease in imposex levels, implying improved reproduction in gastropods OSPAR notes that following actions taken to reduce, minimise or ban TBT use within individual countries, the European Union or globally, imposex is decreasing significantly throughout the convention area (OSPAR 2017). Compared to the QSR 2010, levels of imposex have markedly improved. In most assessment areas, imposex induced by TBT is at or below the level at which harmful effects are first expected to occur and there is also evidence of significant downward temporal trends in the severity of imposex in all areas assessed. Nevertheless, some areas are still subject to high imposex levels. Although levels of imposex are reducing, imposex is not yet at natural background levels in any of the areas assessed. Ongoing measurement of imposex in marine gastropods is an effective tool for monitoring a contaminant-specific pollution effect. Imposex provides a good indicator for TBT pollution and can help in identifying illegal use of stocks of TBT-containing antifouling paints or losses of TBT from dockyards, marinas and vessel maintenance activities.
Objective	Assess the spatial distribution, temporal trends and status of reproductive impairment, specifically imposex, in shellfish (bivalve molluscs) from Irish marine waters according to OSPAR methodology and standards.
State (extended)	The current status of the Criteria Element based on the best available knowledge and / or expert judgment. While some “hot-spots” still exist, over 95% of the sites were deemed to meet the EcoQO (VDSI< 2) threshold with the majority of sites assessed as being at “background” in accordance with OSPAR’s criteria. Temporal trend assessment completed using over 20 years of imposex data revealed that while little change in imposex was evident up to 2005, there was a substantial and significant improvement noted thereafter, this generally reflecting the findings of similar recent studies throughout Europe. Concentrations of TBT in dogwhelk tissue measured in this study broadly correlate with the level of imposex measured, supporting the application of dogwhelks as the most clear-cut tool for Ireland’s monitoring of contaminant-specific pollution effects under the Marine

	Strategy Framework Directive as required for indicator 8.2.1 of Commission Decision 2010/477/EC.
Assessment Method	In assessing contaminants both ‘relative’ and ‘absolute’ aspects have been analysed: • ‘trend assessment’ or spatial distribution assessment to focus on relative differences and changes on spatial and temporal scales – provides information about the rates of change and whether contamination is widespread or rather confined to specific locations; • the ‘status’ assessment of the significance of the (risk of) pollution, defined as the status where chemicals, are at a hazardous level, usually require assessment criteria that take account of the possible severity of the impacts and hence require criteria that take account of the natural conditions (background concentrations) and the contaminants’ ecotoxicology. For example, Environmental Assessment Criteria (EAC) are tools in this type of assessment. Methods for analyses of imposex trends and status Technical Annex 3 to the JAMP Guidelines (OSPAR, 2008a) sets out the guidance for monitoring TBT-specific biological effects (imposex/intersex) in the gastropod species. At present, only Nucella lapillus (dog whelk) and *Nassarius reticulatus* (netted dog whelk) are monitored for assessment of status and trends. Imposex is measured using the Vas Deferens Stage index (VDS), a seven stage measurement based on degree of penis and Vas Deferens (a male sex organ) in females (Table b). Vas Deferens Stage index = 0 indicates normal genitals, while VDS = 5 and VDS = 6 indicate that the female is incapable of reproducing.
Assessment Result	The degree of imposex in female dogwhelks was measured at 59 sites from 12 locations around the coasts of Ireland, from Carlingford Lough (Co. Louth) to Mulroy Bay (Co. Donegal) and compared to previous surveys (see figure 2). Target locations included areas around ports where TBT contamination might be most likely encountered. While small numbers of sterile females were found and reduced numbers of young individuals were noted at three sites (North and South wall at Dublin Bay and Ahanesk Pier in Cork harbour), the majority of individual sampling sites did not indicate significant TBT contamination. This current status exhibits a remarkable improvement in imposex over the last decade. Trend assessments show that until the mid-2000s,

	levels of imposex at many sites remained consistently elevated. However, the 2010/2011 survey showed a notable improvement at many sites, and in 2018 almost all locations were found to be at or close to background exhibiting little evidence of imposex (see figure 3). While a few locations still exhibit some problem levels of imposex it is clear that improvement is also evident at these locations.
Results (figures & tables)	**For ease of reading the following table are included in Annex I of this Assessment Sheet** **Table 1:** Sampling details, imposex measurements and site status as per OSPAR criteria (Blue = Below BAC (EcoQO met), Green = Below EAC (EcoQO met) and Red (Above EAC (EcoQO not met) and other relevant parameters in N. lapillus around the Irish coast **Table 1 cont.:** Sampling details, imposex measurements and site status as per OSPAR criteria (Blue = Below BAC (EcoQO met), Green = Below EAC (EcoQO met) and Red (Above EAC (EcoQO not met) and other relevant parameters in N. lapillus around the Irish coast.  **Figure 2:** Current status in 2018 of imposex (measured as VDSI) in dogwhelks, an indicator of TBT pollution. Levels of imposex in 2018 are typically low or within background range.

	 **Figure 3:** Box-plot (outliers not shown) of all imposex measurements for periodic surveys undertaken since the early 1990s. Since 2005 a marked improvement in imposex status is evident. Dashed lines show timings of adoption of EC regulations and the ratification IMO Antifouling System Convention  **Figure 4:** Example Temporal trend plots Waterford Harbour
Conclusion (extended)	Concentrations of the antifouling agent tributyltin (TBT) and biological effects in marine gastropods resulting from its use have decreased

	following the ban on the use of TBT on small craft in 1987 and on all ships in 2008. Overall, the current status indicates that with a small number of exceptions, there has been a dramatic reduction of TBT contamination around the Irish coast. This demonstrates that measures taken nationally and internationally to phase out known toxic substances can be very effective in reducing marine pollution. While some "hot-spots" still exist the survey notes that over 95% of the sites were deemed to meet the EcoQO (VDSI< 2) threshold with the majority of sites assessed as being at "background" in accordance with OSPAR's criteria. Temporal trend assessment completed using over 20 years of imposex data revealed that while little change in imposex was evident up to 2005, there was a substantial and significant improvement noted thereafter, this generally reflecting the findings of similar recent studies throughout Europe. Based on over 95 % of sites meeting the EcoQO and the significant improvement noted since 2005 Good Environmental Status has been achieved for the Effects on biota: Imposex in marine gastropods.
Knowledge gaps (extended)	There is potential concern about the potential for environmental harm associated with the substitute chemicals used to replace tributyltin (TBT) in antifouling paints. The use of copper-based paints, may require monitoring to avoid adverse consequences of use of substitute chemicals TBT present in historically contaminated sediments could be remobilised and enter the water column, representing a potentially long-term issue. Impacts of illegal use of TBT should not be discounted.
References	Alzieu, C., Heral, M., Thiabud, Y., Dardignac, K. J. & Feuillet, M. (1982). Influences des peintures antisalissures a base d'organostanniques sur la calcification de Ja coquille de l'huitre. Rev. Trav. Inst. Pêches Marit. 45, 101-106. Anon 1987., Department of the Marine, Ireland. 1987. Restriction of Use of Organotin Antifouling Compounds Bye-law No. 657, 1987

	Dafforn, K. A., Lewis, J. A., and Johnston, E. L. 2011. Antifouling strategies: History and regulation, ecological impacts and mitigation. Marine Pollution Bulletin, 62: 453–465. Minchin, D., Duggan, C.B., King, W., 1987. Possible influence of organotins on scallop recruitment. Mar. Pollut. Bull. 18 (11), 604–608. Minchin D. and Duggan, C.B. 1986. Organotin contamination in Irish waters. ICES CM 1986/F:48 (1986), p. 8.d Duggan 1986 Minchin, D., Stroben, E., Oehlmann, J., Bauer, B., Duggan, C.B., Keating, M., 1996. Biological indicators used to map organotin contamination in Cork Harbour, Ireland. Mar. Pollut.Bull. 32 (2), 188–195. OSPAR, 2008. JAMP Guidelines for contaminant specific biological effects Monitoring. (Agreed 2008–2009 Update of the previous Agreement 2002–14; revision of Technical Annex 3(TBT-specific biological effects monitoring)). http://www.ospar.org/documents/dbase/decrecs/agreements/08-09e_contaminants%20specific%20BEF.doc. OSPAR 2017: Intermediate Assessment. Status and Trends in the Levels of Imposex in Marine Gastropods (TBT in Shellfish), D8 - Concentrations of Contaminants, D8.2 - Effects of contaminants https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/contaminants/imposex-gastropods/ Wilson J., Minchin, D., McHugh, B., McGovern, E., Tanner, C.J. Giltrap, M. (2015) Declines in TBT contamination in Irish coastal waters 1987–2011, using the dogwhelk (*Nucella lapillus*) as a biological indicator, Marine Pollution Bulletin, 100, 289-296 Giltrap, M., Kennedy, R., McGovern, E., Joyce, E., Brophy, L., Parker, M., McDonnell, O., Fryer, R., Conway, A., McHugh, B., (In prep). Improving status of imposex in dogwhelk (*Nucella lapillus*) in Irish marine waters. Marine Institute Report EC 2003 REGULATION (EC) No 782/2003 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 14 April 2003 on the prohibition of organotin compounds on ships EC 2008 COMMISSION REGULATION (EC) No 536/2008 of 13 June 2008 giving effect to Article 6(3) and Article 7 of Regulation (EC) No 782/2003 of the European Parliament and of the Council on the

	prohibition of organotin compounds on ships and amending that Regulation IMO 2001 International Convention on the Control of Harmful Anti-fouling Systems on Ships. International Maritime Organisation http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-on-the-Control-of-Harmful-Anti-fouling-Systems-on-Ships-(AFS).aspx			
	Assessment Data			
Data Sources	Monitoring is undertaken by the Marine Institute and reported to ICES database where it is used for OSPAR Joint assessment https://ocean.ices.dk/ohat/ OSPAR Assessment https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/pressures-human-activities/contaminants/imposex-gastropods/ OSPAR Intermediate assessment Imposex in gastropods			
Data Locations (URL)	OSPAR assessment site (most recent) https://ocean.ices.dk/ohat/ OSPAR Assessment output 2019 https://ocean.ices.dk/ohat/?assessmentperiod=2019 http://doi.org/dst5			
Data Time Line	Start Date:	1994	End Date:	2018
Point of Contact	Brendan McHugh/ Evin McGovern, Marine Institute			
Email	Brendan.mchugh@marine.ie; evin.mcgovern@marine.ie			

D8 C3

Reference D8C3 Rev 2	Assessment Sheet: D8C3 - Acute Pollution Events
Key message	The outcome of the surveying carried out each year by the Coast Guard there have been a very limited number of spills detected during the assessment period 2014 to 2018.
Introduction	The objective of this assessment is to evaluate the spatial extent and duration of significant acute pollution events and to ensure that these are minimised. This evaluation considers such acute pollution events which are recorded by the Coast Guard and have taken considerable resources from both the Coast Guard and the Port Authorities to achieve a successful outcome.
Background	**MSFD Initial Assessment (2013)** The following target was proposed for the achievement of GES, “Occurrence and extent of significant acute pollution events (e.g. slicks resulting from spills of oil and oil products, or spills of chemicals) and the impact on biota affected by this pollution is minimised through appropriate risk-based approaches”. The assessment outlined that isolated reports of oiled seabirds are reported to the IRCG but it has proved very difficult to attribute these reports to a particular reported spill incident. There were five notable pollution incidents in Irish marine waters in the period between 2006 and 2011. Based on this low number of incidents, it is estimated that the spatial scale over which adverse effects may have occurred constitute less than 1% of Irish MSFD Assessment Area. The distributional pattern and concentration of contaminants indicate that these events were predominantly confined to inshore areas. Overall, reported incidents over a six-year period have been few, providing no clear indication of recent trends and giving no firm basis for predicting future trends. The current status of the occurrence of significant pollution events and the corresponding impact on seabed habitats and associated biota has not been assessed due to insufficient data. **BONN Agreement** The Bonn Agreement is the mechanism by which ten Governments including Belgium Denmark, France, Germany, Ireland, the

	Netherlands, Norway, Spain, Sweden and the United Kingdom together with the European Union cooperate in dealing with pollution of Sea by oil and other harmful substances. As part of Irelands engagement with the Bonn Agreement the Coast Guard Service undertakes an extensive aerial surveillance over its Exclusive Economic Zone (EEZ), flying 1,005 hours in 2018. This survey data is reported to the Bonn Agreement and it is supplemented with satellite imagery data. **Commission Decision (2017 / 848)** The Commission Decision outlines the Criteria Element under Descriptor 8: Significant acute pollution events involving polluting substances, as defined in Article 2(2) of Directive 2005/35/EC of the European Parliament and of the Council (1), including crude oil and similar compounds. The criterion and associated methodological standards are as follows: **Criteria D8C3** (Primary): The spatial extent and duration of significant acute pollution events are minimised. **Scale of Assessment**: Regional or sub-regional level, divided where needed by national boundaries **Use**: The extent to which good environmental status has been achieved shall be expressed for each area assessed as follows: - an estimate of the total spatial extent of significant acute pollution events and their distribution and total duration for each year. This criterion shall be used to trigger assessment of criterion D8C4. **Current Approach** The Initial Assessment approach outlines that significant acute pollution events impacted on less than 1 % of Irelands MSFD area in that 6-year assessment period and there was insufficient data to assess the impacts on habitats and biota. Migrating to the use of D8C3 Ireland can assess the extent and duration of events which have occurred 2014 to 2018 based on data collected by the Irish Coast Guard and reported under the Bonn Agreement annually.

	It is proposed to adopt D8C3 to as an update from the approach taken in the Initial Assessment 2013, as this aligns with the Commission Decision requirements.
Objective	The objective of this assessment is to evaluate the spatial extent and duration of significant acute pollution events in the Irish MSFD area during the period 2014 - 2018 and minimise their impact through appropriate risk based approaches. In addition, the assessment considers the extent to which good environmental status has been achieved or not. This consideration will lead, if necessary to the application of an assessment under Criterion D8C4 –the adverse effects of acute pollution events.
Drivers	The human activities which can lead to Acute Pollution Events are as follows: • Extraction of non-living resources (oil and gas) • Transport (shipping) • Urban & Industrial uses (waste treatment and disposal) • Tourism & Leisure (infrastructure & activates)
Pressures	The key pressures which can lead to Acute Pollution Events are as follows: • Economic development: leading to increased activates in the marine environment • Shipping related: increase marine traffic, increased vessel size
State	Based on the data reported to the Bonn Agreement between 2014 and 2018 there were 6 detected incidents from surveillance flights and 8 confirmed incidents based on satellite detection. (Tables 1 and 2 below). The volumes of these incidents were not determined. This is a low level of incidents with 2018 having the highest number with 5 detections by surveillance flights and 4 from satellite detections. This amount of data is not sufficient to comment on trends.
Impact	The impact of these recorded incidents has been minimal with no recorded largescale wild life impacts recorded.

Response	The Irish Coast Guard has an important role in the protection of the ocean and the coasts against pollution. In the case of an imminent pollution accident, the Irish Coast Guard has the right to intervene in ships' operations, and the organisation bears the responsibility to do everything within its power to prevent pollution accidents. The Irish Coast Guard is responsible for developing and co-ordinating the following: • preparedness and response to spills of oil and other hazardous substances within the Irish Pollution Responsibility Zone • providing an effective response to marine casualty incidents • monitoring or intervening in marine salvage operations The Irish Coast Guard: • provides and maintains 24-hour marine pollution notification at the three Marine Rescue Centres • develops approved pollution response plans in all harbours and ports, oil handling facilities, marine local authorities and offshore installations • provides and maintains a national stockpile of pollution equipment • co-ordinates exercises and tests of national and local pollution response plans on an ongoing basis The Irish Coast Guard is the representative of the wider public interest in the protection of the environment following a marine incident where there is pollution or a significant threat of pollution. Irish Coast Guard customers are the commercial and recreational users of the sea, harbour and local authorities whose livelihood, property and amenities might be damaged in a pollution incident and or their lives put at risk.
Assessment Method	Ireland carries out extensive monitoring of its Maritime area using an Aerial Surveillance Programme using specially equipped aircraft and specialised personnel to detect spills of oil and other harmful substances. This monitoring has been ongoing since 2014 (Data below taken from Bonn Agreement Annual Reports on Aerial Surveillance 2014 to 2018 (https://www.bonnagreement.org/publications).

Table 1: Flights data from Bonn Agreement

Year	Hrs	Detections	Source	Volume
2014	834.42	1	Ships	Not Available
2015	1,103.02	0	-	-
2016	683.00	0	-	-
2017	614.00	0	-	-
2018	1,005.00	5	Ships (3), Unknown (2)	-

Table 2: Satellite data from Bonn Agreement

Year	Satellite Detections	Confirmed	Not Confirmed or no feedback
2014	11	2 (Mineral Oil)	9
2015	0	-	-
2016	12	1 (Mineral Oil)	11
2017	15	1 (Mineral Oil)	14
2018	76	2 Mineral Oil 2 Other substances 2 Natural phenomena 10 Nothing found	60

Assessment thresholds have not been established for this indicator and there is no agreed definition of 'significant' acute pollution in the context of spills.

Assessment Result	There have not been any acute pollution events detected / recorded in the Irish maritime area in the period 2014 to 2018 based on the survey data reported to the Bonn Agreement during this assessment period.
Results	See assessment Method above
Conclusion	The outcome of the surveying carried out each year by the Coast Guard there have been a very limited number of spills detected during the assessment period 2014 to 2018. Based on this low incidence Good Environmental Status has been achieved for Acute Pollution Events (D8C3) in the Irish maritime area.
Knowledge gaps	The extent and volume of detected spills is not calculated; however, it is not clear that this relates to the detections being very small or the calculations not being possible. Greater detail on volume would be beneficial for future assessments.

	Assessment Data			
Data Sources	Bonn Agreement Website reports on Aerial Surveillance 2014 to 2018 inclusive and Aerial Surveillance Fact Sheets 2014 to 2018 inclusive.			
Data Locations (URL)	https://www.bonnagreement.org/activities/aerial-surveillance https://www.bonnagreement.org/publications			
Data Time Line	Start Date:	2014	End Date:	2018
Point of Contact	Donal Cronin			
Email	Donal.Cronin@housing.gov.ie			

Descriptor 9 – Contaminants in seafood

D9 C1

Ref D9C1	Assessment Sheet: Indicator D9C1 Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards
Key message	Good Environmental Status (GES) has been achieved for Descriptor 9. Seafood sampled from shellfish growing waters and commercial fishing grounds around Ireland, between 2012 and 2017, shows a very high-level of compliance (99.7%) with the Maximum Limits set in Commission Regulation 1881/2006 EC, as amended. This relates to mercury, cadmium, lead, indicator polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/Fs – dioxins), sum of PCDD/Fs and dioxin-like PCBs, and polyaromatic hydrocarbons (PAH).
Introduction / Objective .	The objective of this assessment is to evaluate the status of contaminants in fish and other seafood for human consumption from Irish waters with respect to MSFD Descriptor 9, specifically that "Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards" (Directive 2008/56/EC).
Drivers .	The drivers of contaminant inputs to the marine environment as described in Commission Directive 2017/845 include: • Urban and industrial uses, include waste treatment and disposal; • Production of energy; • Extraction of non-living resources; • Transport.
Pressures	Within the Irish MSFD area the pressures relating to Descriptor 9 are: • Inputs of other substances (e.g. synthetic substances, non-synthetic substances) from diffuse sources, point sources and from atmospheric depositions.

	• Inputs may be from land-based sources (riverine, direct discharge or atmospherically transported) or sea based sources. Some of these substances are globally ubiquitous due to long-range transport.
State	The current state of the Irish marine environment is evaluated as having achieved Good Environmental Status with respect to Descriptor 9. The level of non-compliance for contaminants in seafood is extremely low and concentrations of these contaminants are generally well within the limits set out in Commission Regulation 1881/2006 EC. This relates to mercury, cadmium, lead, 6 indicator polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/Fs – dioxins), sum of PCDD/Fs and dioxin-like PCBs, and polyaromatic hydrocarbons (PAH). An extensive monitoring program and a quality assured dataset underpins this evaluation, covering a broad range of fish, crustacean and shellfish species.
Impact	The levels of contaminants in Irish seafood consistently comply with regulatory limits set in Commission Regulation 1881/2006 EC as amended. Consequently, there is no impact and there is no requirement to withdraw Irish fisheries products/species from the market due to non-compliance with these limits.
Response	No Specific Response is required based on Descriptor 9 assessment. A wide range of national/regional (e.g. EC) and global measures are in place to tackle marine pollution with respect to these substances.
Conclusion	Good Environmental status has been achieved for Descriptor 9. Seafood sampled from shellfish growing waters and commercial fishing grounds around Ireland, between 2012 and 2017, shows a consistently very high level of compliance (99.7%) with Maximum Limits set in Commission Regulation 1881/2006 EC, as amended. This relates to the following contaminants; the metals mercury, cadmium, lead, and the organic substances indicator polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/Fs – dioxins), sum of PCDD/Fs and dioxin-like PCBs, and polyaromatic hydrocarbons (PAH). The overall compliance rate was 99.7% for 2273 test results. Of these, 1422 individual test results were obtained for metals in all samples, with an overall compliance rate of 99.5%. Organic substances showed 100% compliance for 853 individual test results recorded.

	An extensive monitoring program and a comprehensive quality assured dataset for broad range of fish and shellfish species underpins this assessment. The very few non-compliant results were related to very local coastal issues or to other non-pollution related factors.
Assessment Result	The level of non-compliance for contaminants in seafood is extremely low and concentrations of these contaminants are generally well within the limits set in Commission Regulation 1881/2006 EC. The current state of the Irish marine environment is evaluated as Good with respect Descriptor 9 with Good Environmental Status being achieved. A comprehensive monitoring program and a quality assured dataset underpins this evaluation covering a broad range of fish and shellfish species.
Knowledge gaps	• D9 by definition is limited to assessing exceedance levels established by Community legislation or other relevant standards in this case Commission Regulation 1881/2006 as amended. This assessment is limited to the assessment of compliance for a limited number of substances for which maximum limits for seafood have been set in this Regulation. • While there is a good overall database, there are limited data for some species. Ongoing monitoring by the Marine Institute attempts to address these gaps by targeting species for which there is limited data available. Additional marine food matrices e.g. seaweeds, are not covered at present by the regulations.
Background (extended) (figures & tables)	MSFD Descriptor 9 requires that ‘Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards’. Commission Regulation (EC) 1881/2006, as amended, sets maximum limits for environmental contaminants, in foodstuffs including seafood. The Marine Institute (MI) measures levels of contaminants in Irish seafood including bivalve molluscs from designated shellfish growing waters, finfish and crustaceans from Irish waters, and has over 25 years of data. Substances monitored include trace metals, and organic compounds including polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), dioxins, furans and dioxin-like PCBs, brominated flame-retardants and other substances of emerging concern. The D9 assessment focuses on compliance with Maximum

	Limits for environmental contaminants in the edible tissues of seafood, as established Commission Regulation (EC) 1881/2006 as amended. Specifically, limits are set for cadmium, lead, mercury, polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/Fs, otherwise referred to as dioxins), indicator and "dioxin-like"-PCBs and certain PAH. There are no additional maximum limits established in national legislation of relevance. Farmed finfish are not included in definition of GES for D9 and are excluded from the assessment.
Objective (extended).	To assess the concentrations for environmental contaminants in seafood (2012 – 2017) from Irish waters and to evaluate level of compliance with relevant maximum limits set in Regulation (EC) 1881/2006.
Drivers (Activities) (extended)	See above
Pressures (extended)	See above
State (extended)	The current state of the Irish marine environment has achieved Good Environmental Status with respect to Descriptor 9. The level of non-compliance for contaminants in seafood is extremely low and concentrations of these contaminants are generally well within the limits set out in Commission Regulation 1881/2006 EC. This relates to mercury, cadmium, lead, 6 indicator polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/Fs – dioxins), sum of PCDD/Fs and dioxin-like PCBs, and polyaromatic hydrocarbons (PAH). An extensive monitoring program and a quality assured dataset underpins this evaluation, covering a broad range of fish, crustacean and shellfish species.
Impact (extended)	Levels of contaminants in seafood are compliant with regulatory limits. There is no impact as there is no significant requirement to withdraw Irish fisheries products from the market due to non-compliance with these limits.
Response (extended)	No Specific Response is required based on D9 assessment. A wide range of national/regional (e.g. EC) and global measures are in place to tackle marine pollution with respect to these substances. Available measures include; • Measures to reduce emissions, discharges and losses of target substances as detailed for Descriptor 8.

<table>
<tr><td></td><td>Consumer protection measures include the removal of seafood products or consignments from the market and/or issuing of consumption advice, for example with recommendations for the frequency or volume of consumption of particular species with known high concentrations of certain contaminants.</td></tr>
<tr><td>Assessment Method</td><td>Bivalve molluscs, sampled from designated shellfish growing waters, and fish, crustaceans and cephalopods, typically sampled from landings at national ports or during fisheries surveys, were analysed for relevant contaminants and assessed against the Maximum Limits set in Commission Regulation (EC) 1881/2006 as amended. The contaminants assessed were those for which limits are set in the above regulation (Table 1):

Trace elements: lead, cadmium and mercury,
Polyaromatic hydrocarbons (PAH):

benzo(a)pyrene (BaP) and,
the sum of 4 PAH (BaP and benz(a)anthracene, benzo(b)fluoranthene, chrysene). Note maximum levels are only set for PAH in bivalve molluscs as they are rapidly metabolised in fish.

Organochlorine compounds:

indicator polychlorinated biphenyls (PCB 28, 52, 101, 138, 153 and 180 -ICES sum of 6 PCBs),
Sum of 17 WHO polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/Fs) – Dioxins; expressed as WHO-2005 Total Toxicity Equivalence (TEQ)
Sum of 12 WHO “dioxin-like” PCBs (dl-PCBs) + 17 PCDD/Fs; expressed as WHO-2005 Total Toxicity Equivalence (TEQ)

Samples collected between 2012 and 2017 are included in this assessment. Fish landings were sampled at Irish ports, visited during June-August in the years reported and a selection of species sampled. Additional samples were taken on-board the RV Celtic Explorer during the MI’s annual Irish Groundfish Surveys and other surveys. Wild salmon were obtained from the MI Newport facility in Furnace, Co. Mayo. Bivalve mollusc samples from designated shellfish growing waters were collected annually in November/December by officers of the Sea Fisheries Protection Authority. Figure 1 below indicates the designated Irish shellfish growing waters, ports sampled, and shows</td></tr>
</table>

ICES (sub-)areas. Fish and crustaceans were sampled from the ports and annual Marine Institute groundfish survey as outlined below:

- Castletownbere (75 fish), 1 Nephrops)
- Clogherhead (3 fish)
- Dunmore East (26 fish, 1 Nephrops)
- Greencastle (28 fish, 2 Nephrops)
- Howth (18 fish)
- Killybegs (9 fish, 1 Nephrops)
- Ros a Mhíl (22 fish)
- Marine Institute Ground Fish Survey (53 fish, 26 crabs, 2 Nephrops)

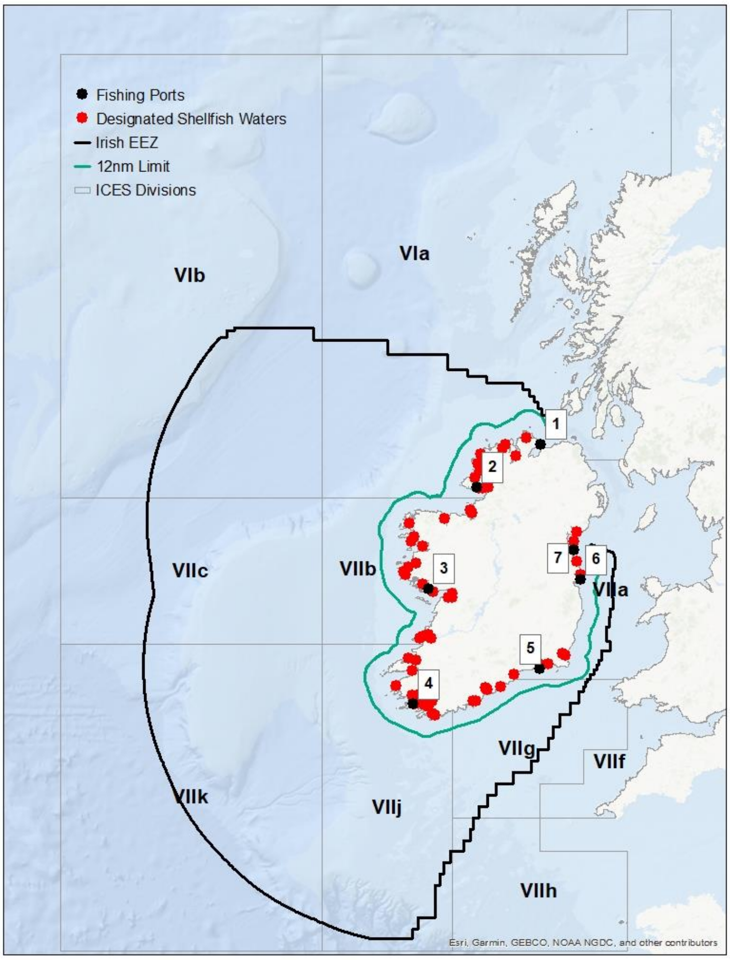


Figure 1: Sampling Locations. A Bivalve molluscs Shellfish Growing Waters Designated. B Fish and Crustaceans were sampled at fishing ports listed (1 Greencastle; 2 Killybegs, 3 Ros a Mhíl, 4 Castletownbere, 5 Dunmore east, 6 Howth, 7 Clogherhead) or on-board Marine Institute fisheries surveys. ICES fishing areas are also shown. Where locational information was available, fish samples originated from areas VIa, VIIa, VIIb, VIIg, VIIj and crustaceans from VIa, VIIa, VIIb and VIIg

Table 1: Table of maximum limits established for seafood intended for human consumption from European Commission Regulation (EC) No. 1881/2006 as amended

Analyte (unit wet weight)	Muscle Meat of Fish	Muscle Meat of Selected Fish Species	Cephalopods (without Viscera)	Crustaceans[a]	Bivalve Molluscs
Lead (mg/Kg)	0.3	0.3	0.3	0.5	1.5
Cadmium (mg/Kg)	0.05	0.1, 0.15, 0.25[b]	1.0	0.5	1.0
Mercury (mg/Kg)	0.5	1.0[c]	0.5	0.5	0.5
Benzo(a)pyrene (µg/Kg)					5
Sum of 4 polyaromatic hydrocarbons (PAHS) (µg/Kg)					30
Sum of dioxins (WHO2005 PCDD/F-TEQ ng/Kg)	3.5	3.5	3.5	3.5	3.5
Sum of dioxins and dioxin-Like PCBs (WHO2005PCDD/F-PCB-	6.5	6.5	6.5	6.5	6.5

PCB-TEQ ng/Kg					
Sum of ICES-6 PCBs 28, 52, 101, 138,153 and 180 (µg/Kg)	75	200, 300[d]	75	75	75

[1] Commission Regulation 1881/2006 regulates the maximum level of contaminants in foodstuffs including fish. This Regulation lays down the maximum quantities for certain contaminants and states that food with levels of contaminants higher than those specified in the Annex to the Regulation cannot be placed on the market. These maximum limits cover not only the edible part of food but also processed, dried or diluted foods (taking into account a concentration or dilution factor).

[a] Muscle meat from appendages and abdomen, excluding the cephalothorax for crustaceans. In the case of crabs and crab-like crustaceans (*Brachyura* and *Anomura*): muscle meat from appendages.

[b] For Cadmium mackerel, tuna and bichique have a limit of 0.1, bullet tuna 0.15 and anchovy, swordfish and sardine are 0.25 mg/Kg.

[c] For Mercury the following species have a max limit of 1.0 mg/Kg; anglerfish, Atlantic catfish, bonito, eel, soldierfish, grenadier, halibut, marlin, megrim, mullet, pike, plain bonito, poor cod, Portuguese dogfish, rays, redfish, sailfish, scabbard fish, seabream, shark, snake mackerel or butterfish, sturgeon, swordfish and tuna.

[d] For wild caught spiny dogfish and wild caught eel, limits of 200 µg/Kg and 300 µg/Kg, respectively, apply.

Analysis

Analysis was conducted at the laboratories using the methods outlined in Table 2. A comprehensive analytical quality assurance programme underpins testing at the Marine Institute and the listed subcontracting laboratories all which possess accredited testing.

Table 2: Analytical laboratories and test methods

Test Compound	Test Location (s)	LOQ	Lab Accreditation	Method
Cadmium and Lead	Marine Institute (Galway) ALS (Sweden)	0.002 mg/Kg	ISO 17025:2005 (MI) ISO9001:2000 and ISO 17025:2005 (ALS)	Microwave oven (CEM Mars Xpress) ICP-MS (Agilent 7700x with High Matrix Introduction (HMI) system (MI). ICP-SFMS (sector field mass spec) ALS.
Mercury	Marine Institute (Galway) Fera (UK)	0.002 mg/Kg	ISO 17025:2005 (MI) UK National Reference Laboratory, ISO 17025:2005 (FERA)	Microwave oven (CEM Mars Xpress). Cold Vapour Atomic Fluorescence Spectroscopy (CV-AFS) using a PSA Merlin. ICP-MS used by Fera.
PAHs	Marine Institute (Galway) Environment Agency (EA UK)	0.038 µg/Kg	ISO 17025:2005 (MI) ISO 17025:2005	Lipid concentrations determined gravimetrically. Agilent gas chromatograph (GC) coupled to either a

						5973N mass spectrometric (MSD) or) or a triple quadrupole (QQQ) using electron ionisation (EI) mode with helium as a carrier gas. EA Samples extracted by non-polar solvent extraction and separated by gel permeation chromatography. Concentrations were determined by GC MS with Selected Ion Monitoring.	
		PCB	Eurofins (Germany) Marine Institute (Galway)	0.05 µg/Kg	ISO 17025:2005 (Eurofins) ISO 17025:2005 (MI)	High-resolution gas chromatography and mass spectrometry (HRGC/MS), with DB-5 capillary column (Eurofins, State Lab). MI testing utilized an	

	<table><tr><td></td><td></td><td></td><td></td><td>Agilent 6890 GC coupled to either a 5973N Mass Spec or Quadrupole using Electron Ionisation with a helium carrier gas and an SGE HT8 column.</td></tr><tr><td>Dioxin, DL-PCB</td><td>Eurofins (Germany), State Lab (Dublin)</td><td>0.05 ng/Kg</td><td>ISO 17025:2005 (Eurofins) ISO 17025:2005 (State Lab)</td><td>Accelerated Solvent Extraction (ASE) State Lab, Smedes lipid extraction (MI) Tissue extraction using appropriate solvents (Eurofins). Gas Chromatography-High Resolution Mass Spectrometry (GC-HRMS)</td></tr></table>
Assessment Result (extended)	Good Environmental Status (GES) has been achieved for D9. Seafood sampled from Irish marine waters between 2012 and 2017 indicated a very high-level of compliance with Maximum Limits set in Commission Regulation 1881/2006 (EC), as amended, for mercury, cadmium, lead, polychlorinated biphenyls (PCBs), dioxins (PCDD/Fs), PCDD.Fs + dl-PCBs, and polyaromatic hydrocarbons (PAH). Table 3 summarises the results.

	Table 3: Summary table of compliance with maximum limits established in Commission Regulation 1881/2006/EC as amended for seafood sampled 2012 – 2017

	Lead	Cadmium	Mercury	Benzo(a)pyrene	Sum of 4 PAHs	Sum of ICES6 PCBs	PCDD?Fs	PCDD/Fs + DL-PCBs
Fish	134 (100%)	134 (100%)	225 (100%)			54 (100%)	22 (100%)	22 (100%)
Bivalve Mollusc	272 (100%)	272 (98%)	274 (100%)	214 (100%)	212 (100%)	272 (100%)		
Cephalopod	4 (100%)	4 (100%)	4 (100%)					
Crustacean	24 (100%)	54 (96%)	21 (100%)	1 (100%)	1 (100%)	19 (100%)	18 (100%)	18 (100%)

Sample number tested (% compliance with maximum limit. Green - 100% compliance. Amber <100% compliance).

Out of 1422 individual test results for metals in all samples, an overall compliance of 99.5% was achieved. For organic substances 100% compliance for 853 individual test results was recorded. The overall compliance rate was 99.7% for 2273 test results.

Concentrations of contaminants can vary greatly between species and even between tissues within an organism, depending on many biological factors such as accumulation, diet/position in the food web, life-span, bioregulation etc. Consequently, limits are often specific to different species/taxa/tissues. However, monitoring data indicate that levels of the target contaminants measured are typically were well below the relevant regulatory limits. Only cadmium showed any non-compliant results, 5 of 173 oyster samples, all native oyster *Ostrea edulis* from one localised coastal area, 2 of 43 crab claw samples. In general, cadmium concentrations are very low in crab claw but can be naturally high in hepatopancreas. The Maximum Limit for crabmeat only applies to the appendages and excludes meat from the cephalothorax (which includes the hepatopancreas). However, it is possible that post-mortem cross contamination between tissues before sampling led to higher claw values for these particular samples.

Results (figures & tables)	Trace Metals Overall the compliance rate for metals in seafood was very high:

- Overall there was a high level of compliance for cadmium. n = 464 seafood samples tested (Table 4). Only 2 of 43 brown crab (*Cancer pagurus*) claw samples tested as non-compliant with results above the maximum limit. Brown crab are known to have high levels of cadmium in the hepatopancreas so this may relate to inter-tissue transfer possibly post-mortem before declawing. Note there is no limit for cadmium for meat in the cephalothorax which includes the hepatopancreas. 5 of 272 bivalve mollusc samples (all native oysters, *Ostrea edulis*, from one coastal location) exceeded the Maximum Limit. As these non-compliant results do not represent a wider contamination issue they are not considered to affect overall GES for D9

- There was 100% compliance for lead in all seafood samples tested (Table 5)

- There was 100% compliance for mercury in all seafood samples tested (Table 6)

Table 4 Summary Results for Cadmium (mg /Kg WW) in Seafood Samples from Irish Waters, 2012-2017.

Species	Count (n)	Limit mg /Kg ww	Compliance	Median mg /Kg ww	Max mg /Kg ww	n<LOQ
Albacore	5	0.10	100 %	0.008	0.01	0
Brill	3	0.05	100 %	<0.002	<0.002	3
Dab	1	0.05	100 %	-	<0.002	1
Dogfish, Lesser Spotted	1	0.05	100 %	-	0.005	0
Dogfish, Spurdog	3	0.05	100 %	<0.002	0.006	2
European Sea Bass	1	0.05	100 %	-	<0.002	1
Gurnard, Grey	2	0.05	100 %	-	<0.002	2
Mackerel, Atlantic	8	0.10	100 %	0.004	0.02	1

	Mackerel, Horse	3	0.10	100 %	<0.002	<0.002	1
	Cod, Atlantic	11	0.05	100 %	<0.002	<0.002	11
	Haddock	9	0.05	100 %	<0.002	<0.002	9
	Hake, European	8	0.05	100 %	<0.002	<0.002	8
	Herring, Atlantic	6	0.05	100 %	<0.002	<0.002	5
	John Dory	6	0.05	100 %	<0.002	<0.002	6
	Ling, European	3	0.05	100 %	<0.002	<0.002	3
	Megrim	4	0.05	100 %	<0.002	<0.002	4
	Monkfish	13	0.05	100 %	<0.002	<0.002	13
	Plaice, European	6	0.05	100 %	<0.002	<0.002	6
	Pollack, Black	1	0.05	100 %	-	<0.002	1
	Pollack, European	2	0.05	100 %	-	<0.002	2
	Ray	4	0.05	100 %	<0.002	<0.002	3
	Salmon, Wild	2	0.05	100 %	--	<0.002	2
	Sole, Black	6	0.05	100 %	<0.002	<0.002	6
	Sole, Lemon	7	0.05	100 %	<0.002	<0.002	7
	Turbot	4	0.05	100 %	<0.002	<0.002	4
	Whiting, Blue	5	0.05	100 %	<0.002	0.01	2
	Whiting, European	9	0.05	100 %	<0.002	<0.002	9
	Witch	1	0.05	100 %	-	<0.002	1

	Crab, Brown (Claw)	43	0.50	95.3 %	0.005	1.29	3
	Crab, Spider	6	0.50	100 %	0.008	0.04	0
	Nephrops	5	0.50	100 %	0.04	0.13	0
	Clam Razor	6	1.00	100 %	0.02	0.021	0
	Clam, Manila	1	1.00	100 %	-	0.02	0
	Cockle	2	1.00	100 %	-	0.06	0
	Mussel, Blue	90	1.00	100 %	0.06	0.27	0
	Oyster, European Flat	13	1.00	61.5 %	0.59	8.675	0
	Oyster, Pacific	160	1.00	100 %	0.17	0.72	0
	Squid, Common	4	1.00	100 %	0.004	0.05	2

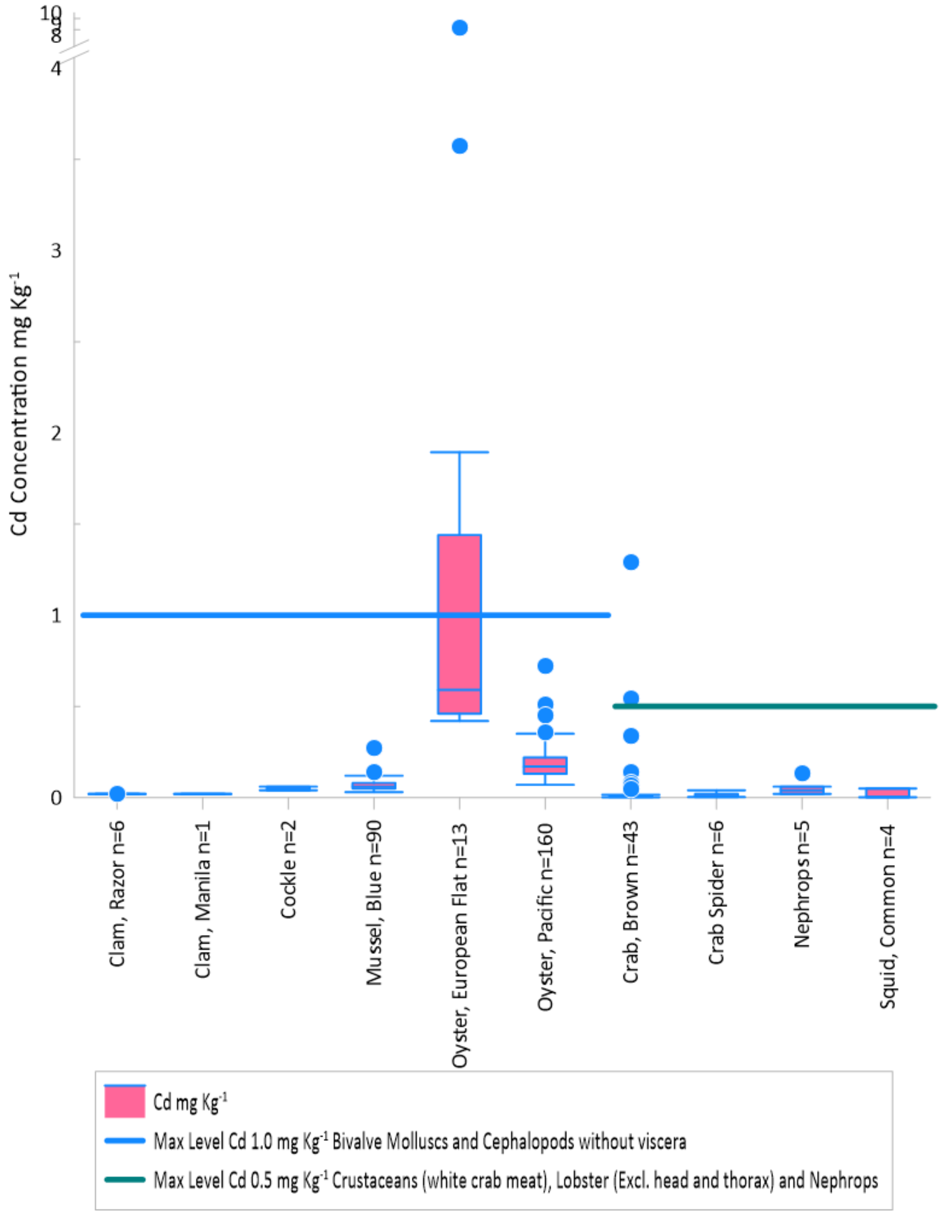


Figure 2: Levels of cadmium[2] in shellfish 2012-2017.
Fish are not plotted as few detections > limit of quantification

[2] For the European Flat Oyster (native oyster) samples taken were from a single location in Tralee Bay (Maharees)

Table 5: Summary Results for Lead (mg /Kg WW) in Seafood Samples from Irish Waters, 2012-2017.

Species	Count (n)	Limit mg /Kg ww	Compliance	Median mg /Kg ww	Max mg /Kg ww	n<LOQ
Albacore	5	0.3	100%	<0.02	<0.02	5
Brill	3	0.3	100%	<0.02	<0.02	3
Dab	1	0.3	100%	-	<0.02	1
Dogfish, Lesser Spotted	1	0.3	100%	-	<0.02	0
Dogfish, Spurdog	3	0.3	100%	<0.02	<0.02	3
European Sea Bass	1	0.3	100%	-	<0.02	1
Gurnard, Grey	2	0.3	100%	-	<0.02	2
Herring, Atlantic	6	0.3	100%	<0.02	<0.02	6
Mackerel, Atlantic	8	0.3	100%	<0.02	0.09	7
Mackerel, Horse	3	0.3	100%	<0.02	<0.02	3
Cod, Atlantic	11	0.3	100%	<0.02	<0.02	11
Haddock	9	0.3	100%	<0.02	<0.02	9
Hake, European	8	0.3	100%	<0.02	<0.02	8
John Dory	6	0.3	100%	<0.02	<0.02	6
Ling, European	3	0.3	100%	<0.02	<0.02	3
Megrim	4	0.3	100%	<0.02	<0.02	4
Monkfish	13	0.3	100%	<0.02	<0.02	13
Pollack, Black	1	0.3	100%	-	0.004	1
Pollack, European	2	0.3	100%	-	<0.02	2
Plaice, European	6	0.3	100%	<0.02	0.04	5
Ray	4	0.3	100%	<0.02	<0.02	3

	Salmon, Wild	2	0.3	100%	-	<0.02	2
	Sole, Black	6	0.3	100%	<0.02	<0.02	6
	Sole, Lemon	7	0.3	100%	<0.02	<0.01	7
	Turbot	4	0.3	100%	<0.02	<0.02	4
	Whiting, Blue	5	0.3	100%	<0.02	<0.01	5
	Whiting, European	9	0.3	100%	<0.02	<0.02	9
	Witch	1	0.3	100%	-	<0.02	1
	Crab, Brown (Claw)	19	0.5	100%	<0.02	0.11	15
	Nephrops	5	0.5	100%	<0.02	0.03	3
	Clam, Manila	1	1.5	100%	-	0.04	0
	Cockle	2	1.5	100%	-	0.15	0
	Clam Razor	6	1.5	100%	0.11	0.15	0
	Mussel Blue	90	1.5	100%	0.12	0.55	3
	Oyster European Flat	13	1.5	100%	0.03	0.06	2
	Oyster Pacific	160	1.5	100%	0.05	0.21	9
	Squid Common	4	0.3	100%	<0.007	<0.01	4

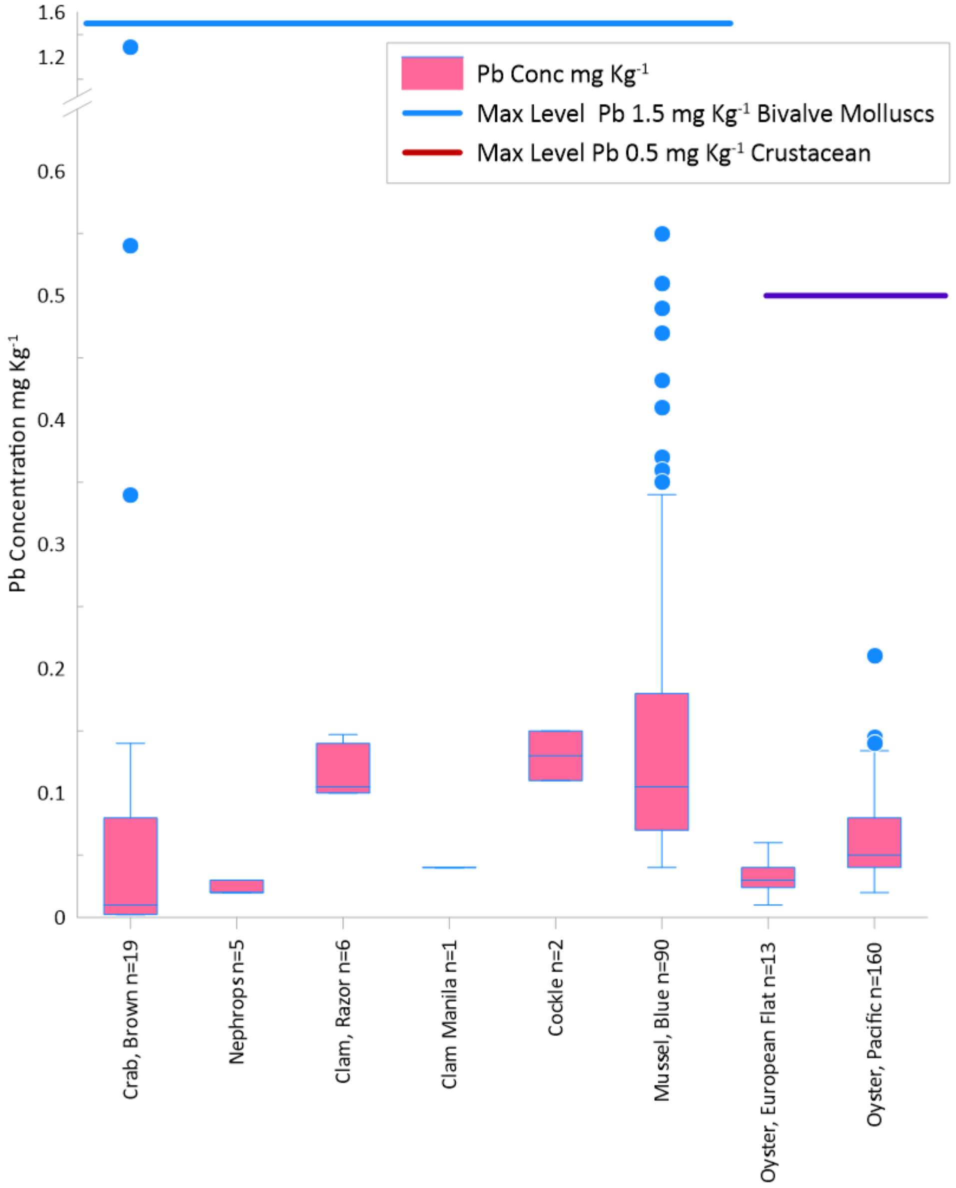


Figure 3: Levels of lead in shellfish 2012-2017
Fish are not plotted as few detections > limit of quantification

Table 6: Summary Results for Mercury (mg/Kg WW) in Seafood Samples from Irish Waters, 2012-2017.

Species	Count (n)	Limit mg /Kg ww	Compliance	Median mg /Kg ww	Max mg /Kg ww	n<LOQ
Albacore	16	1.00	100%	0.3	0.41	0
Brill	4	0.5	100%	0.045	0.06	0
Dogfish, Lesser Spotted	2	0.5	100%	0.33	0.4	0

	Dogfish, Spurdog	4	0.5	100%	0.165	0.381	0
	Dab	3	0.5	100%	0.11	0.145	0
	European Sea Bass	1	0.5	100%	-	0.02	1
	Forkbeard	2	0.5	100%	-	0.05	0
	Mackerel, Atlantic	9	0.5	100%	0.02	0.05	0
	Mackerel, Horse	4	0.5	100%	0.1	0.146	0
	Cod, Atlantic	14	0.5	100%	0.127	0.39	0
	Gurnard, Grey	3	0.5	100%	0.199	0.21	0
	Haddock	21	0.5	100%	0.08	0.216	0
	Hake, European	15	0.5	100%	0.098	0.29	0
	Herring, Atlantic	7	0.5	100%	0.045	0.06	0
	John Dory	8	0.5	100%	0.131	0.21	0
	Ling, European	5	0.5	100%	0.17	0.294	0
	Megrim	8	1.0	100%	0.065	0.19	0
	Monkfish	20	0.5	100%	0.11	0.189	0
	Plaice, European	16	0.5	100%	0.05	0.13	0
	Pollack Black	3	0.5	100%	0.06	0.091	0
	Pollack European	3	0.5	100%	0.07	0.07	0
	Ray	7	1.0	100%	0.06	0.16	0
	Salmon, Wild	2	0.5	100%	0.10	0.11	0
	Sole, Black	11	0.5	100%	0.06	0.18	0
	Sole, Lemon	10	0.5	100%	0.054	0.17	0
	Turbot	4	0.5	100%	0.09	0.138	0
	Whiting, Blue	6	0.5	100%	0.039	0.07	0
	Whiting, European	13	0.5	100%	0.1	0.18	0
	Witch	4	0.5	100%	0.26	0.41	0

Crab, Brown (Claw)	14	0.5	100%	0.07	0.12	0
Nephrops	7	0.5	100%	0.09	0.25	0
Clam, Manila	1	0.5	100%	-	0.01	0
Cockle	2	0.5	100%	-	0.01	0
Clam Razor	6	0.5	100%	0.014	0.028	0
Mussel Blue	92	0.5	100%	<0.015	0.035	21
Oyster European Flat	13	0.5	100%	0.022	0.09	1
Oyster Pacific	160	0.5	100%	0.02	0.05	29
Squid Common	4	0.5	100%	0.022	0.05	0

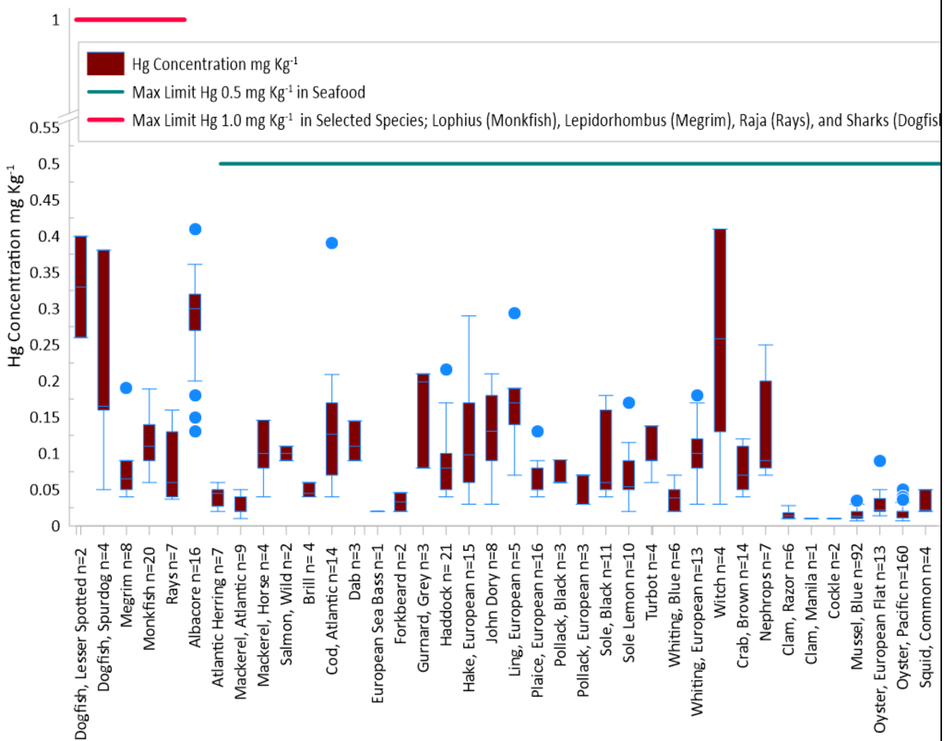


Figure 4: Levels of mercury in fish and shellfish 2012-2017

Organic contaminants

- There was 100% compliance with Maximum Limits set in Regulation 1881/2006/EC for all samples tested for (Benzo(a)pyrene and sum of 4 PAH – tables 7 and 8). PAH are rapidly metabolised in finfish and consequently limits are only set for bivalve molluscs. There were no exceedances for PAH in in bivalve molluscs from designated shellfish waters (benzo(a)pyrene in bivalve molluscs, or for the sum of benzo(a)pyrene, benzo(a)anthracene, and benzo(b)fluoranthene and chrysene)

- There was 100% compliance with Maximum Limits set in Regulation 1881/2006/EC for all samples tested for sum of 6 Indicator PCBs (Table 9) and PCDD/Fs-WHO_{2005}-TEQ (Table 10) and Sum of sum of PCDD/Fs and dioxin like PCBs as WHO_{2005}-TEQ (Table 11)

Table 7: Summary Results for Benzo(a)pyrene (µg /Kg WW) in Seafood Samples from Irish Waters, 2012-2017.

Species	Count (n)	Limit µg /Kg ww	Compliance	Median µg /Kg ww	Max µg /Kg ww	n<LOQ
Clam Razor	5	5	100 %	0.591	1.083	0
Cockle	1	5	100 %		0.43	0
Crab brown	1	5	100 %		0.63	0
Mussel Blue	68	5	100 %	0.148	0.983	3
Oyster European Flat	11	5	100 %	0.11	0.305	1
Oyster Pacific	129	5	100 %	0.14	1.511	0

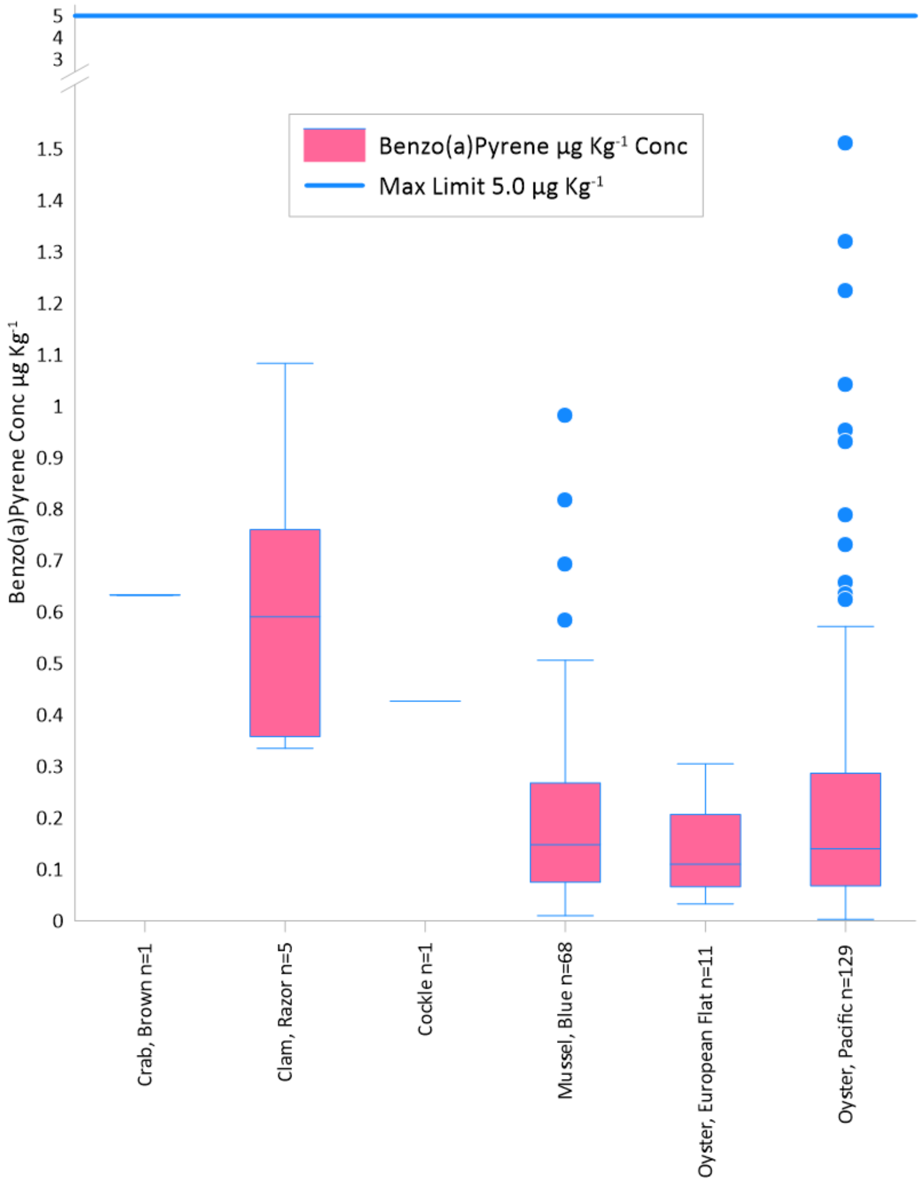


Figure 5: Levels of Benzo(a)pyrene in bivalve molluscs 2012-2017

Table 8: Summary Results for Sum of 4 PAHs (µg /Kg WW upperbound) in Seafood Samples from Irish Waters, 2012-2017 (4 PAH: benzo(a)pyrene, benz(a)anthracene, benzo(b)fluoranthene, chrysene)

Species	Count (n)	Limit µg /Kg ww	Compliance	Median µg /Kg ww	Max µg /Kg ww
Clam Razor	5	30	100%	6.325	7.865
Cockle	1	30	100%		2.96
Crab brown	1	30	100%		5.07

Mussel Blue	67	30	100%	1.587	8.034
Oyster European Flat	10	30	100%	2.205	4.397
Oyster Pacific	129	30	100%	2.839	17.49

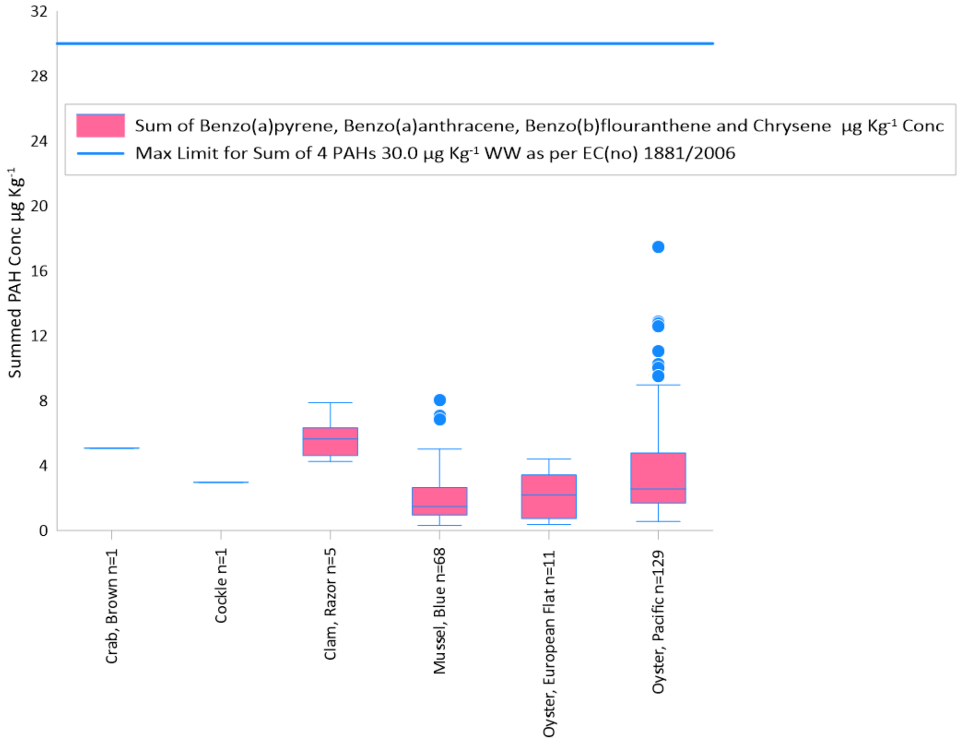


Figure 6: Levels of Summed PAHs in bivalve molluscs 2012-2017

Table 9: Summary Results for Sum of ICES 6 PCBs (µg/Kg WW) in Seafood Samples from Irish Waters, 2012-2017

Species	Count (n)	Limit µg /Kg ww	Compliance	Median µg /Kg ww	Max µg /Kg ww
Cod, Atlantic	8	75	100%	0.7845	1.828
Black Sole	1	75	100%	-	1.22
Haddock	3	75	100%	0.780	0.780
Hake, European	5	75	100%	0.626	1.440
Herring, Atlantic	3	75	100%	4.598	12.36
John Dory	1	75		-	2.064
Lemon Sole	2	75	100%	0.356	0.379
Mackerel, Atlantic	5	75	100%	2.361	4.368

	Monkfish	5	75	100%	0.300	0.780
	Plaice, European	3	75	100%	0.344	0.970
	Pollock, European	1	75	100%	-	0.728
	Pollock	1	75	100%	-	0.728
	Ray	1	75	100%	-	0.970
	Turbot	1	75	100%	-	0.970
	Tuna, Albacore	1	75	100%	-	3.113
	Whiting, European	3	75	100%	0.569	1.280
	Wild Salmon	10	75	100%	3.621	7.102
	Crab, brown	1	75	100%	-	2.581
	Nephrops	2	75	100%	1.231	1.969
	Crab, Brown (claw)*	16	75	100%	0.43	0.7
	Clam, manila	1	75	100%	-	1.584
	Clam, razor	6	75	100%	0.808	1.245
	Cockle	2	75	100%	0.240	0.314
	Mussel, blue	90	75	100%	0.610	2.693
	Oyster, European flat	13	75	100%	0.475	2.048
	Oyster, Pacific	160	75	100%	0.485	3.954
	*2012 crab study					

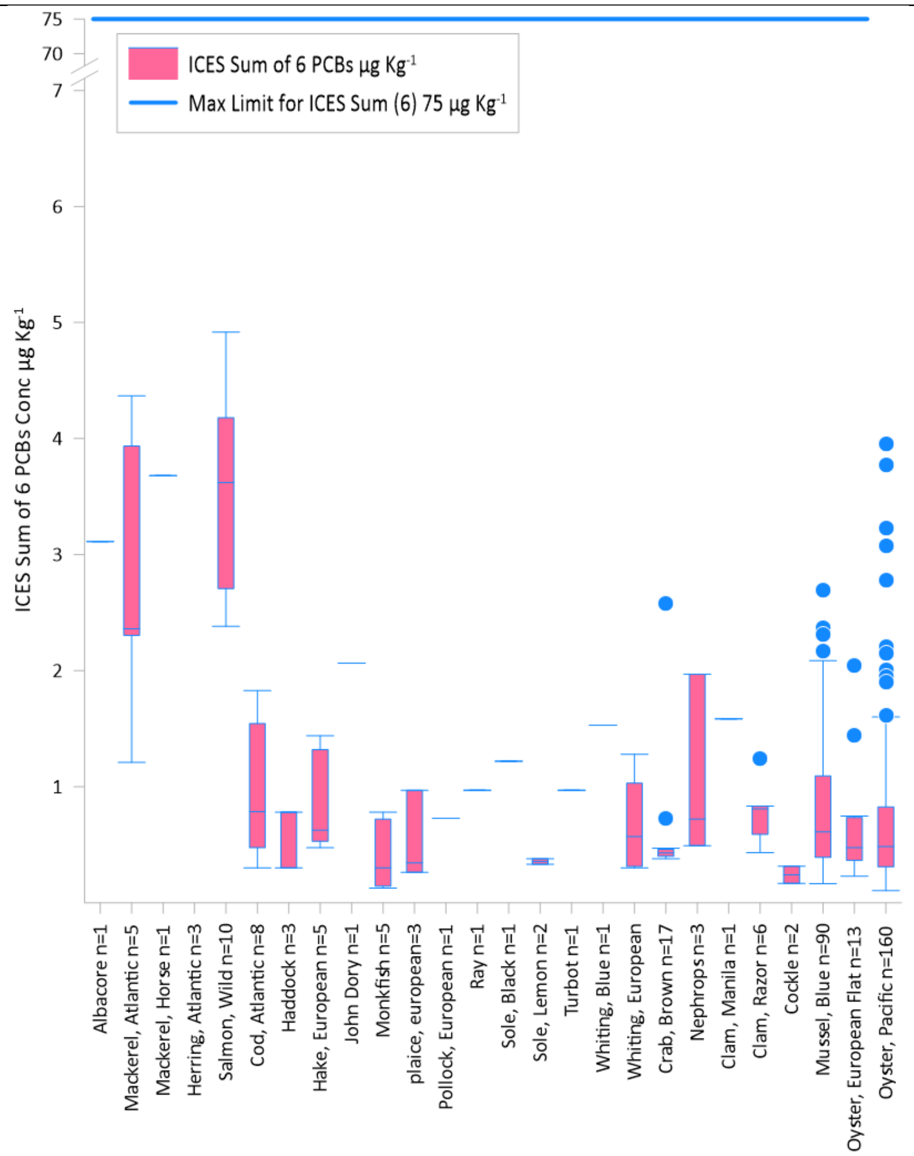


Figure 7: Levels of ∑6 indicator PCBs in fish and shellfish 2015-2017

Table 10: Summary Results for the Dioxin Sum of WHO-PCDD/F-TEQ ng/Kg 2015 – 2017 (Results expressed as WHO 2005 TEQ)

Species	Count (n)	Limit TEQ ng /Kg ww	Compliance	Median TEQ ng /Kg ww	Max TEQ ng /Kg ww
Cod, Atlantic	2	3.5	100%	0.158	0.158
Codling	1	3.5	100%	-	0.160
Haddock	2	3.5	100%	0.158	0.158
Hake	1	3.5	100%	-	0.158
Herring, Atlantic	3	3.5	100%	0.307	0.538
Lemon Sole	2	3.5	100%	0.159	0.161
Mackerel	3	3.5	100%	0.228	0.247
Monkfish	1	3.5	100%	-	0.158

Plaice, European	2	3.5	100%	0.158	0.158
Tuna, Albacore	2	3.5	100%	0.169	0.177
Whiting	3	3.5	100%	0.158	0.158
Nephrops	2	3.5	100%	0.184	0.210
Crab, Brown (claw)*	16	3.5	100%		0.118

*2012 crab study

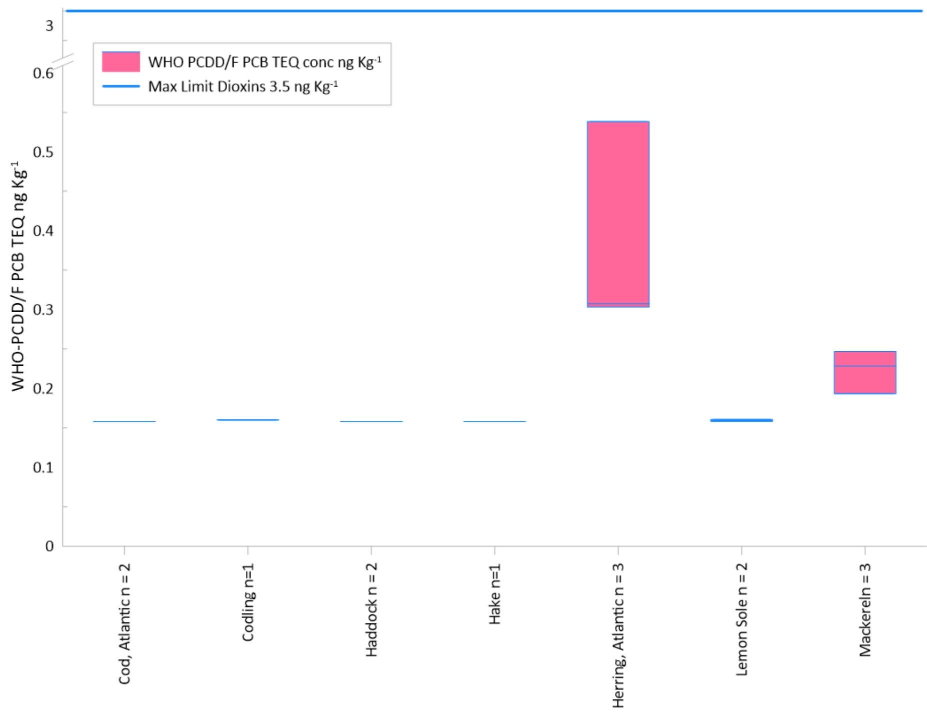


Figure 8: Sum of PCDD/F TEQ in seafood 2012-2017.

Table 11: Summary Results for Dioxin-Like PCB WHO-PCDD/F-PCB-TEQ ng/kg 2015 - 2017

Species	Count (n)	Limit ng TEQ /Kg ww	Compliance	Median ng TEQ /Kg ww	Max ng TEQ /Kg ww
Cod, Atlantic	2	6.5	100%	0.194	0.207
Codling	1	6.5	100%	-	0.180
Haddock	2	6.5	100%	0.174	0.178
Hake	1	6.5	100%	-	0.195

Herring, Atlantic	3	6.5	100%	0.742	1.209
Lemon Sole	2	6.5	100%	0.192	0.195
Mackerel	3	6.5	100%	0.702	0.704
Monkfish	1	6.5	100%	-	0.167
Plaice, European	2	6.5	100%	0.203	0.219
Tuna, Albacore	2	6.5	100%	0.404	0.437
Whiting	3	6.5	100%	0.201	0.206
Nephrops	2	6.5	100%	0.269	0.353
Crab, Brown (Claw)*	16	6.5	100%	0.125	0.188

*2012 crab study

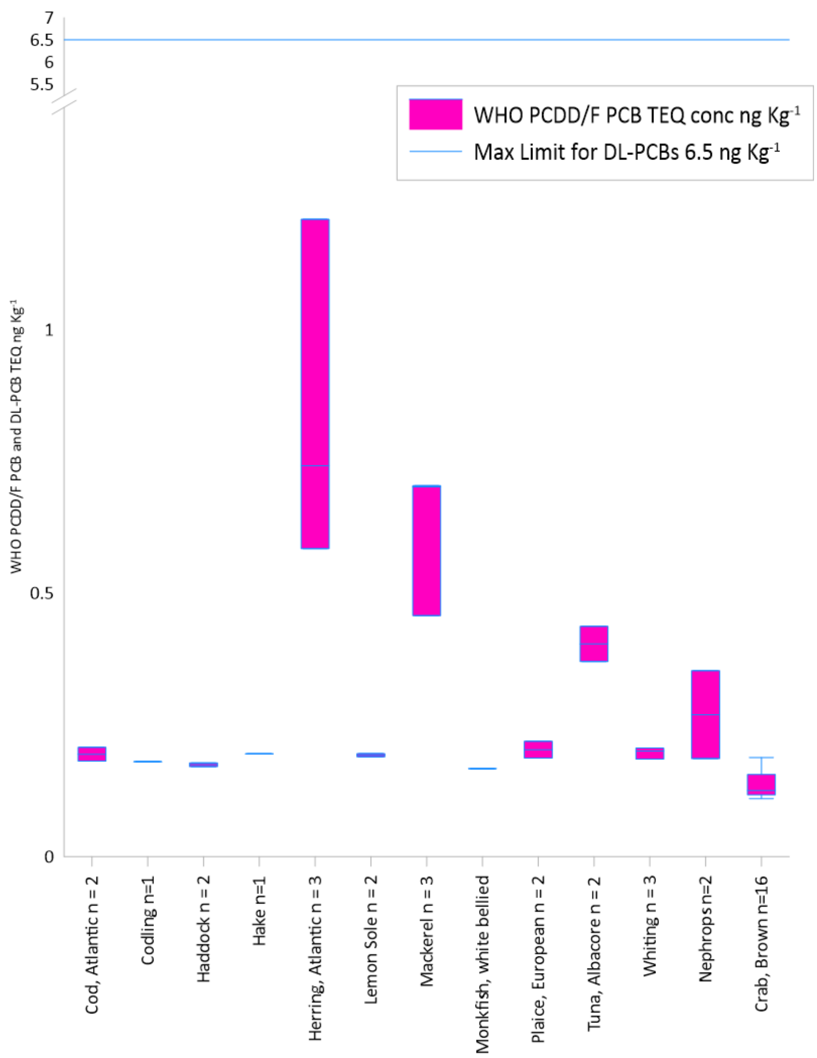


Figure 9: levels of ∑ PCDD/F & DL-PCB TEQ Seafood 2012-2017.

Conclusion (extended)	Good Environmental Status has been achieved for Descriptor 9. Seafood sampled from shellfish growing waters and commercial fishing grounds around Ireland, between 2012 and 2017, shows a consistently very high level of compliance (99.7%) with Maximum Limits set in Commission Regulation 1881/2006 EC, as amended. This relates to the following contaminants; mercury, cadmium, lead, indicator polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/Fs – dioxins), sum of PCDD/Fs and dioxin-like PCBs, and polyaromatic hydrocarbons (PAH). Out of 1422 individual test results for metals in all samples, an overall compliance of 99.5% was achieved. Organic substances show 100% compliance for 853 individual test results was recorded. The overall compliance rate was 99.7% for 2273 test results. An extensive monitoring program and good dataset of results covering a broad range of fish and shellfish species underpins this assessment. On the very rare occasions of non-compliant results were detected these related to very local coastal issues or to other non-pollution related factors			
Knowledge gaps (extended)	• D9 by definition is limited to assessing exceedance levels established by Community legislation or other relevant standards in this case Commission Regulation 1881/2006 as amended. This assessment is limited to the assessment of compliance for small number of substances for which maximum limits for seafood have been set in this Regulation. • While there is a good overall database, there are limited data for some species. Ongoing monitoring by the Marine Institute attempts to address these gaps by targeting species for which there is limited data available. • Additional marine food matrices e.g. seaweeds, are not covered at present by the regulations			
	Assessment Data			
Data Sources	Marine Institute seafood monitoring 2021 – 2017			
Data Locations (URL)	www.marine.ie Seafood data held on Marine Institute contaminants in biota database			
Data Time Line	Start Date:	2012	End Date:	2017
Point of Contact	Evin McGovern/ Jenny Ronan, Marine Institute			
Email	Evin.mcgovern@marine.ie; jenny.ronan@marine.ie			

Descriptor 10 – Marine Litter

D10 C1

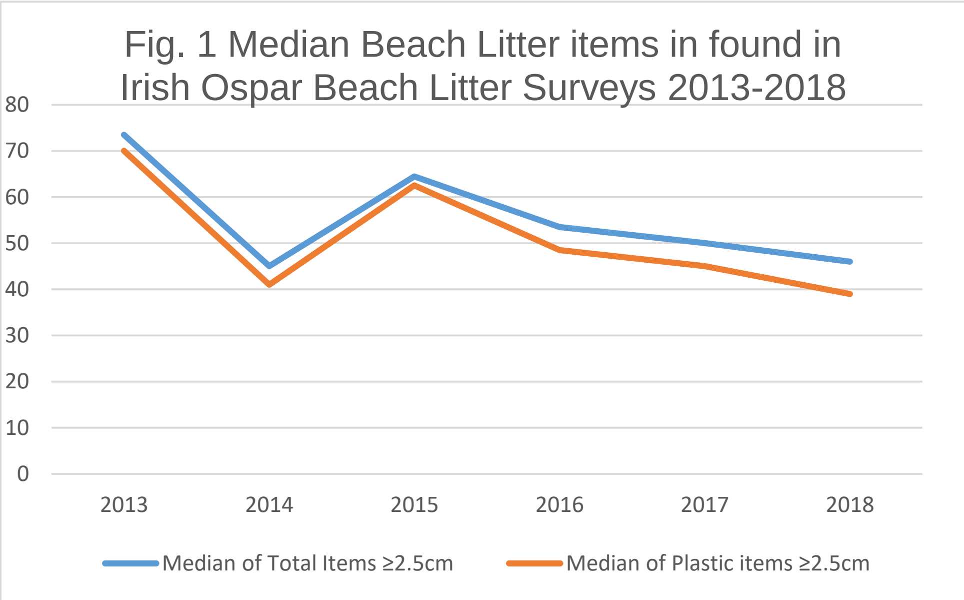
Ref D10C1	Assessment Sheet: Criteria D10C1 Litter (excluding micro-litter), classified in the following categories: artificial polymer materials, rubber, cloth/textile, paper/cardboard, processed/worked wood, metal, glass/ceramics, chemicals, undefined, and food waste. Additional national targets will be set in relation to the median number of litter items found in beach litter surveys and single use plastic items which are to be prohibited from being placed on the market from 2021 by EU Directive (EU) 2019/904 on the reduction of the impact of certain plastic products on the environment.
Background	In 2013, Ireland completed the Initial Assessment of its maritime area under the Marine Strategy Framework Directive (MSFD). It concluded that there was lack of established evidence in relation to the environmental impacts of marine litter. It also concluded that insufficient survey data from beach litter surveys and seabed litter monitoring undertaken as part of International Bottom Trawl Surveys (IBTS) to form a comprehensive analysis. Thus, it was not possible at that time to assess the status of the pressure and determine whether or not GES had been achieved. The EU Commission Decision 2017/848 sets out comprehensive requirements for the determination of GES. These are: • The composition, amount and spatial distribution of litter on the coastline, in the surface layer of the water column, and on the seabed, are at levels that do not cause harm to the coastal and marine environment. • Member States shall establish threshold values for these levels through cooperation at Union level, taking into account regional or sub -regional specificities. The Decision classifies litter for consideration under D10C1 criteria in the following categories: artificial polymer materials, rubber, cloth/textile, paper/cardboard, processed/worked wood, metal, glass/ceramics, chemicals, undefined and food waste. Since 2013, Ireland's data collection and methods of assessment in relation to coastal and seabed litter have progressed significantly. There is now consistent longitudinal beach litter data available from

	Ireland's OSPAR beach litter surveys to indicate trends. This data may be used to meet assessment requirements as set out under MSFD Article 8. However, at this time there is no established or agreed methodology for the assessment of the surface layer of the water column. Work to develop threshold values is underway at EU Level under the auspices of the MSFD Technical Working Group on Marine Litter (MSFD-TGML) and this is being supported by work under regional sea conventions such as OSPAR.
Objective	The objective of this assessment is to evaluate if the composition, amount and spatial distribution of litter on the coastline, in the surface layer of the water column, and on the seabed, are at levels that do not cause harm to the coastal and marine environment. This evaluation will ultimately have to be made in accordance with baselines and threshold values agreed jointly with Member States through cooperation at Union level.
Drivers	**Drivers** The primary drivers of marine litter are deliberate or accidental loss of materials into the environment through littering, mismanaged waste or accidental spillage and through abrasion, wear and fragmentation. This includes: • land based human activities generating litter within Ireland with pathways to the marine environment, such as rivers, streams, drains, sewage and other wastewater outflows; or in proximity to coastal areas, in particular coastal urban conglomerations, recreational/ tourist areas, ports, harbours and marinas; • mismanaged municipal, industrial (including service industry) agricultural or other waste entering the environment in coastal areas or in proximity to pathways to the marine environment; • litter generated by by maritime human activities within the Irish Exclusive Economic Zone, in particular fishing and aquaculture activities, but also activities such as shipping, offshore installations, or maritime recreational and tourist activities; and

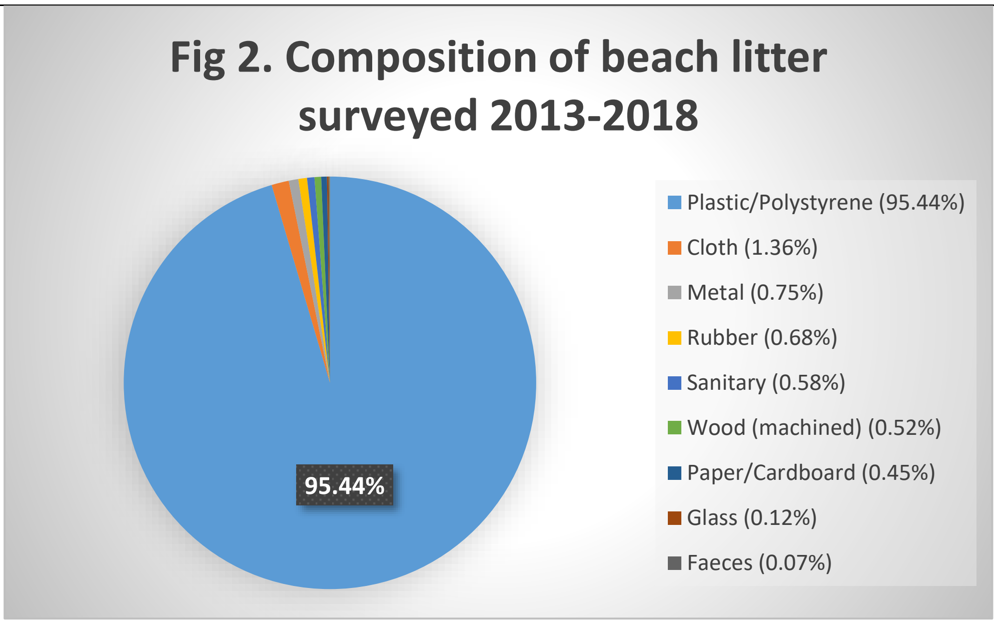
	• marine litter originating from landward or maritime activities beyond the national jurisdiction carried into the Irish maritime area by currents or winds.
Pressures	MSFD Annex III table 2 "anthropogenic pressures" solely identifies the "Input of litter (solid waste matter, including micro-sized litter)" as the pressure arising from marine litter. However, potential pressures may arise from litter deposition and accumulation in key habitats; large scale entanglements such as "ghost fishing" by lost or discarded fishing or aquaculture gear; and potential harm to species generated through large scale ingestion of plastics.
State	**Litter on the Coastline (Beach Litter)** The Draft Joint Research Council Technical reports Marine Beach Litter Baselines and A European Beach Litter Threshold Value and Assessment Method recommended that the median number of beach litter items of ≥ 2.5 cm should be considered rather than the arithmetic mean for the determination of baselines and threshold values. "Two commonly used assessment metrics, the arithmetic mean and median, were compared with respect to the criteria: (a) quantitative comparability, (b) robustness against extreme values and (c) transparency and practicality. Based on this comparison (Annex 2), TG-ML agreed to use the median as assessment metric" [Beach Litter Threshold Value and Assessment Method, P.8]. While the actual baselines and threshold values have yet to be agreed, this method for determining them is supportable as it helps to mitigate against statistical anomalies caused by outlier events. The table and graph below outline the mean number of beach litter items ≥ 2.5 cm found on Irish beaches in Ireland's OSPAR beach litter surveys undertaken since Ireland's MSFD initial Assessment was produced in 2013. These are commissioned by the Department of Housing, Planning and Local Government's Marine Environment Section and reported to a central OSPAR Database hosted by the Marine Conservation Society in the United Kingdom.

Table 1. median beach litter items found in OSPAR surveys 2013-2018

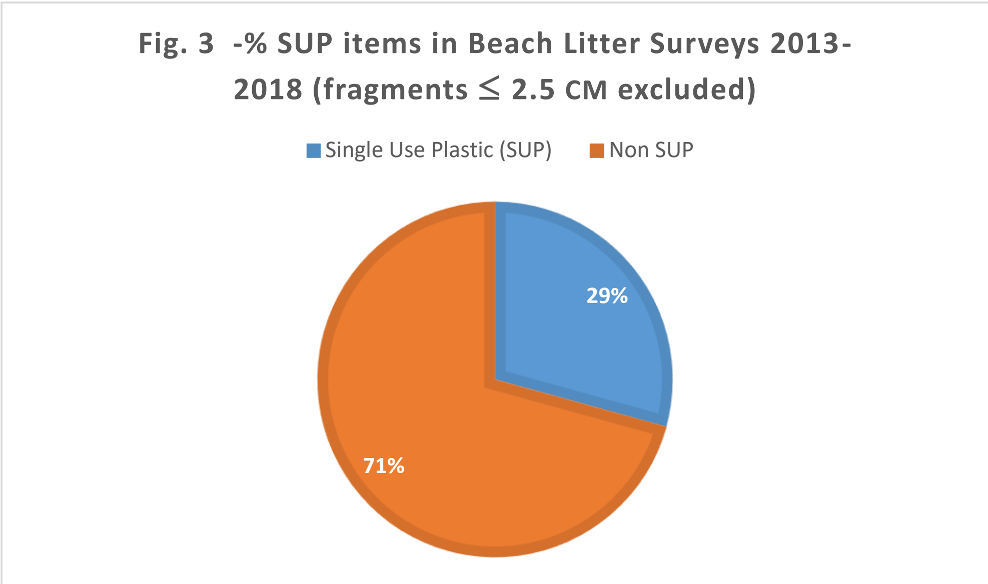
Year	Median of Total Items ≥ 2.5cm	Median of Plastic items ≥ 2.5cm	% Plastic relative to Total items
2013	73.5	70	95.24%
2014	45	41	91.11%
2015	64.5	62.5	96.90%
2016	53.5	48.5	90.65%
2017	50	45	90.00%
2018	46	39	84.78%



The pie chart below (Figure 2) outlines the composition of beach litter found in surveys between 2013 and 2018 categorised by the material types set out in the D10 C1 criteria for determining GES in EU Commission Decision 2017/848. It is clear that the overwhelming bulk of beach litter found in surveys is plastic.



According to Beach litter surveys undertaken, commissioned by the Department of Housing Planning and Local Government, the percentage of single use plastic items (SUP) in the total amount of beach litter identified in Irish OSPAR beach litter surveys 2013-2018 was 25.79%. When this total is adjusted to remove smaller micro-litter items considered microplastics (i.e. litter fragments ≤ 2.5 cm are not included in the MSFD TG-ML Baseline Report), this proportion becomes 29.28% (see fig. 3 below)



(Non-SUP items include larger lost or discarded re-usable items such as fishing or aquaculture gear, strings, plastic fragments, discarded clothing etc.)

The top ten items found in Beach Litter Surveys during the period 2013-2018 are outlined in Table 2 highlighting the source between Single Use Plastic (SUP) and Non-SUP items. Figure 4 outlines the percentage breakdown of Total Single Use Plastic by category items found in Irish beach litter surveys 2013-2018.

Table 2 - top 10 items found in Beach Litter surveys 2013-2018

Beach Litter item	**SUP/ Non-SUP**	**% of Total Beach Litter 2013-2018 (includes items excluded by TG-ML Baseline Report)**
Plastic: String and cord (diameter less than 1 cm)	Non-SUP	37.54%
Plastic/polystyrene pieces [3] 0 - 2.5 cm	Non-SUP	11.52%
Plastic: Crisp/sweet packets and lollipop sticks	SUP	10.25%
Plastic: Rope (diameter more than 1 cm)	Non-SUP	7.70%
Plastic: Small bags (e.g. freezer bags/ sandwich bags)	SUP	4.16%
Plastic: Caps/lids	SUP	3.73%
Plastic: Plastic/polystyrene pieces 2.5 cm > < 50cm	Non-SUP	2.89%
Plastic: Drinks (bottles, containers and drums)	SUP	2.76%
Plastic: Food containers including fast food containers	SUP	1.37%
Plastic: Large Bags (e.g. shopping bags)	SUP	1.32%

[3] Although included in the OSPAR beach litter surveys, small plastic is not included in TG-ML Baseline Report

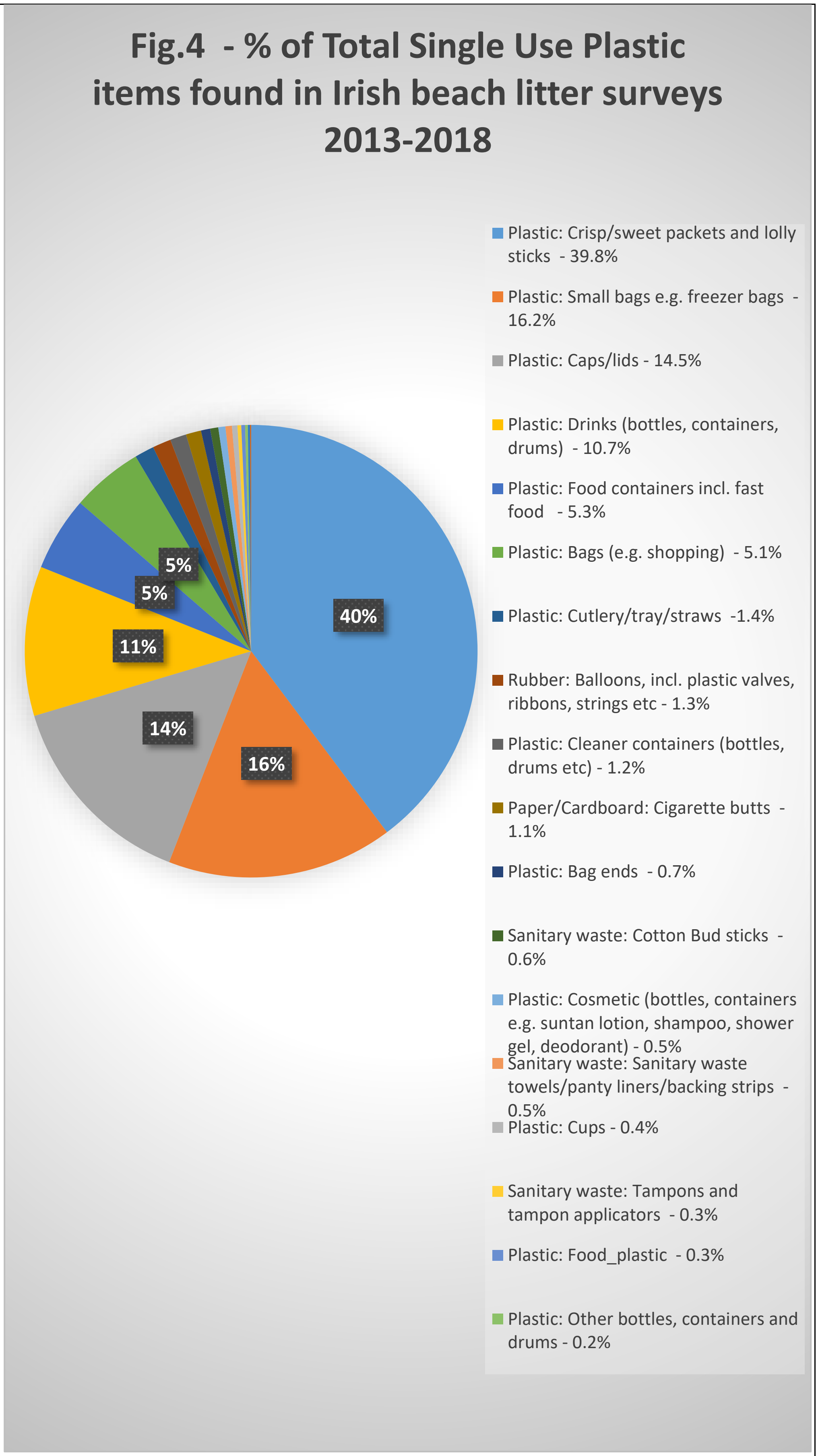


Fig.4 - % of Total Single Use Plastic items found in Irish beach litter surveys 2013-2018
40%
16%
14%
11%
5%
5%
Plastic: Crisp/sweet packets and lolly sticks - 39.8%
Plastic: Small bags e.g. freezer bags - 16.2%
Plastic: Caps/lids - 14.5%
Plastic: Drinks (bottles, containers, drums) - 10.7%
Plastic: Food containers incl. fast food - 5.3%
Plastic: Bags (e.g. shopping) - 5.1%
Plastic: Cutlery/tray/straws -1.4%
Rubber: Balloons, incl. plastic valves, ribbons, strings etc - 1.3%
Plastic: Cleaner containers (bottles, drums etc) - 1.2%
Paper/Cardboard: Cigarette butts - 1.1%
Plastic: Bag ends - 0.7%
Sanitary waste: Cotton Bud sticks - 0.6%
Plastic: Cosmetic (bottles, containers e.g. suntan lotion, shampoo, shower gel, deodorant) - 0.5%
Sanitary waste: Sanitary waste towels/panty liners/backing strips - 0.5%
Plastic: Cups - 0.4%
Sanitary waste: Tampons and tampon applicators - 0.3%
Plastic: Food_plastic - 0.3%
Plastic: Other bottles, containers and drums - 0.2%

	The JRC Technical Report – A European Beach Litter Threshold Value and Assessment Method, recommends that 2015-2016 is taken as reference years for the setting of a European baseline for beach litter found in 100 metre surveys. This has not yet been agreed by Member States and it remains under consideration. The overall EU-wide median number of items found in 100m beach litter surveys in these years was 165 items. The Report found that there was an overall median value of 61 items per 100 metre beach litter on Irish beaches surveyed for OSPAR in the same period. This represents 36.97% of the corresponding EU-wide median value of 165. By this measure, Ireland's maritime area has the 7th lowest incidence of beach litter out of 29 EU subregions. By end 2018, there was a further 20% decrease (from 61 to 49 items) in the median number of beach litter items found on Irish beaches in OSPAR surveys. Overall, beach litter levels have decreased at Irish beaches surveyed, so beach litter levels are in compliance with Good Environmental Status in the context of the target set out in Ireland's 2013 Initial Assessment. **Seabed Litter** The MSFD TG-ML Draft Guidance on Monitoring of Marine Litter in European Seas recommends that monitoring of litter on continental margins (>20 m and < 800m depth) should be undertaken within existing trawling programmes for the assessment of fish stocks[4]. The Irish Groundfish Survey (IGFS) is an annual fisheries survey coordinated by the International Council for the Exploration of the Seas (ICES) as part of the International Bottom Trawl Survey, covering NE Atlantic and Baltic Sea. In the Irish Exclusive Economic Zone, France and Ireland currently survey the Celtic Sea area, Ireland covers the shelf West of Ireland, Ireland and the UK Scotland survey the north coast of Ireland and the UK Northern Ireland covers the Irish Sea. Brexit may impact upon the future management of this survey.

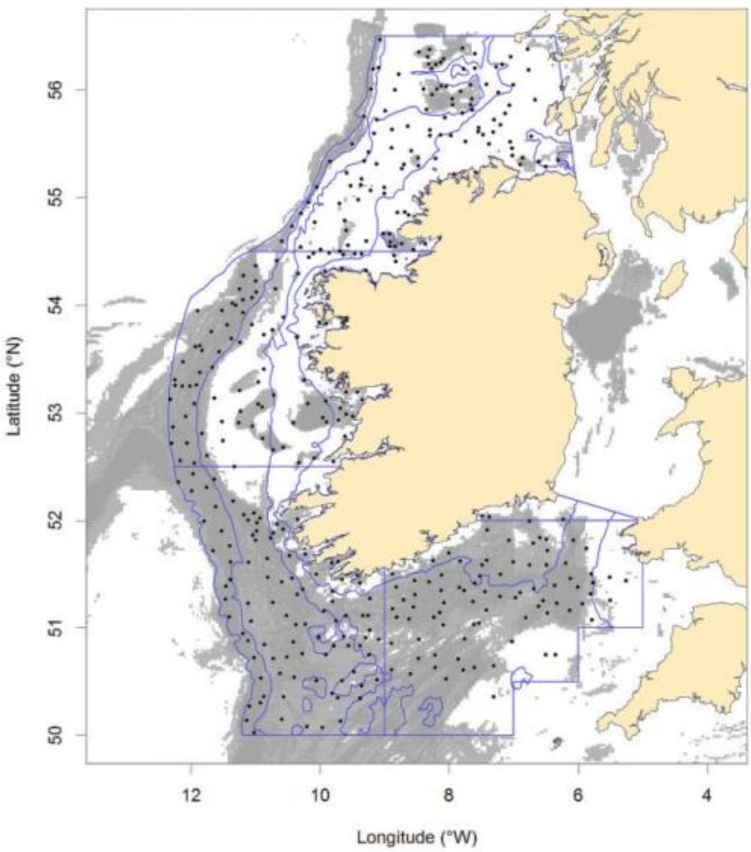
[4] 'JRC Scientific and Policy Reports - A gsuidance document within the Common Implementation Strategy for the Marine Strategy Framework Directive;' Report EUR 26113 EN; MSFD Technical Subgroup on Marine Litter; Joint Research Centre; Ispra, Italy; 2013 – P.60

The Marine Institute has been collecting IBTS coordinated seafloor litter data since 2010. Each year, approximately 165 Stations are selected randomly to be surveyed by trawl. 992 groundfish survey trawls were carried out in Irish marine waters between 2012-2018 excluding 2015[5].

Table 3: Number of survey trawls per year 2012-2018 (excluding 2015)

Year (excl. 2015)	2012	2013	2014	2016	2017	2018	Total 2012-2018 (excl. 2015)
Total trawls	172	176	170	172	149	153	992

Fg. 5 – Map of IGFS historic haul positions (black circles) Darker shading highlights higher commercial fishing intensity



Seabed litter was reported on average in 62% of seabed survey trawls in Irish waters between 2012-2018 (excluding 2015). The proportion of trawls reporting seabed litter and the average number of litter items per trawl has increased over the period from 2012 to 2018.

[5] A shortfall in resources prevented surveys from being undertaken in 2015.

As the biodegradability of certain marine litter items, such as plastic, in the marine environment is low this could occur due to the accumulation on non-degrading litter, even if inputs of marine environment are steady or even decreasing over time.

Table 4 – proportion of trawls in in Irish waters where marine litter was found

Year (excl. 2015)	2012	2013	2014	2016	2017	2018	% 2012-2018 (excl. 2015)
% trawls containing marine litter	45.93%	52.84%	63.53%	63.95%	78.52%	70.59%	62.00%

Fig .6 – Percentage of seabed trawls that contain litter 2012-2018 (excluding 2015)

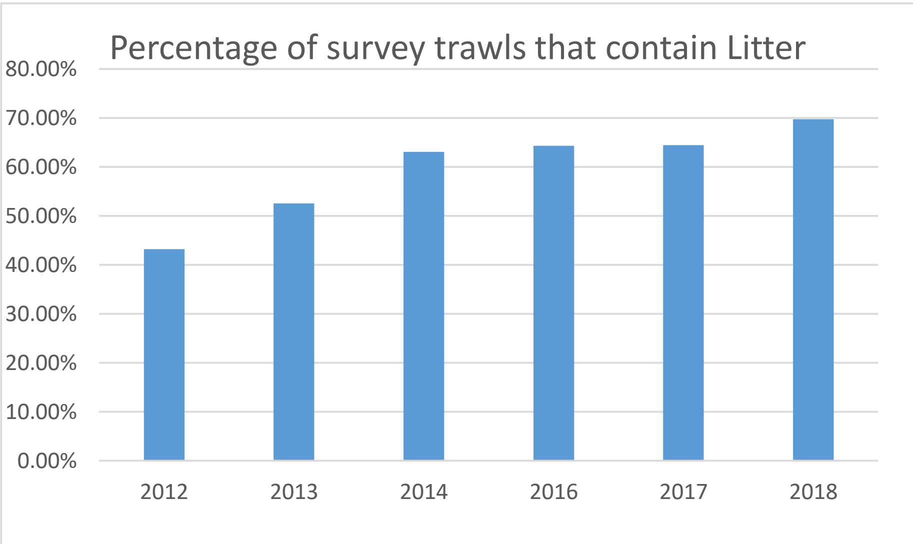


Table 5 – Average number of seabed litter items normalised to km^2 per trawl between 2012-2018 (excluding 2015)

Year	2012	2013	2014	2016	2017	2018
Average no. of litter items normalised to km^2 per trawl (rounded to nearest integer)	8	11	18	14	19	17

	ICES subregion 27.7g, (South-Cork), had the highest number of survey trawls containing litter and the highest average number of litter items per trawl. The lowest seabed litter levels were reported for the ICES subregion of 27.6a (Northwest– Donegal). Both the number of trawls where litter was present and the average number of litter items per trawl decreased from the south coast up along the western seaboard to the northwest coast of Ireland. Analysis of 2010-2014 Irish seabed litter data by Moriarty, M. et al. (2016)[6] determined it would be unlikely that trends in litter occurrence could be detected within 15 years, unless very striking changes occur. They calculated that a minimum of 25 years' data would be required to detect even a 30% change in litter occurrence under the current sampling regime. The draft OSPAR Intermediate Assessment 2019 Seafloor Litter Report also highlighted that more stations or longer datasets would be needed to detect 10 or 20% changes in the abundance of seafloor litter within 5 years. There are large quantitative variations in the geographical distribution of seabed litter levels in Irish marine waters, which may be due to a various factors including hydrodynamics, geomorphology and human factors. Moriarty et al. (2016) only found a small correlation between fishing effort and seabed litters levels off the southern coast of Ireland[7]. The seabed litter was categorised according to the classification system in the guidance document on Monitoring of Marine Litter in European Seas[8]. There are six main seafloor litter categories i.e. Plastic, Metals, Rubber, Glass/Ceramic, Natural products and Miscellaneous, with further subcategories (40 in total) as per Table 6 below.

[6] Moriarty, M. et al 2016 Spatial and temporal analysis of litter in the Celtic Sea from Groundfish Survey data: Lessons for monitoring. Marine Pollution Bulletin 103 195-205.

[7] Moriarty, M. et al. (2016) Spatial and temporal analysis of litter in the Celtic Sea from Groundfish Survey data: Lessons for monitoring. Mar Pollut Bull. 2016 Feb 15;103(1-2):195-205. doi: 10.1016/j.marpolbul.2015.12.019.

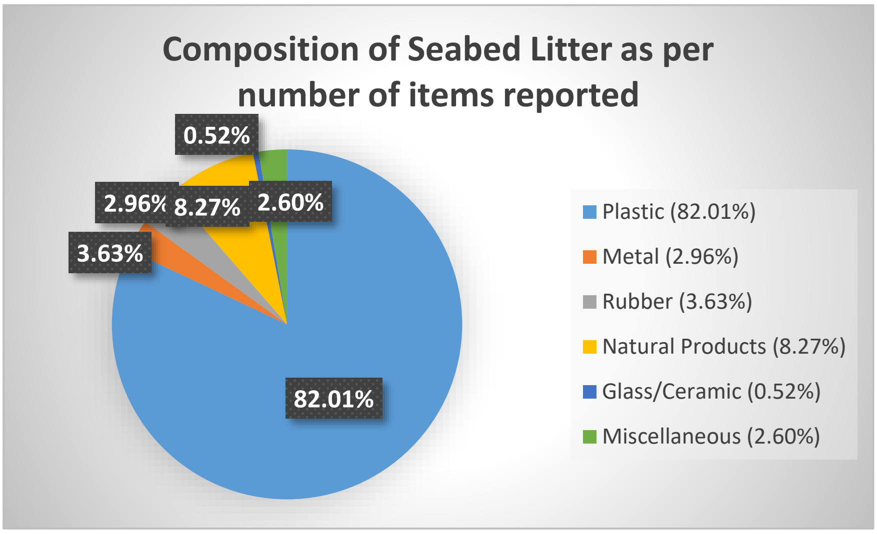
[8] Galgani, F. et al ? (2014) Guidance on Monitoring of Marine Litter in European Seas p1-128. https://doi.org/10.2788/99475.

Table 6 - Litter categories from IBTS for the North East Atlantic Region (TG-ML, 2013). A5, A6, A8, B3 and C3 subcategories are related to fishing.

A: Plastic	B: Metals		Related size category
A1. Bottle	B1. Cans (food)		A: <5*5 cm= 25 cm^2
A2. Sheet	B2. Cans (beverage)		B: <10*10 cm= 100 cm^2
A3. Bag	B3. Fishing related		C: <20*20 cm= 400 cm^2
A4. Caps/ lids	B4. Drums		D: <50*50 cm= 2500 cm^2
A5. Fishing line (monofilament)	B5. appliances		E: <100*100 cm= 10000 cm^2= 1 m^2
A6. Fishing line (entangled)	B6. car parts		F: >100*100 cm = 10000 cm2= 1 m2
A7. Synthetic rope	B7. cables		
A8. Fishing net	B8. other		
A9. Cable ties			
A10. Strapping band			
A11. crates and containers			
A12. diapers			
A13. sanitary towel/tampon			
A14. other			
C: Rubber	**D: Glass/ Ceramics**	**E: Natural products**	**F: Miscellaneous**
C1. Boots	D1. Jar	E1. Wood (processed)	F1. Clothing/ rags
C2. Balloons	D2. Bottle	E2. Rope	F2. Shoes
C3. bobbins (fishing)	D3. piece	E3. Paper/ cardboard	F3. other
C4. tyre	D4. other	E4. pallets	
C5. Glove		E5. other	
C6. other			

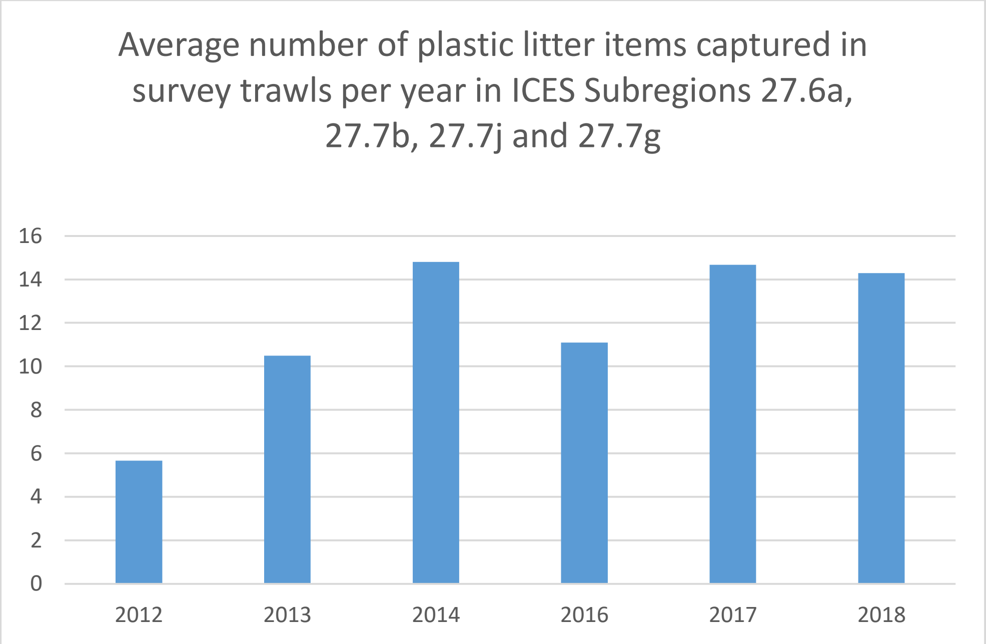
Plastic (82.01%) was the predominant material type found in seabed litter trawls between 2012-2018, followed by natural materials (8.27%).

Fig. 7 – Percentage of main seabed litter categories in survey trawls 2012-2018 (excluding 2015)



Overall, the average number of plastic litter per km^2 trawl is increasing over the years in all ICES Subregions apart from 27.7a which showed a decrease.

Fig.8 - Average number of plastic litter items captured in survey trawls per year in ICES Subregions 27.6a, 27.7b, 27.7j and 27.7g between 2012-2018 (excluding 2015)



Although standard otter trawls have been found to provide a satisfactory method for sampling litter[9], they are not designed to

[9] Galgani, F. et al. 2000 Litter on the sea floor along European coasts. Marine Pollution Bulletin 40 (6), 516-527.

	survey seabed litter. This may potentially result in underestimates of quantities present, and thus be more representative of relative densities rather than absolute values[10]. Fishing trawls are designed to catch fish based on the behaviour of certain species rather than inanimate objects like litter. As plastics are prone to drifting[11] they may be more likely to be retained in the cod end once kicked up by the gear, whereas metals, glass and ceramics and other heavier materials are more likely to drop out through the mesh before reaching the cod end. As such, different types of litter have different catchabilities and therefore will be differently represented in the catch[12]. Survey results can still be compared as catchability remains relatively constant, with little change between surveys. The number of stations monitored will determine how many years of survey data will be needed to obtain acceptable confidence in detecting trends in seafloor litter. Analysis of 2010-2014 seabed litter from Irish water by Moriarty, M. et al. (2016)[13] calculate that a minimum of 25 years' data could be required to detect a 30% change in the level of litter on the seafloor using the current sampling system. The Draft OSPAR Intermediate Assessment 2019 Seafloor Litter Report also posits that more stations or longer datasets may be needed to detect 10% or 20% changes in the abundance of seafloor litter within 5 years[14]. The distribution of the number of seabed litter categories captured per trawl is frequently highly skewed, with counts of 0 and 1 being most highly reported, however there are also some very high counts. These high counts could overly influence simple yearly means. The subcategory data has thus been expressed as the percentage of trawls in which the litter item was recorded.

[10] TSG-ML 2011 Marine litter: technical recommendations for the implementation of MSFD requirements. JRC Scientific and Technical Report, MSFD GES Technical Subgroup on Marine Litter (TSG-ML).
[11] Andrady, A.L., 2011 Microplastics in the marine environment. Marine Pollution Bulletin 62 (8), 1596-1605.
[12] Van der Sluis, M. Hall, R. r.V. 2014 Collecting marine litter during regular fish surveys. IMARES – Institute for Marine Resources & Ecosystem Studies, Report number C065/14.
[13] Moriarty, M. et al 2016 Spatial and temporal analysis of litter in the Celtic Sea from Groundfish Survey data: Lessons for monitoring. Marine Pollution Bulletin 103 195-205.
[14] Draft OSPAR Intermediate Assessment Seafloor Litter Report 2019, P.26

Table 7 – Frequency of seabed litter subcategories captured in trawls from highest to lowest frequency for 2012-2018 (excluding 2015)

Subcategory	Description of subcategory	% of trawls that contain this subcategory
A4	Plastic - caps/lids	14.52%
A2	Plastic - sheet	13.61%
A10	Plastic - strapping band	12.50%
A5	Plastic - fishing line (monofilament)	10.28%
A7	Plastic - synthetic rope	8.57%
A11	Plastic - crates and containers	7.66%
A3	Plastic - bag	7.36%
A1	Plastic - bottle	5.14%
A9	Plastic - cable ties	4.54%
E2	Natural Products - rope	4.03%
E1	Natural Products - Wood (processed)	3.02%
A8	Plastic - Fishing net	2.82%
A14	Plastic - other	2.72%
B2	Metal - cans (beverage)	2.12%
F3	Miscellaneous - other	2.12%
C5	Rubber - gloves	1.51%
E5	Natural Products - other	1.51%
C3	Rubber - bobbins(fishing)	1.31%
A6	Plastic - fishing line (entangled)	1.21%
C6	Rubber - other	0.91%
E3	Natural Products - paper/cardboard	0.81%
B8	Metal - other	0.60%
B1	Metal - cans (food)	0.50%
F1	Miscellaneous - clothing/rags	0.50%
D2	Glass/Ceramic - bottle	0.40%
B3	Metal - fishing related	0.30%
C4	Rubber - tyres	0.20%
D3	Glass/Ceramic - piece	0.20%
F2	Miscellaneous - shoes	0.20%
C1	Rubber - boots	0.10%
D1	Glass/Ceramic - jar	0.10%
A12	Plastic - diapers	not found
A13	Plastic - sanitary towel/tampon	not found
B4	Metal - drums	not found
B5	Metal - appliances	not found
B6	Metal - car parts	not found
B7	Metal - cables	not found
C2	Rubber - balloons	not found
D4	Glass/Ceramic - other	not found
E4	Natural products - pallets	not found

	Plastic caps and lids were the most frequently observed subcategory in the seabed litter between 2012-2018. Heavy items such as metal, wood, glass/ceramic, cloth(wet) appear to make up a greater proportion of the seabed litter compared to beach litter surveys. This may be explained by the heavier densities of non-plastic materials. Rubber makes a greater proportion of seabed litter than beach litter items which may be due to certain rubber items being heavier (e.g. tyres and boots). Plastic tends to be lighter than most of the other materials so makes up a greater proportion of the beach litter, compared to the seabed litter. There are likely to be higher amounts fishing-related litter in seabed surveys than beach litter surveys which may explain some of the differences in category proportions between the two survey types. As there is not sufficient statistical confidence to determine trends in relation to seabed litter in Irish waters surveyed, it is not considered possible to make a determination as to whether or not it has achieved good environmental status. Marine Litter on the surface layer of the water column As this is currently not monitored as part of Ireland's MSFD monitoring programme, not regionally under the OSPAR Convention, it is not possible to draw any conclusions as to the state of Irelands marine area in relation to this criterion.
Impact	In 2013, Ireland completed an Initial Assessment of its maritime area, under the 2008 Marine Strategy Framework Directive (MSFD). Characterising GES as: 'The amount of litter, and its degradation products*, on coastlines and in the marine environment is reducing over time and are at levels which do not result in harmful effects to the coastal or marine environment.' The characteristics of Good Environmental Status for marine litter set out in this Assessment were that "the amount of litter, and its degradation products, on coastlines and in the marine environment is reducing over time and are at levels which do not result in harmful effects to the coastal or marine environment". Given the trends indicated above, Ireland can be said to have achieved GES in relation to coastal litter although it is not yet possible to make such a determination in relation to seabed litter.

	However, to establish whether or not GES will be achieved in the future under the Commission Decision criteria requires that agreed methodologies and threshold values need to be determined. MSFD TGML is working to generate advice on this issue but in the absence of adequate data on harm to populations, it is challenging to set strong scientifically justified thresholds for GES in marine litter. At this time, it remains the case that any approach to marine litter will have to be taken on the precautionary principle and interim GES thresholds will have to be considered and agreed on this basis until such time as greater evidence of harm becomes available. **Harm** The EU Joint Research Council (JRC) report Harm Caused by Marine Litter, States that "the monitoring of impacts on biota is challenging, but there is clear evidence of harm to individuals and, to a lesser extent, assemblages of organisms and populations of some species. There is evidence that increasing numbers of species are experiencing encounters with marine litter with manifold consequences.[15]" **Entanglement** The JRC report states that harm from entanglement is easier to observe and therefore to quantify than harm resulting from ingestion. There is evidence of harm to individuals from entanglement especially for species of birds, mammals, fish and turtles. There may be a particular risk from the negative impact of abandoned, lost or discarded fishing gear on marine species including commercial stocks However, the impact on overall populations remains inconclusive. **Ingestion** There is evidence that a substantial number of marine species ingest plastic litter. The JRC report points out that for some species, including mammals, birds, fishes and invertebrates, there is also evidence that in some populations a large number of individuals may have ingested plastic litter. While there is some evidence from laboratory experiments of negative physical/mechanical impacts from ingestion of plastic on the condition, reproductive capacity and survival of some individual

[15] Harm caused by Marine Litter'; Stefanie Werner, Ania Budziak, Jan van Franeker, François Galgani, Georg Hanke, Thomas Maes, Marco Matiddi, Per Nilsson, Lex Oosterbaan, Emma Priestland, Richard Thompson, Joana Veiga and Thomais Vlachogianni; Joint research Council; Ispra, Italy; 2016, - P58.

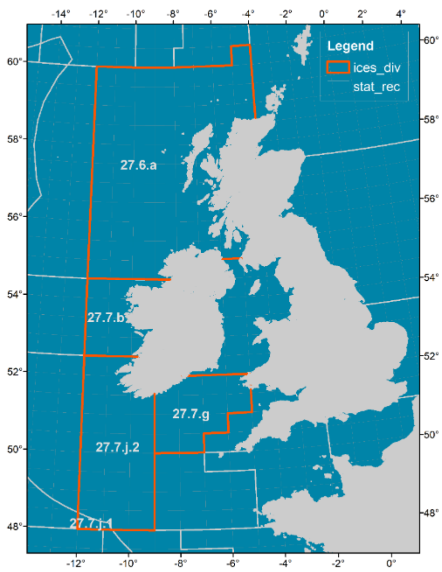
	marine organisms from lower trophic levels, at this time, the report states that "quantifying the extent of this harm would be extremely challenging". **Chemical transfer** Some plastics contain potentially harmful chemical additives. As with other particulates, plastics may also sorb and concentrate chemicals from seawater. The JRC document states that there is evidence that plastic may transfer chemicals contaminants to wildlife. However, there is considerable uncertainty about the relative importance of plastic as a such a pathway compared to other pathways such as from water or natural diet. **Marine Litter as a vector for transport of biota** Bacteria (including pathogens), algae, unicellular organisms, and invertebrates have been demonstrated to settle on debris, floating or on the sea floor (i.e."rafting"). Litter items have both similar and different characteristics to natural floating debris in facilitating transport, dispersion and potential colonisation. To date, it is hard to quantify the relative importance of rafting on anthropogenic compared to natural debris. **Marine litter altering/modifying assemblages of species** The presence of marine litter can affect marine assemblages as a consequence of either smothering, direct physical damage, provision of a new habitat, modifying existing natural habitats, or transport chemical contaminants and invasive species. However, to date evidence of effects comes from localized studies. There is a poor understanding of how this data could be extrapolated to larger spatial scales. **General Impact** There is direct evidence that there are harmful effects of marine litter on individual organisms of many species. However, the JRC document concludes that linking evidence of individuals affected by marine plastic litter to negative effects on populations is not possible to date for most affected species. There is some evidence that marine litter negatively affects population of some species and there is increasing evidence that marine litter, in combination with other anthropogenic stressors, may represent a

	substantial additional challenge to marine biodiversity. As with many other anthropogenic stressors, quantifying the effects of marine litter in isolation on biodiversity is often extremely challenging. **Animal welfare** Marine litter has been demonstrated to cause unnecessary and avoidable suffering to individual marine animals. **Socioeconomic impact** Evidence available indicates that marine litter has negative social and economic impacts including significant costs to the sectors affected. **Harm to humans** Marine litter including nets and ropes, pieces of glass, metal fragments and discarded medical waste may be harmful to humans. Marine litter can act as a vector for the transport of pathogens but the JRC document concludes that the relative importance of this pathway from a human health perspective is uncertain.
Response	It is not yet possible to set targets in relation to threshold values marine litter agreed by EU Member States in accordance with Commission Decision 2017/848 as these are not yet established. However, the expert EU Technical Working Group on Marine Litter has commenced work on developing beach litter baseline and threshold values. This work is being informed and supported by the OSPAR Intercessional Correspondence Group on Marine Litter and Environmental impacts of Human Activities committee. It is also supported by national seabed litter data reported to ICES. However, it is proposed to maintain the following national targets: • The composition, amount and spatial distribution of litter in the coastline, and on the seabed, are at levels that do not cause harm to the coastal or marine environment. • In accordance with the provisions of Article 5 of Directive (EU) 2019/904 by the end of 2023 eliminate beach litter caused by the items prohibited from the market under that Directive. These items are: plastic cotton bud sticks, disposable plastic cutlery and plates, plastic straws, plastic beverage stirrers, plastic balloon sticks, expandable polystyrene fast food containers and expandable polystyrene beverage containers and cups.

Assessment Method	**OSPAR Beach Litter Survey** The OSPAR Commission has designed and prepared guidelines for beach litter surveys. These are designed to generate data on marine litter according to a standardized methodology and may be found at the link below: https://www.ospar.org/ospar-data/10-02e_beachlitter%20guideline_english%20only.pdf This uniform way of monitoring allows for regional interpretation of the litter situation in the OSPAR area and comparisons between regions. In Ireland, monitoring is carried out at each of the four beaches (detailed below) on four separate occasions, one per quarter, over a 12-month period and form Ireland's contribution to the OSPAR beach litter monitoring programme. Where possible, the surveys are held on the same dates each year. • Co. Cork - Long Strand, Galley Head • Co. Mayo - Silver strand, nr. Louisburg • Co. Wexford - Carnsore (Carnsore point heading towards Kilmore Quay) • Co. Louth - Beach just south of Clogherhead Each beach survey consists of a comprehensive survey of a 100 metre stretch of the beach for all litter items observed regardless of size. On each subsequent survey of the beaches the same stretches are surveyed. (The 1 kilometre survey previously required by OSPAR is no longer being undertaken). Results are reported to the DHPLG using a template provided within three weeks of the conclusion of each survey to ensure that the reporting to OSPAR is timely. Once cleared by DHPLG, the surveyors then upload the data to the OSPAR Beach Litter database currently hosted by the UK's Marine Conservation Society. On the completion of the 4th survey, the contractor provide an analysis of the data gathered over all four surveys and prepares and submits a report summarising the results and provides a recommendation on possible future beach monitoring programmes.

	Seabed Litter Seabed litter surveys are carried out as part of existing trawling programmes for the assessment of fish stocks. The International Council for the Exploration of the Seas (ICES) coordinates the International Bottom Trawl Survey, covering NE Atlantic and Baltic Sea. In the Irish EEZ, France and Ireland currently survey the Celtic Sea area, Ireland covers the shelf West of Ireland, Ireland and the UK Scotland survey the north coast of Ireland and the UK Northern Ireland covers the Irish Sea. The Marine Institute carries out the Irish Groundfish Survey (IGFS) from its 65m research vessel, the R.V. Celtic Explorer, on an annual basis over 42 days in the autumn/winter. The Marine Institute has been collecting IBTS coordinated seafloor litter data since 2010. Each year, The Marine Institute randomly selects approximately 165 Stations to be surveyed by trawl (30 minutes each at 4 knots). The survey uses a high headline Grande Ouverture Verticale (GOV) trawl with a 20mm coded liner. Sampling is stratified into 17 strata on depth and ICES divisions, resulting in on average 165 hauls per year (30 minutes each at 4 knots). The area sampled at each station was estimated from the width of the net multiplied by the assumed distance it had been functioning once in contact with the seabed. The seabed litter data collected from these trawls has been normalised to km^2. Survey protocols for data collection and processing are detailed in the western International Bottom Trawl Surveys (IBTS) manual [16] [17]. The Irish Groundfish Survey collects data from four of the ICES Subregions – 27.6a, 27.7b, 27.7j and 27.7g. The borders of these ICES Subregions are highlighted in orange in the figure below.

[16] ICES 2010 Manual for the International Bottom Trawl Surveys in the Western and Southern Areas. Revision III (IBTSWG), 22-26 March 2010, Lisbon, Portugal
[17] ICES 2013 Report of the International Bottom Trawl Survey Working Group (IBTSWG), 8-12 April 2013, Lisbon, Portugal (ICES CM 2013-SSGESST:10)

	 The IGFS uses a semi-random depth stratified survey design. Stations are stratified according to ICES divisions (management units) as well as depth bands, with 15 strata in total Depth boundary are 0-80m, 81-120m, 121-200m, 201-600m corresponding to Coastal, Medium, Deep and Slope respectively. Haul allocation per strata is proportional to the area. Some of the Irish seabed is of soft sediment or is not flat and thus is not trawlable, thus influencing the sites that can be trawled for the survey. Data is uploaded to the ICES's DATRAS database.
Assessment Result	**Beach Litter** As laid out in the "State" section above, our beach litter surveys indicated that there is there is an overall downward trend in the total number of beach litter items (including plastic items) being found in beach litter surveys undertaken to the OSPAR methodology. Table 1 and Fig. 1 in the State above indicate that there is an overall downward trend in the total number of beach litter items (including plastic items) being found in beach litter surveys. The target set in relation to marine litter in Ireland's MSFD Cycle 1 Initial Assessment was "A reduction in the number of visible litter items within specific categories/types on coastlines" target 1 page 88]. **Thus, Ireland has achieved GES according to this target according to the 2013 target**.

	However, EU Commission Decision 2017/848 revising the criteria for determining GES in terms of marine litter as follows: "The composition, amount and spatial distribution of litter on the coastline, in the surface layer of the water column, and on the seabed, are at levels that do not cause harm to the coastal and marine environment. Member States shall establish threshold values for these levels through cooperation at Union level, taking into account regional or subregional specificities. This evaluation is to be made in accordance with baselines and threshold values agreed jointly with Member States through cooperation at Union level. " With this in view, new parameters will have to be put in place for the determination of GES in relation to coastal litter in future years. **Seabed Litter** As set out above, it is not considered that there is a sufficient statistical confidence level yet from existing seabed litter to determine whether or not GES has been achieved according to this criterion. Furthermore as the Commission Decision requires threshold values agreed jointly with Member States through cooperation at Union level for seabed litter also. These have yet to be established. **Litter on the Surface of the Water Column** As neither data nor agreed thresholds are available, it is not possible to determine.
Conclusion	The target set in relation to marine litter in Ireland's MSFD Cycle 1 Initial Assessment was "A reduction in the number of visible litter items within specific categories/types on coastlines" target 1 page 88]. This target has been met as the median number of beach litter items has declined from 73.5 to 46 between 2013 and 2018. However, as stated above Commission Decision (EU) 2017/848 has set new criteria requiring the assessment of categories of beach litter in accordance with thresholds and baselines agreed by EU member States. As these baselines and thresholds have not yet been finalised, it is not possible to state whether or not Ireland has reached good environmental Status in relation to beach litter.

	For similar reasons to it is not possible to state whether or not Ireland is in GES in relation to marine litter on the seabed or on the surface of the water column at this time as baselines and thresholds have not yet been set for these. However, it is positive to note that trends from OSPAR beach litter surveys indicate a downward trend in the amount of marine litter being recovered. It is necessary to continue to take the necessary measures to continue this downward trend in cycle 2.
Knowledge gaps	**Harm** Knowledge gaps exist in relation to harm caused by marine litter (both to ecosystems and in socioeconomic terms). Further co-ordinated research is necessary in this area to set refined and justifiable threshold values for marine litter. New models and experimental research is needed to determine whether marine biota populations are declining because of litter and, if so, which parts of the life cycle are affected. At this time, it remains necessary to rely upon the precautionary principle. **Surface of the Water Column** There is no reliable data at this time in relation to marine litter items on the surface of the water column. Efficient, robust and cost effective monitoring techniques need to be developed for such monitoring to an agreed standard that can be agreed with other EU member States and, ideally, contracting parties to the OSPAR Regional Seas Convention would agree the same monitoring protocols as this is aspect of the marine environment has particular transboundary impact by its nature. **Seabed Litter** Work is ongoing at TGML to develop a harmonised seabed litter indicator. At this time, survey data is not being gathered in a uniform manner with and the existing data sets do not provide a sufficient level of statistical confidence to be able to determine trends. **Thresholds and Baselines** In order to be able to meet the requirements of Commission Decision (EU) 2017/848, these will have to be agreed by EU member States with the advice of MSFD-TGML.

	Assessment Data			
Data Sources	OSPAR Beach Litter; Groundfish Survey - Seabed Litter			
Data Locations (URL)	OSPAR beach Litter Data base: http://www.mcsuk.org/ospar/ Groundfish survey marine litter data made available to DHPLG by Marine Institute			
Data Time Line	Start Date	01-01-2013	End Date	31-12-2018
Point of Contact	Conall O'Connor			
Email	conall.oconnor@housing.gov.ie			

D10 C2

Ref D10C2 V1	**Assessment Sheet: Criteria D10C2** The composition, amount and spatial distribution of micro-litter on the coastline, in the surface layer of the water column, and in seabed sediment, are at levels that do not cause harm to the coastal and marine environment.
Background	Currently, very little data is available on micro-litter in to marine environment. Work to develop monitoring programmes and threshold values is underway at EU Level under the auspices of the MSFD Technical Working Group on Marine Litter (MSFD-TGML) and this is being supported by work under regional sea conventions such as OSPAR.
Objective	The objective of this assessment is to evaluate if the composition, amount and spatial distribution of micro-litter on the coastline, in the surface layer of the water column, and in seabed sediment, are at levels that do not cause harm to the coastal and marine environment. This evaluation is to be made in accordance with baselines and threshold values agreed jointly with Member States through cooperation at Union level.
Drivers	The primary drivers of marine litter are deliberate or accidental loss of materials into the environment through littering, mismanaged waste or accidental spillage and also in the case of micro-litter, through abrasion, wear and fragmentation. This includes: • land based human activities generating litter within Ireland with pathways to the marine environment, such as rivers, streams, drains, sewage and other wastewater outflows; or in proximity to coastal areas, in particular coastal urban conglomerations, recreational/ tourist areas, ports, harbours and marinas; • mismanaged municipal, industrial (including service industry) agricultural or other waste entering the environment in coastal areas or in proximity to pathways to the marine environment; • litter generated by by maritime human activities within the Irish Exclusive Economic Zone, in particular fishing and aquaculture

	activities, but also activities such as shipping, offshore installations, or maritime recreational and tourist activities; and • marine litter originating from landward or maritime activities beyond the national jurisdiction carried into the Irish maritime area by currents or winds. The SAPEA paper A Scientific Perspective on Microplastics in Nature and Society[18] identified "environmental factors acting on large pieces of plastic debris, generating secondary microplastics, are among the most common sources of nano and microplastic pollution". Abandoned, lost and discarded fishing gear is considered particularly relevant sources of such plastic debris. Section 2.3.1 of the report identifies abraded fibres from synthetic textiles, primarily created during laundering processes and transported into freshwater bodies (e.g. river lakes etc.), or abraded fibres transported through the air, which may end up in coastal or marine zones as a potentially significant source of microplastic litter. Other sources include: • Abraded vehicle tyres (this is considered a large source of micro- and possibly nanoplastics by many sources); • abraded plastic coating and paints; • old tyre tread particles used as infill in artificial turfs, which are considered important sources for micronised rubber particles in the environment; • city dust resulting from weathering, environmental abrasion and spills; • pollution coming from abrasion of recreational fishing and marine vessels; and • microbeads in cleaning products. The SAPEA document points out that certain environmental entry pathways can be considered referred to as sources. For example,

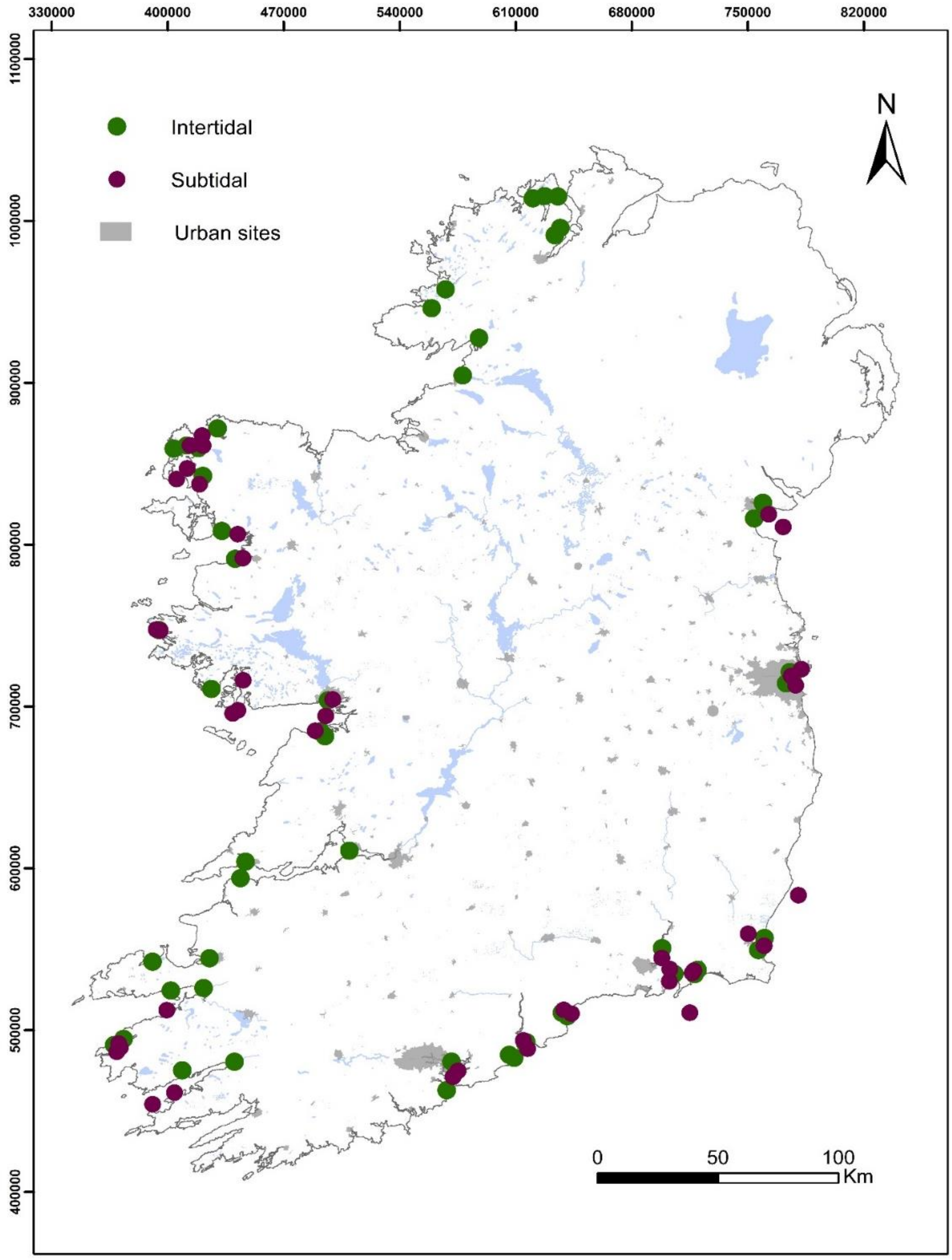
[18] ‘A Scientific Perspective on Microplastics in Nature and Society;’ SAPEA - Science Advice for Policy by European Academies; Berlin; 2019; P.24

	atmospheric deposition can be considered as a Nano and Microplastic entry pathway for land, freshwaters and the oceans, and export from rivers can imply an input to marine systems. Sewage treatment plants are sometimes considered a source or entry pathway of microplastics input into freshwater systems. Microplastics have been detected in both the primary and secondary sewage treatment stages. Post-filtration (tertiary treatment) has been found to remove up to 97% of microplastic particles, when in use. However, sewage effluents are still considered a major contributor to the presence of microplastics in surface waters. This raises the issue of microplastic content in sewage sludge from treatment plants and the management and disposal of such sludge. The Galway Mayo Institute of Technology (GMIT) produced a paper for DHPLG entitled Microplastic pollution- with a specific focus on the Irish context[19] identified the following additional sources of microplastics: Industrial sources • microplastics entering the environment as a result of accidental spillage and loss (e.g. of pre-production pellets, resin powders, etc.); • secondary microplastics generated by industries arising from specific processes such as machining creating microplastic swarf), which may escape into the environment due to improper handling and/or disposal; • other processes or procedures in polymer producers, plastic converters and recycling companies which may release primary or secondary microplastics into the environment Agricultural sources • Improper disposal and/ or weathering of macro-plastics such as plastic films, mulch films, silage wraps, plastic hoses/tubes/pipes, etc. leading to fragmentation and release into fields and watercourses

[19] 'Microplastic pollution- with a specific focus on the Irish context;' Dr. La Daana Kanhai; Galway Mayo Institute of Technology; Galway; 2018

	The Environmental Protection Agency (EPA) funded study entitled Scope, Fate, Risks and Impacts of Microplastic Pollution in Irish Freshwater Systems reported that[20] • sewer discharges from a plastic recycling company contained 661,000 microplastic particles per m^3 and a polymer production company contained 51,400 microplastic particles per m^3; and • wastewater from landfills was reported to contain between 2,500 – 26,000 particles per m^3. Samples of sewage sludge from seven waste water treatment plants (WWTPs) in Ireland were reported to contain between 4,196 – 15,385 particles per kg dry weight.[21] The study reported that the influent at a sampled WWTP contained up to 97,000 particles per m^3. It stated that "samples of effluent… showed a reduction to 2000particles/ m^3. This was halved again during the tertiary treatment, ending in a final release of 1000 particles/ m^3".[22]
Pressures	MSFD Annex III table 2 "anthropogenic pressures" solely identifies the "Input of litter (solid waste matter, including micro-sized litter)" as the pressure arising from marine litter. However, potential pressures may arise from potential harm to species generated through large scale ingestion of microplastics.
State	The Department of Housing Planning and local Government (DHPLG) has commissioned research to examine surface sediment samples taken from intertidal and subtidal zones at 95 sampling locations around the State. The samples were collected from 18 Special Areas of Conservation (SACs) and 4 Special Protection Areas (SPAs) and 1 additional location between May and November 2016 IN 2019, DHPLG awarded research contract to the Earth and Ocean Sciences and Ryan Institute, NUIG to undertake an analysis of these samples to establish presence of microplastics with a view to providing data for to inform the discussions under the MSFD in relation to sediment

[20] 'Scope, Fate, Risks and Impacts of Microplastic Pollution in Irish Freshwater Systems;' Anne Marie Mahon, Rick Officer, Róisín Nash and Ian O'Connor; Environmental Protection Agency; Wexford; 2017 p.22
[21] *Ibid*.; p.16
[22] *Ibid.;* p.13

	thresholds and baselines and in relation to the development of a microplastics in sediment indicator under the OSPAR Convention.  **Figure 1**: Map of Ireland showing the sample locations and their proximity to urban and municipal centres[23] Interim results have been received providing analysis of microplastic content of 4 samples taken from Kilkieran Bay SAC, Galway Complex

[23] Chart reproduced from DHPLG commissioned research entitled Determination of micro-litter content of 95 coastal sediment samples in support of Marine Strategy Framework Directive (MSFD) implementation; Mendes, A. R., Golden, N. & Morrison, L.; Earth and Ocean Sciences and Ryan Institute, National University of Ireland, Galway

SAC, Galway Complex SAC and Cork Harbour Special Protection Area (SPA.) This analysis has identified the number of microplastics (MP)s per kg at each location as well as giving an indication of the type of microplastics found (fibres/ pellets/ fragments). These interim results are set out in Table 1 below.

Table 1. Microplastics per kg (dry weight) found in 4 sediment samples

Location	Intertidal/ Subtidal	Sediment type	Exposure	Type of MP (fibre, pellet, fragment, other)	MP per Kg (dry weight)
Kilkieran Bay SAC	Subtidal	Sand, heavily populated with shells.	Exposed	Fibres	99
Galway Complex SAC	Subtidal	Mixed sediment.	Sheltered	Fibres	176
Galway Complex SAC	Subtidal	Sandy mud.	Moderately exposed	Fibres	49
Cork Harbour SPA	Intertidal	Sand, heavily populated with shells.	Moderately sheltered	Fibres	17

While microplastics are evident in all four samples, they have been found in small quantities. However, it is not possible to draw conclusions until all 95 samples have been analysed.

Impact	Unknown at this time.
Response	Ireland will continue to actively work with OSPAR ICG-ML, EIHA and the MSFD TGML to develop indicators, [threshold values and baselines] for micro-litter on the coastline, in seabed sediment and on the surface of the water column on the basis of the precautionary principle while also contributing to further research on potential harm to ecosystems caused by micro-litter.
Assessment Result	It is not possible to determine if micro-litter on the coastline, in the surface layer of the water column, and in seabed sediment, are at levels that do not cause harm to the coastal and marine environment at this time. Therefore it is unknown whether or not GES has been achieved in relation to this criterion.

Conclusion	It is necessary to address knowledge gaps, using a Risk Based approach, through the development of agreed and robust monitoring programmes to establish the scale presence of microplastics in sediment on coastlines and the seabed and floating on the surface of the state. Once robust monitoring programmes have been designed and put in place, these will have to be in operation for a statistically significant period of time to be able to draw conclusions from them. Ireland will continue to engage with other Member States through the MSFD Technical Working Group on Marine litter to develop thresholds and baselines to meet the requirements of EU Common Decision 2017/848 laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment, and repealing Decision 2010/477/EU. Ireland will also continue to work with other contracting parties to the OSPAR convention on work being undertaken under the Regional Action Plan on Marin litter to develop a candidate sediment indicator for microplastics. While it is accepted that a great amount of microplastic and nanoplastic pollution is caused by the breakdown of larger items of plastic marine litter, is also necessary to identify sources and pathways for direct microplastics inputs, to monitor these inputs and, where appropriate, put measures in place to address them. Thus, riverine or airborne sources and pathways will need to be assessed more fully in the future. Research projects such as the Environmental Protection Agency Sources, Pathways and Environmental Fate of Microplastics (focused on microplastics freshwater systems) currently being undertaken by GMIT in conjunction with UCD may be very useful in informing future environmental assessment, monitoring and actions in this area.
Knowledge gaps	**Micro-litter and Microplastics** **Presence, Sources and Pathways** At this time there is no clear data on the presence of micro-litter on the coastline, in the surface layer of the water column, or in seabed sediment. It is anticipated that the DHPLG commissioned research on sediment sampled from around the coast will provide initial indications of the prevalence and scale of microplastic pollution in Ireland's coastal zone.

	As SAPEA' s report, A Scientific Perspective on Microplastics in Nature and Society states "there are gaps in knowledge on the actual sources and entry pathways in quantitative terms. Furthermore, currently no reliable method exists for tracing and tracking the origin, source, transport or manufacturer of microplastics found in environmental samples." [P.26]. However, there is a need for Member States to develop and agree cost effective, robust, appropriate longitudinal monitoring within the EU so that appropriate thresholds and baselines may be agreed. It is hoped that work to develop a sediment indicator at OSPAR will help inform EU MSFD processes. **Sources, Pathways and Environmental Fate of Microplastics** A large scale EPA funded study is currently underway which is intended to expand on the Scope, Fate, Risks and Impacts of Microplastic Pollution in Irish Freshwater Systems study referred to in the “drivers” section above. The new study also looks at freshwater system. It combines the expertise of scientists (GMIT) and engineers (UCD and aims to: • characterise important sources not already covered by previous studies in Ireland; • evaluate pathways of MPs and determine factors import for their dispersal in aquatic systems; • provide recommendations for monitoring; and • provide recommendations for policy development with a view to building significant national capacity in this area. Although the focus of this study is on freshwater systems, rivers systems are considered a potentially significant source of plastic pollution in the marine environment. **Other sources** There are still very wide knowledge gaps in terms of the amount of marine micro-litter marine generated by fragmentation of larger items and from airborne sources

	Harm Knowledge gaps exist in relation to harm caused by marine micro-litter (both to ecosystems and in socioeconomic terms). Further co-ordinated research is necessary in this area to set refined and justifiable threshold values for marine litter. It is acknowledged that such research is challenging. In the absence of such knowledge at this time, it remains necessary to rely upon the precautionary principle due to the unknown level of risk associated with increased plastic pollution. **Nanoplastics** The harm, prevalence, sources pathways and fate of nanoplastics remain unknown. They present particular difficulties for monitoring due to their size. There is a need for co-ordinated EU research on this to inform the MSFD process.			
	Assessment Data			
Data Sources	Unpublished draft interim report submitted to DHPLG - Determination of micro-litter content of 95 coastal sediment samples in support of Marine Strategy Framework Directive (MSFD) implementation			
Data Locations (URL)	n/a			
Data Time Line	Start Date:	2016	End Date:	2016
Point of Contact	Conall O'Connor			
Email	conall.oconnor@housing.gov.ie			

Descriptor 11 – Energy, including underwater noise

D11 C1

Ref D11C1Rev7	**Assessment Sheet: Indicator D11C1 The spatial distribution, temporal extent, and levels of anthropogenic impulsive sound sources do not exceed levels that adversely affect populations of marine animals.**
Key message	The level of impulsive underwater noise causing activities within Irelands designated Marine Strategy Framework Directive area was low overall during the assessment period 2016-2018. The current state of the Irish marine environment is compatible with Good Environmental Status for spatial distribution, temporal extent, and levels of anthropogenic impulsive sound sources.
Background	This assessment considers current anthropogenic impulsive sound sources in Irish marine waters, while also assessing our potential to assess the effects of these sounds on marine animals in the future. **MSFD Initial Assessment (2013)** The characteristics of GES outlined in the Initial Assessment were: Human activities introducing loud, low and mid-frequency impulsive sounds into the marine environment are managed to the extent that no significant long term adverse effects are incurred at the population level, or specifically to vulnerable/threatened species and key functional groups. **2013 Targets:** No target given. Targets reported as 'under development'. **2013 Indicators:** No indicator given. Indicators reported as 'under development'. **MSFD Article 11 Monitoring Programme (2015)** One sub-programme was reported under Descriptor 11, which was the Implementation of an Impulsive Noise Register. The assessment and contribution of data to the OSPAR/ICES impulsive noise register was carried out in November 2018 and again in November 2019. **Commission Decision (EU) 2017/848** Criteria D11C1 "The spatial distribution, temporal extent, and levels of anthropogenic impulsive sound sources do not exceed levels that adversely affect populations of marine animals. Member States shall

	establish threshold values for these levels through cooperation at Union level, taking into account regional or subregional specificities" was adopted under the 2017 Commission Decision. This decision outlines the need for the establishment of threshold values and cooperation at Union level is required to agree threshold values. **The EU Technical Group on Underwater Noise (TG Noise) ongoing developments** TG Noise, through their 2016-2019 MSFD Common Implementation Strategy (CIS) Work Programme have been tasked with providing further advice to EU Member States on the development of threshold values. The results of this work are that TG Noise are initially focusing on developing a generic methodology for assessing the effects of anthropogenic sound on the marine environment; the intent is to enable the use of common methods at Union level as the first step to establishing impact thresholds. TG Noise Methodologies for assessing underwater impulsive noise include: • The implementation of Joint Monitoring of Impulsive Sound Sources, in accordance with the JRC-published Monitoring Guidance • The definition of Scope of Assessment: Specific Purpose, Area covered, Period • A decision on use of Indicator/Representative Species or other methodology to define sound characteristics likely to affect ecosystems components • A definition of Sound Characteristics to be used in the assessment • The production of Pressure Maps based on impulsive noise register data and the sound characteristics chosen • The specification of estimated animal density (of indicator/generic species) • The production of risk or exposure maps by identifying overlap between noise pressure and disturbance or habitat data

	• The computation of proportion of species or habitat exposed, potentially using an exposure curve or index • The determination of potential for population/ecosystem effects It is envisaged that after risk or exposure maps have been produced by Member States (possibly through cooperation in a sub-region), there will then be an opportunity to define threshold values. Such a threshold value could be the (maximum) amount of animal exposure or habitat affected, in time and space (with the metric still to be defined), that is considered to be the point where Good Environmental Status still occurs. Such a threshold value is more clearly aligned to the 2017 Commission Decision than a pressure-based threshold value; however, more information is needed to make an assessment, and some information on how exposure is related to impact would be required when using a threshold value at this level. Once an exposure-based threshold is defined, this implicitly sets a threshold on pressure, and the methodology allows this to be derived. This allows a scientifically derived threshold to be directly translated into a policy target that could be implemented by regulatory decision makers. **Irish assessment and contribution to the OSPAR/ICES Noise Register** In May 2018 Ireland reported data on Airgun Arrays from Seismic Surveys, carried out in 2016 and 2017, to OSPAR, this data was then uploaded to the ICES Impulsive Noise Register. Data from seismic survey carried out in 2018 was uploaded to the noise register in November 2019. These seismic surveys were carried out under licence from Petroleum Affairs Division (PAD) of the Department of Communications, Climate Action and Environment (DCCAE). The surveys are used to produce detailed images of local geology to determine the location and size of possible oil and gas reservoirs. The data consists of both 3D and 2D seismic surveys. To date Ireland has reported Airgun Arrays and Generic Explicitly Impulsive Sources.

	Data from 1 2D Seismic survey carried out in 2018 was uploaded to the OSPAR/ICES Impulsive Noise Register on the 4th of November 2019. **ObSERVE project** The ObSERVE acoustic survey of cetaceans project was carried out in 2015 and 2016 by an international consortium led by the Galway-Mayo Institute of Technology with partners the Marine Institute, JASCO Applied Sciences (Underwater Acoustics Consultancy), SMRU Consulting and the Irish Whale and Dolphin Group. The main aim was to improve knowledge and understanding of protected offshore species and sensitive habitats through high quality, state-of-the-art data collection across Ireland's Exclusive Economic Zone(EEZ). The project was delivered by the Department of Communications, Climate Action and Environment (DCCAE), in partnership with the National Parks and Wildlife Service of the Department of Culture, Heritage and the Gaeltacht. The ObSERVE Acoustic survey used both static underwater listening devices and towed hydrophone systems deployed from the Marine Institute's RV Celtic Voyager and other vessels. Information generated and analysed under the programme is expected to feed into the sustainable management of offshore activities and important marine conservation strategies. **The JONAS project** Ireland, through University College Cork's Centre for Marine and Renewable Energy, is coordinating the implementation of the JONAS project. The JONAS project is an Atlantic Area-funded project that brings together partners from Ireland, UK, France, Portugal, and Spain to address the transboundary issue of underwater noise. JONAS is an ongoing project that may bring better monitoring and risk management to the Northeast Atlantic region, supporting European nations in meeting MSFD requirements.
Objective	The objective of this assessment is to evaluate levels of anthropogenic impulsive sound sources in Irish marine waters and to ensure that these sounds do not exceed levels that adversely affect populations of animals in Irish marine waters in accordance with the requirements of Criteria D11C1.
Drivers	The driver of underwater noise in Irish marine waters is economic development. The following activities are listed in the revised directive 2017/845 as drivers associated with underwater noise generation:

	• Renewable energy generation • Transport infrastructure • The extraction of oil & gas (including petroleum exploration & production and decommissioning) • Transmission of electricity and communications (including laying of telecommunication cables) • Research, survey & educational activities (including seafloor mapping) • Military operations Impulsive noise generating activities which were documented in Irish waters, during the assessment period 2016 to 2018, are contained within the categories: • The extraction of oil and gas (seismic/acoustic activity associated with petroleum exploration) • Research, survey and educational activities.
Pressures	The primary pressure for D11C1, as outlined in the Directive is the 'Input of impulsive anthropogenic sound' Links to the Descriptor 1 biological pressure 'disturbance of species (e.g. where they breed, rest and feed) due to human presence' is also relevant.
State	The assessment of the current state of Descriptor 11 is most appropriately made in terms of the levels of underwater noise generating activities in Irish marine waters; these activities are Petroleum exploration and production, Research, survey and educational activities. The primary anthropogenic impulsive sound source in Irish marine waters during this assessment period is associated with acoustic surveys carried out for petroleum exploration. The spatial distribution, temporal extent, and levels of seismic/acoustic survey activity in Irish marine waters during 2016, 2017 and 2018 have been assessed, using the data Ireland has reported to the OSPAR/ICES Noise Register.

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Impulsive noise levels from 2016, 2017 and 2018, expressed as Pulse Block Days*, are summarised in Figure 1 from across the OSPAR Regions II, III and V. The OSPAR regions are as follows Region II - The Greater North Sea, Region III - The Celtic Seas and Region V - The Wider Atlantic. This assessment highlights that The Greater North Sea had by far the highest levels of anthropogenic impulsive noise when compared with the Celtic Seas and the Wider Atlantic. All Irish impulsive noise generating activities carried out between 2016 and 2018 occurred in the Wider Atlantic and no other parties carried out impulsive noise generating activities in the Wider Atlantic during this period.

The levels of underwater noise causing adverse effect to populations of marine animals within Irelands MSFD area is generally low in comparison with impulsive noise generating activity levels in neighbouring OSPAR Regions.

* Where Pulse Block Days are the number of days within a specified spatial unit in which anthropogenic impulsive sources occurred in a given calendar year.

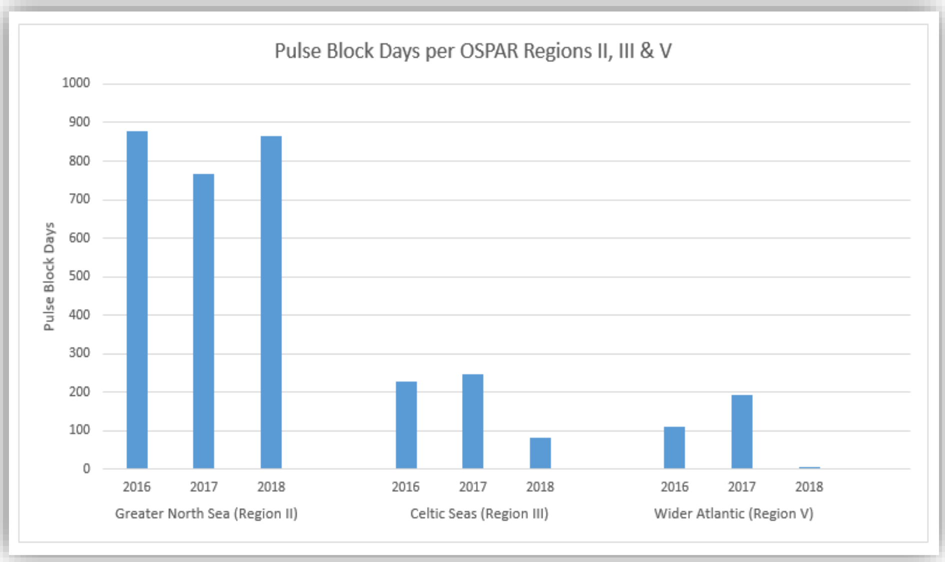

Figure 1: Impulsive noise pulse block days per OSPAR Regions II, III & V
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<td>Impact</td>
<td>Underwater noise can interfere with key life functions of marine animals (e.g., foraging, mating, nursing, resting, migrating) by impairing hearing sensitivity, masking acoustic signals, eliciting behavioural responses, or causing physiological stress.</td>
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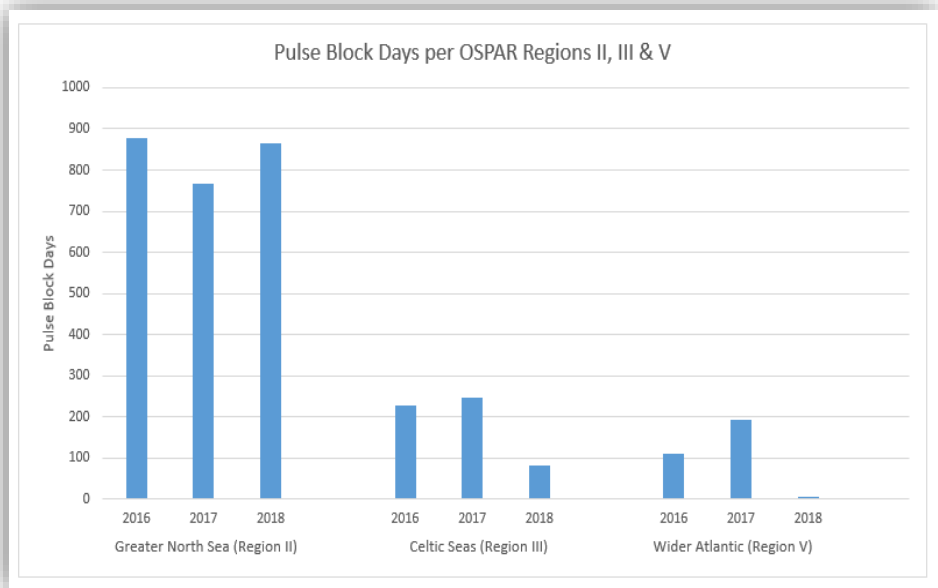
	There is considerable knowledge of the impacts of impulsive underwater noise on a selected number of individual marine species. These impacts can be quantifiable, like changes in behavior and/or death. Other impacts, such as hearing sensitivity reduction or physiological stress, are be more difficult to quantify. The potential impacts of underwater noise on animal populations and/or ecosystems have yet to be fully understood. TG Noise recognise these knowledge gaps in relation to impacts. The current advice document states that underwater noise is 'a relatively new topic, and at this stage, with the knowledge and information available, Member States should not expect to have full understanding of impacts of noise on populations and ecosystems in the near future, and defining internationally agreed threshold values is therefore difficult'.
Response	**The Marine Noise Register** The Department of Housing Planning and Local Government (DHPLG) reported data on seismic activity carried out during 2016, 2017 and 2018 to the OSPAR/ICES noise register. This register can be used to assess levels and distribution of impulsive noise sources to determine whether they could potentially compromise the achievement of Good Environmental Status. **Marine Planning and Development Management Bill** The DHPLG is developing the Marine Planning and Development Management Bill which should be advanced through the Oireachtas during 2020. This bill will update the legislation addressing the following elements of Irelands Marine Planning System: • Forward planning through the National Marine Planning Framework • Development management through an updated process of considering applications for developments • Enforcement This new legislation will provide a single state consent regime for the entire maritime area, reinforce the environmental impact assessment

	and appropriate assessment requirements for maritime developments under Irish law and improve compliance / enforcement provisions. Marine planning will provide insight into where best to conduct certain activities, particularly regarding multiple use (cumulative effects) as our understanding of the levels, patterns and impacts of underwater noise improves. **Existing legislative framework** Continued implementation of existing underwater noise related legislation, including but not exclusively; Impact assessments, undertaken to protect habitats and species identified in Natura 2000 sites and European Protected Species by the Habitats Directive, the Environmental Impact Assessment Directive and associated legislation in relation to licences and consents and Implementation of Directive 2013/30/EU on safety of offshore oil and gas operations within Irish Legislation. **Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish waters** The NPWS guidance document 'Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish waters'[24] was first developed in 2007 and updated in 2014. This document provides the statutory method of mitigating lethal or sub-lethal injury of marine mammals from acoustic surveys and blasting in Irish waters. These guidelines are based on monitoring a prescribed mitigation zone around an acoustic source and are considered to be some of the most robust guidelines in Europe for the protection of marine mammals during acoustic surveys and blasting. Since these Guidelines were introduced in 2014, adherence to them has been a condition of any application for searching for petroleum with an acoustic noise element. All applications for offshore petroleum activities are submitted to the NPWS for their observations.
Assessment Method	Outline of the levels of impulsive noise in the Irish maritime area based on data from the OSPAR Noise Register and comparative assessment across the OSPAR Regions II, III & V.
Results	Impulsive noise levels from 2016, 2017 and 2018, expressed as Pulse Block Days, were compared across OSPAR Regions II, III and V. This

24 https://www.npws.ie/sites/default/files/general/Underwater%20sound%20guidance_Jan%202014.pdf

	assessment highlights that Region II The Greater North Sea had by far the highest levels of anthropogenic impulsive noise when compared with the Celtic Seas and the Wider Atlantic. All Irish impulsive noise generating activities carried out between 2016 and 2018 occurred in the Wider Atlantic and no other parties carried out impulsive noise generating activities in the Wider Atlantic during this period. *https://www.ices.dk/marine-data/data-portals/Pages/underwater-noise.aspx The levels of underwater noise causing adverse effect to populations of marine animals within Irelands MSFD area is generally low in comparison with impulsive noise generating activity levels in neighbouring OSPAR Regions.  **Figure 1:** Impulsive noise pulse block days per OSPAR Regions II, III & V **Note:** The spatial distribution, temporal extent, and levels of Seismic Airgun Arrays carried out in Irish marine waters during the years 2016, 2017 and 2018 have been assessed and uploaded to the ICES/OSPAR Impulsive Noise Register
Conclusion	Impulsive noise data, from activities carried out under licence, during 2016, 2017 and 2018 has been included in the ICES/OSPAR Impulsive Noise Register.

	The extent and levels of impulsive noise generating activities in Irish marine waters for 2016, 2017 and 2018 were assessed and a comparison of Pulse Block days in OSPAR Regions II, III and V was carried out. This assessment highlights the limited activity and low levels of impulsive noise generated in the Irish MSFD area. The current state of the Irish marine environment is compatible with Good Environmental Status for spatial distribution, temporal extent, and levels of anthropogenic impulsive sound sources.			
Knowledge gaps	The key knowledge gap is understanding the levels of anthropogenic underwater noise that can lead to effects at the population level and ecosystem scales. Particularly how to quantify the risk of impact at these scales for vulnerable/threatened species and key functional groups. Risks to populations need to be more clearly established in order to develop proportionate measures. These knowledge gaps need to be addressed before the impacts of impulsive underwater noise in Irish marine waters can be categorically assessed.			
	Assessment Data			
Data Sources	Data from the OSPAR Impulsive noise register and the DCCAE ObSERVE programme			
Data Locations (URL)	https://www.ices.dk/data/data-portals/Pages/underwater-noise.aspx https://secure.dccae.gov.ie/downloads/SDCU_DOWNLOAD/ObSERVE_Acoustic_Report.pdf			
Data Time Line	Start Date:	2016	End Date:	2018
Point of Contact	Mary Hegarty			
Email	Mary.Hegarty@housing.gov.ie			

housing.gov.ie

Department of Housing, Planning and Local Government

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