Microplastics in surface water

Scottish Government
Riaghaltas na h-Alba
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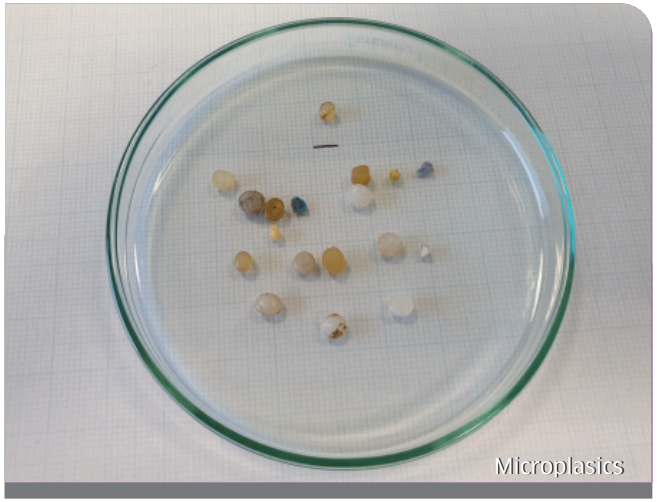
Key message

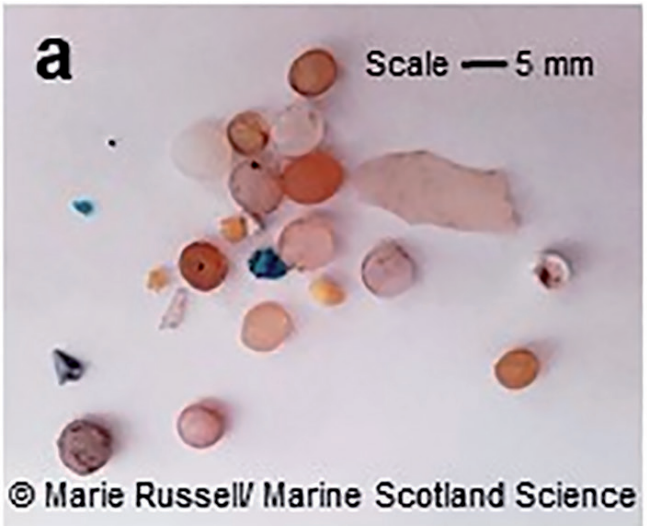
Microplastics, which are plastic particles < 5 mm in their longest dimension, are present in the surface waters of all the Scottish sea areas surveyed. Concentrations are variable between areas and also between years. Fragmented plastics account for almost 50% of the microplastics recovered from the sea surface from 2013/14 - 2019/20.



Background

Large scale production of plastics began in the 1950s and since then plastics of various types have formed an increasing percentage of the litter found in the marine environment, with a higher percentage of plastics in beach and floating litter as opposed to seabed litter. Microplastics are pieces of plastic whose longest dimension is 5 mm or less (Figure 1).

Microplastics have two sources. Primary microplastics are manufactured for a specific purpose, e.g. resin pellets (commonly called nurdles) or the microplastics in personal care products. Secondary microplastics result from the breakdown of big litter into smaller fragments over time, or wear and tear of other plastic items such



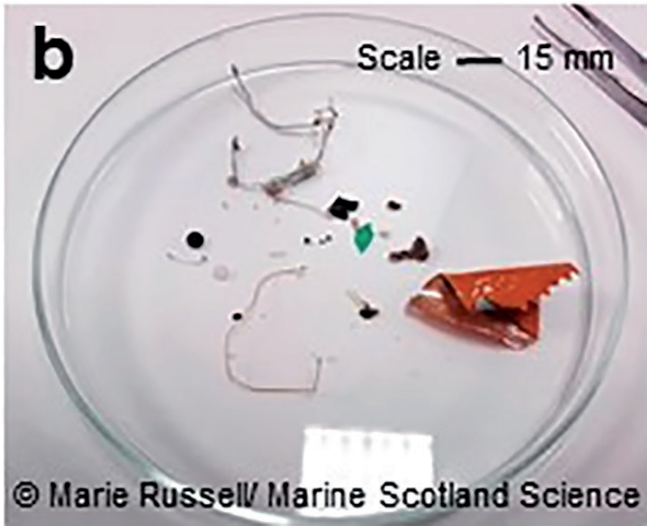


Figure 1:
Examples of plastic material collected in the sampling net. This includes nurdles (a) and fibres and film (b). Note the larger scale for (b).

For further information on this topic go to: https://marine.gov.scot/sma/assessment/microplastics-surface-water

as car tyres. Plastics (primary and secondary) can also contain a wide variety of chemicals either added as part of the manufacturing process e.g. flame retardants, plasticisers, or adsorbed from the environment over time.

The widespread presence of microplastic particles and their potential uptake by marine life is of increasing concern given the capacity of plastic particles to absorb and transport pollutants. Microplastic fragments (particles and fibres) may be eaten by marine life potentially causing obstruction and physical damage to their digestive tracts.

Results

Three hundred and seventy two (372) sample sites are within a Scottish Marine Region (SMR) (Figure 2a) and all eleven SMRs were sampled at least once during the period 2014-2020. The remaining sites (26) are within an Offshore Marine Region (OMR) (Figure 2b).

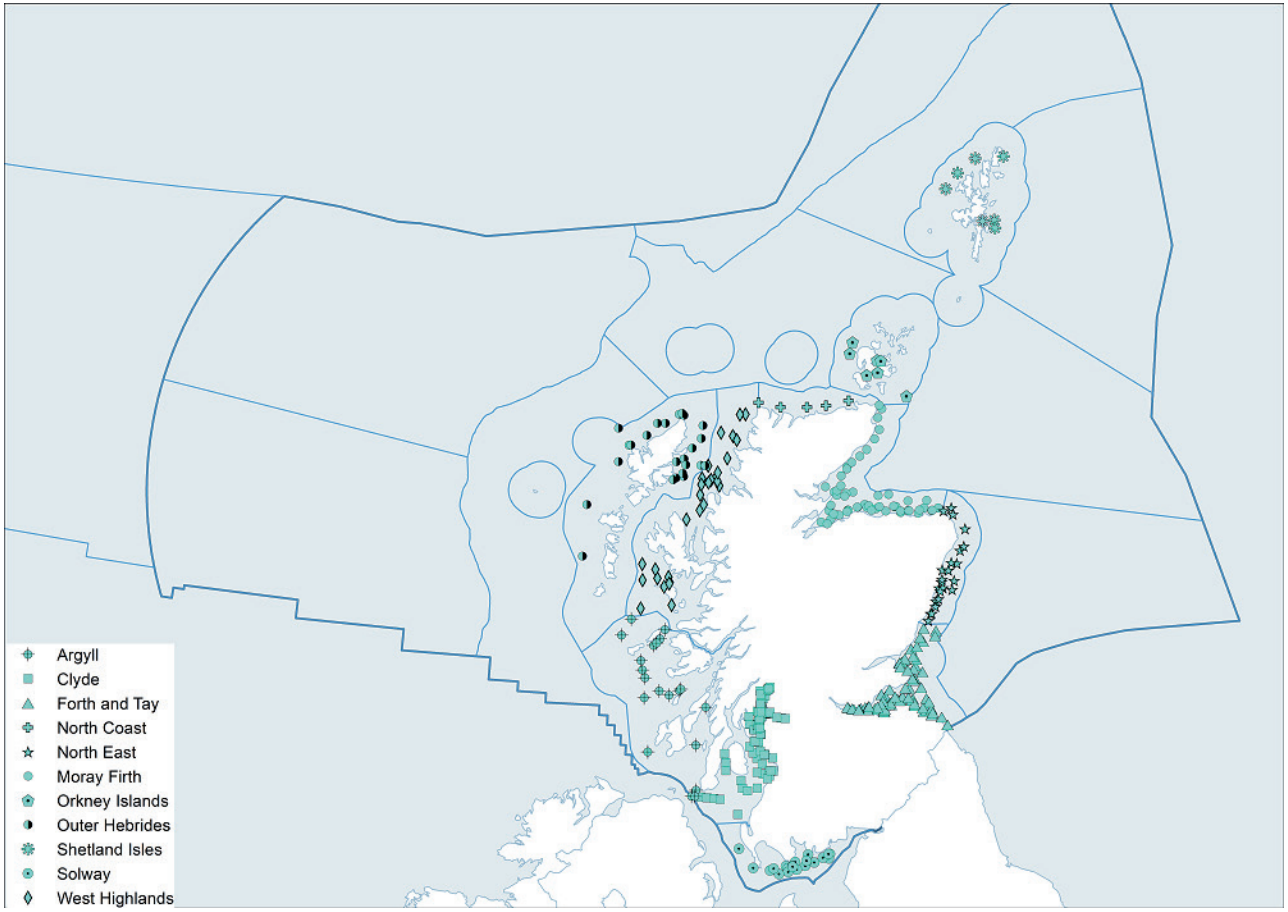


Figure 2a:
SMR Sample sites.

Not all SMRs were sampled in every year and the number of sampling sites also varied (Table 1). These variations were due to a number of factors such as the primary purpose of the cruise having precedence but also the prevailing wind and sea conditions as sea surface sampling for microplastics requires calm or relatively calm seas.

Although microplastics were found in all of the sea areas sampled almost 35% of the 398 sites (includes OMRs) surveyed between 2013/14 and 2019/20 contained no microplastics (Figure 3). The Clyde, in particular Loch Long, and the Solway SMRs on the west coast and the Forth and Tay SMR on the east coast have the highest concentrations with some sites having over 70,000 microplastics per km2 of sea surface. The Argyll SMR on the west coast has elevated microplastic concentrations, though not as high as the Clyde, Solway and Forth and Tay SMRs. The North East, Moray Firth, North Coast, Orkney Islands and Shetland Isles SMRs all have relatively low concentration (< 5,000 microplastics per km2

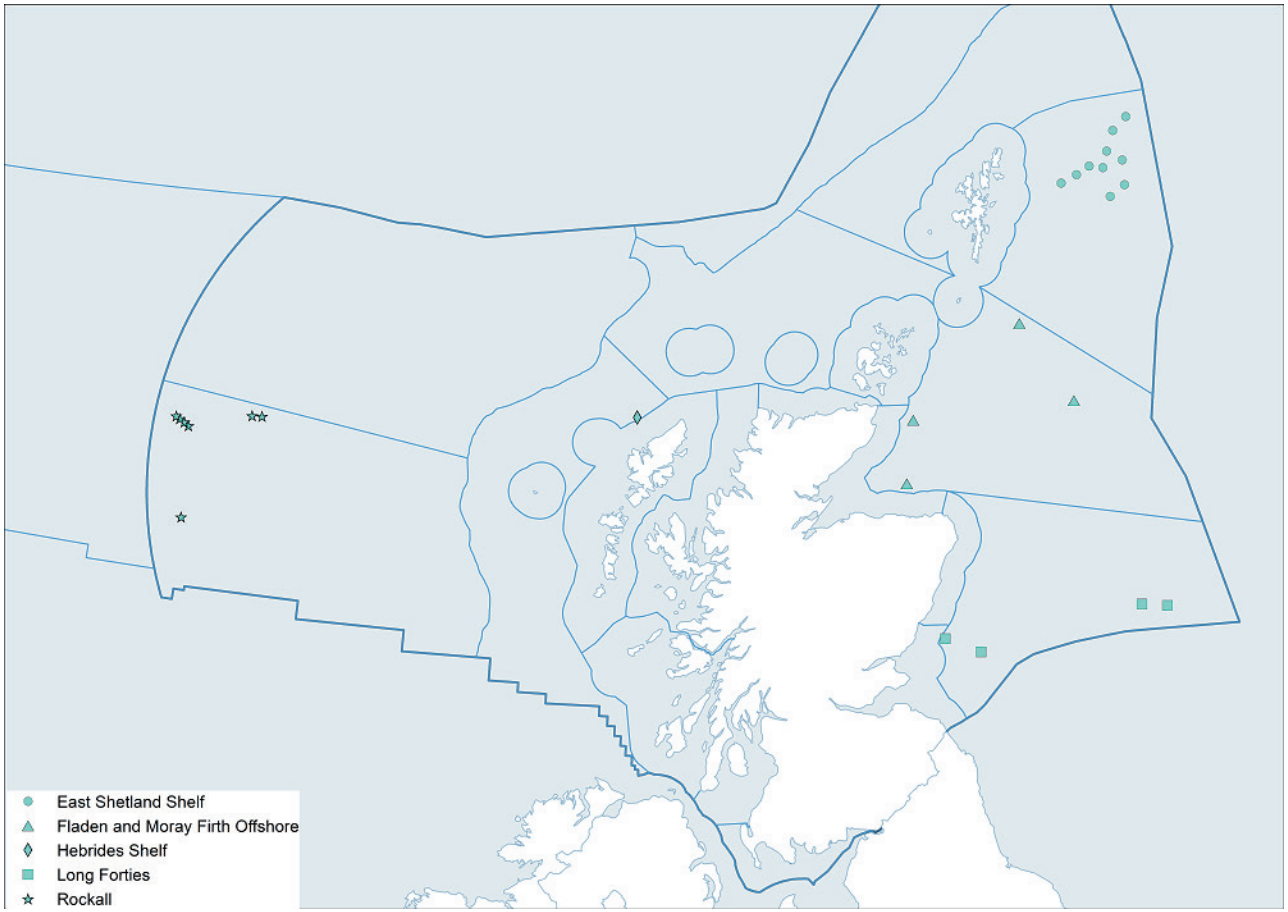


Figure 2b:
OMR Sample sites.

of sea surface). The OMRs also have relatively low concentrations (< 5,000 microplastics per km2 of sea surface, except for 2 sites on the East Shetland Shelf and 1 out near Rockall).

The Clyde and the Forth and Tay SMRs are offshore of the most urbanised and industrial areas in Scotland and this is likely to be the reason for the higher concentrations of microplastics for these two areas. In the Clyde SMR the highest concentrations are near the head of Loch Long and could be attributed to microplastics being transported up the Loch from the more urbanised areas in the Firth of Clyde. The Solway SMR is surrounded by one of the least densely populated areas in Scotland but is to the north of some very densely populated and industrialised areas in England. For the Argyll SMR the coastal current is generally north-eastwards and may be transporting microplastics into this area. Additional microplastics could be sourced from the wider Atlantic Ocean though the magnitude of this possible source is unknown.

	2013 - 2014	2014 - 2015	2015 - 2016	2016 - 2017	2017 - 2018	2018 - 2019	2019 - 2020	TOTAL
Argyll		1	9		7	1	2	20
Clyde		12	4	1	15	54	19	105
Forth and Tay	2	16	4		17	7	28	74
Moray Firth	12	11			11	20		54
North Coast	4	2			1			7
North East	3		2	3	8		7	23
Orkney Islands	7							7
Outer Hebrides	10	1			6	3	4	24
Shetland isles	6					1		7
Solway		4	8	4	2		3	21
West Highlands	11	4	3		9		3	30
E.Shetland Shelf	10							10
FL & MF Off	2				1	1		4
Hebrides Shelf	1							1
Long Forties		2			1	1		4
Rockall							7	7
TOTALS	**68**	**53**	**30**	**8**	**78**	**88**	**73**	**398**

Table 1:
Sampling sites per year and SMR/OMR.

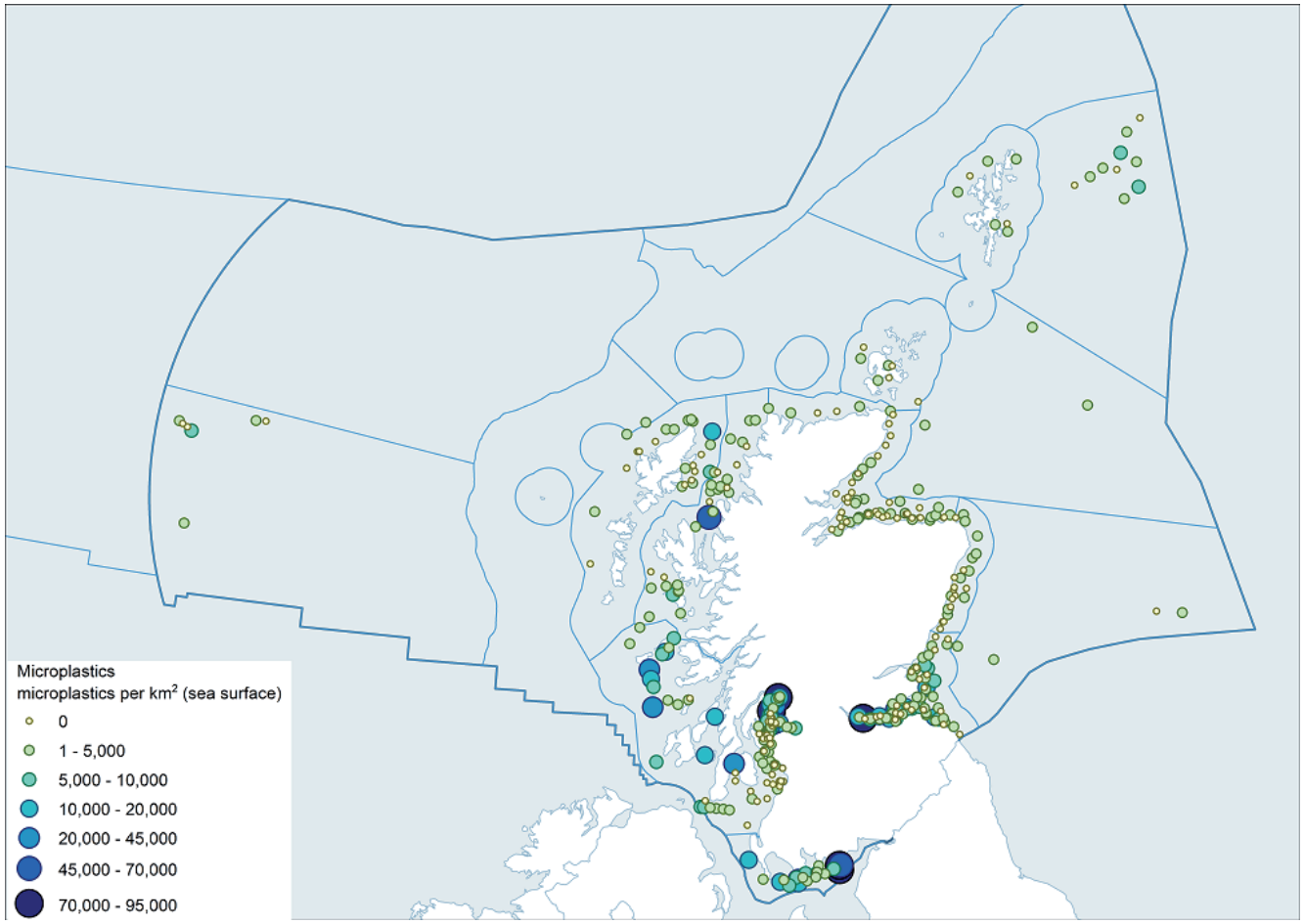


Figure 3. Sea surface microplastics (items km-2 sea surface) for individual sample sites (SMR and OMR) for the years 2013/14 – 2019/20.
Due to the variable temporal and geographic extents (Table 1) it is not possible to do any meaningful trend assessments for the SMRs or OMRs

Conclusion

Microplastics are present in the surface waters of all Scottish Marine Regions though not all sample sites within the SMRs contained microplastics. Fragments are the most abundant category of microplastics, indicating that much of the microplastics in Scotland's seas are from the fragmentation of larger items.

The Clyde, Forth and Tay and Solway SMRs are the most contaminated. The Argyll SMR also has elevated concentrations of microplastics compared to SMRs on the north and east coasts. The Clyde and Forth and Tay SMRs are next to the most urbanised and industrialised areas of Scotland whilst the Solway SMR is north of heavily industrialised and urbanised areas of England. For the Argyll SMR the higher concentrations may be explained by transport of microplastics on the coastal current from the more contaminated areas to the south or inputs from the Atlantic Ocean to the west.

Due to the variable geographic and temporal extents of the data currently available it is not possible to carry out a trend assessment.

Factors such as wind and sea state affect the efficiency of sampling by neuston net. Additionally some microplastic categories and sizes may be under represented in the samples. Therefore confidence in the physical counting of particles to give concentrations per km2 of seawater is high, the actual counts may be an underestimate, particularly e.g. for the small pink beads, which are smaller than the net mesh aperture.

Knowledge gaps

Insufficient spatial and annual coverage due to limited sampling. To make the most effective use of the Marine Scotland ship time available, the microplastics sampling uses the same survey vessel time as for other monitoring. This means that sampling for microplastics has to integrate into other sampling priorities. A baseline does not yet exist for microplastics so a trend analysis is not possible.

Status and Trend assessment

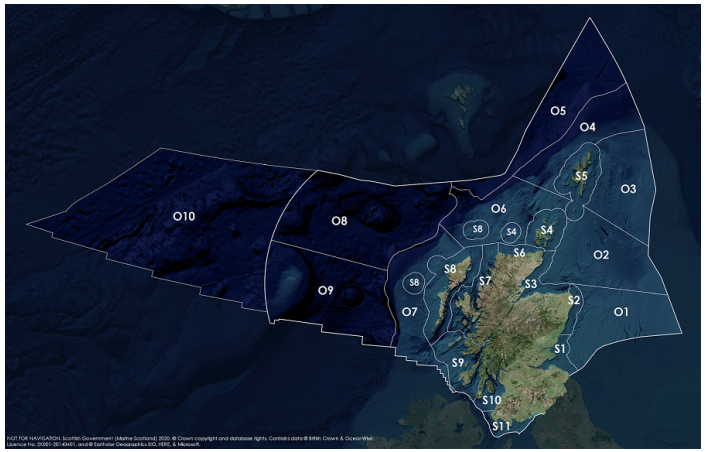
Region assessed	Status with confidence	Trend with confidence	Comments
Argyll			Due to the variable temporal and geographic extents it is not possible to do any meaningful status or trend assessment.
Clyde			Due to the variable temporal and geographic extents it is not possible to do any meaningful status or trend assessment.
Forth and Tay			Due to the variable temporal and geographic extents it is not possible to do any meaningful status or trend assessment.
Moray Firth			No assessment criteria as yet therefore status or trend assessment not possible.
North Coast			No assessment criteria as yet therefore status or trend assessment not possible.
North East			No assessment criteria as yet therefore status or trend assessment not possible.
Orkney Islands			No assessment criteria as yet therefore status or trend assessment not possible.
Outer Hebrides			No assessment criteria as yet therefore status or trend assessment not possible.
Shetland Isles			No assessment criteria as yet therefore status or trend assessment not possible.
Solway			No assessment criteria as yet therefore status or trend assessment not possible.
Western Islands			No assessment criteria as yet therefore status or trend assessment not possible.

Status and trend assessment legend

Status assessment (for Clean and safe, Healthy and biologically diverse assessments)		Trend assessment (for Clean and safe, Healthy and biologically diverse and Productive assessments)	
	Many concerns		No / little change
	Some concerns		Increasing
	Few or no concerns		Decreasing
	Few or no concerns, but some local concerns		No trend discernible
	Few or no concerns, but many local concerns		All trends
	Some concerns, but many local concerns	**Confidence assessment**	
	Lack of evidence / robust assessment criteria	**Symbol**	**Confidence rating**
	Lack of regional evidence / robust assessment criteria, but no or few concerns for some local areas		Low
	Lack of regional evidence / robust assessment criteria, but some concerns for some local areas		Medium
	Lack of regional evidence / robust assessment criteria, but many concerns for some local areas		High

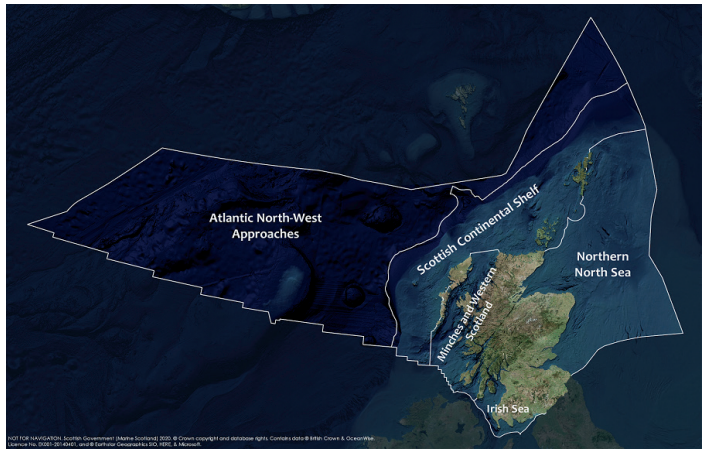
Overal confidence

Assessment regions

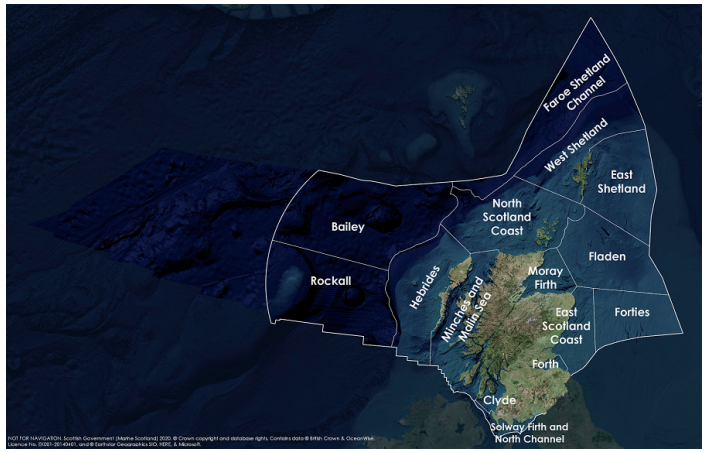


The Scottish Marine Regions (SMRs; S1 – S11) and the Scottish Offshore Marine Regions (OMRs, O1 – O10)

Key: S1, Forth and Tay; S2, North East; S3, Moray Firth; S4 Orkney Islands, S5, Shetland Isles; S6, North Coast; S7, West Highlands; S8, Outer Hebrides; S9, Argyll; S10, Clyde; S11, Solway; O1, Long Forties, O2, Fladen and Moray Firth Offshore; O3, East Shetland Shelf; O4, North and West Shetland Shelf; O5, Faroe-Shetland Channel; O6, North Scotland Shelf; O7, Hebrides Shelf; O8, Bailey; O9, Rockall; O10, Hatton.



Biogeographic, Charting Progress 2 (CP2) Regions. These have been used as the assessment areas for hazardous substances.



Scottish Sea Areas as used in Scotland's Marine Atlas 2011. These are sub divisions of the biogeographic, or Charting Progress 2 (CP2), Regions.

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NatureScot
Scotland's Nature Agency
Buidheann Nàdair na h-Alba

JNCC
Joint Nature Conservation Committee

SEPA
Scottish Environment Protection Agency

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