

## EROD - an indicator of exposure of fish to some organic contaminants

### Key message

Measurement of EROD can show if fish have been exposed to some contaminants. Throughout Scottish seas, the majority of fish had acceptable levels of EROD. However, there are certain industrialised areas of Scotland where EROD levels were above background, indicating that fish have been exposed to contaminants.



### Background

Detoxification enzymes are proteins that the body produces to speed up the breakdown of harmful substances. In fish, detoxification enzymes are produced when the fish is exposed to contaminants in the marine environment. Fish can be exposed to these contaminants through contaminated water, sediment and diet. Exposure through sediment is considerable as contaminants can build up in sediments. The main sources of contaminants in Scotland's seas are deposits from the atmosphere, industrial discharges and as a result of oil spills.

The measurement of EROD (7-ethoxyresorufin O-deethylase) activity in fish indicates if



Figure 1:  
Dab are one of the fish species used for the determination of EROD in the waters around Scotland.

detoxification enzymes are present, and, therefore, if the fish may have been exposed to contaminants. EROD is measured in flatfish as they are closely associated with sediments where the contaminants accumulate. Contaminants that relate to EROD include PAHs, PCBs and dioxins. Further information on some of these chemicals can be found in their Hazardous Substances assessments. Other factors that affect EROD activity include species, sex, reproductive status, season and environmental temperature. These elements are taken into account in the sampling plan.

## Results

EROD activity in fish was assessed at 14 locations in Scottish marine waters, which covered three biogeographic regions - Northern North Sea, Minches and Western Scotland, and Irish Sea (Clyde and Solway) (Figure 2). No sampling points located in the Scottish Continental Shelf were included in the analysis. The time between sampling visits varied from annually to once every six years. The data used in the assessment were collected between 2002 and 2018.

For regional assessment and trend analysis, only biogeographic regions with a minimum of three suitable stations with a reasonable geographic spread were included. There were insufficient data for regional analysis of the Minches and Western Scotland region.

The level of EROD activity was assessed by comparing it to OSPAR Background Assessment Criteria (BAC). These assessment criteria were developed to determine if observed levels are at background or elevated above background. EROD activities above background levels indicate exposure to increased concentrations of organic contaminants.

EROD activity in fish from the Northern North Sea was below background (Figure 3), indicating little exposure to contaminants. Higher EROD activity was found in fish from the Irish Sea biogeographic region, where levels were above background indicating that the fish have been exposed to contaminants. A number of the sites sampled in the Irish Sea (Clyde and Solway) are around the Clyde, an area with a high level of industry which has resulted in high concentration of contaminants. The high level of EROD activity observed here is consistent with other Hazardous Substances assessments of contaminants (PAHs and PCBs).

Trends in EROD activity were assessed in Scottish biogeographic regions where there were at least five years of data from representative sites (Figure 4). There were sufficient data for trend analysis in the Northern North Sea and the Irish Sea (Clyde and Solway). Across both biogeographic regions, the level of EROD activity was stable.

The overall picture presented in 2011 was very similar to what the 2019 assessment has found, with highest EROD activity found in sites in the Clyde, which is consistent with the contaminant assessments.

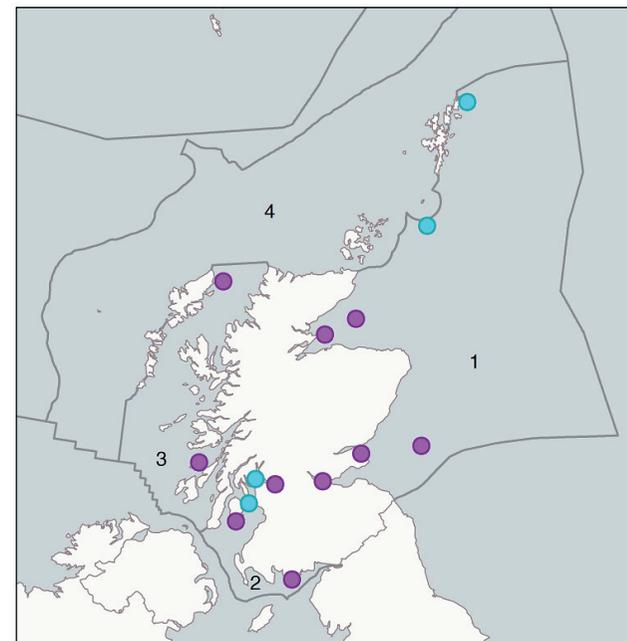


Figure 2: Monitoring stations included in the EROD status and trend assessments in fish per biogeographic region (grey lines). Magenta dots = stations used for trend and status assessments. Cyan dots = stations used for status assessment only. 1, Northern North Sea; 2, Irish Sea (Clyde and Solway); 3, Minches and Western Scotland; 4, Scottish Continental Shelf.

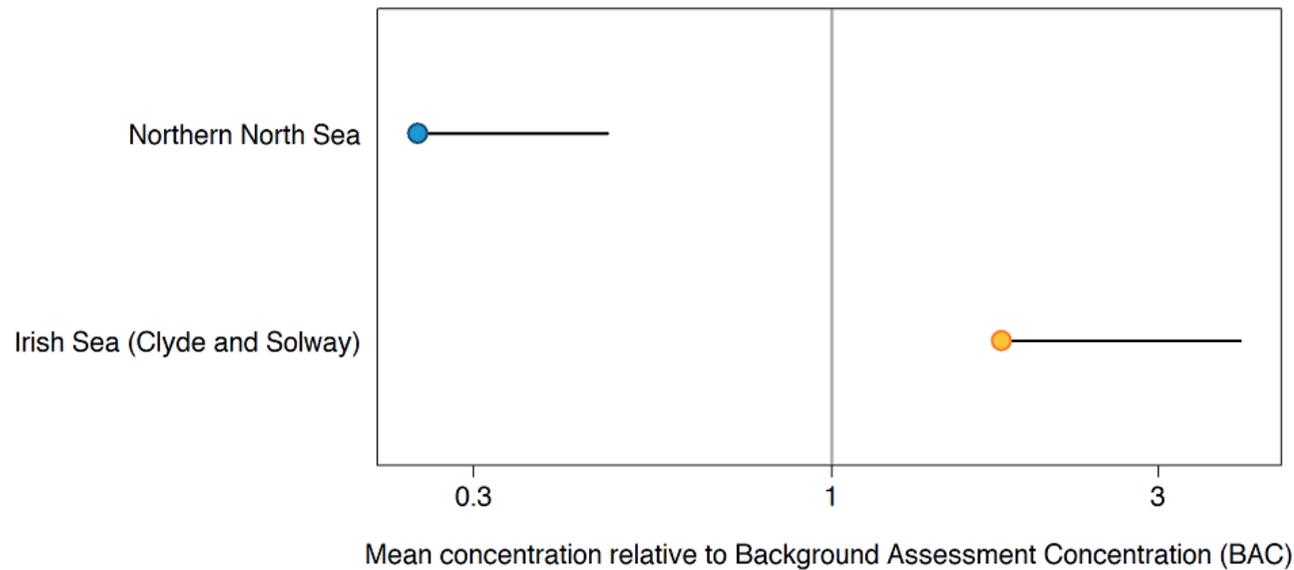


Figure 3:  
 Status assessment; mean EROD activity in each Scottish biogeographic region relative to the OSPAR Background Assessment Criteria (BAC) (with 95% confidence limits) where the BAC value is 1. EROD activity is significantly below the BAC if the upper confidence limit is below 1. Blue = statistically significantly below the BAC. Orange = at or above the BAC.

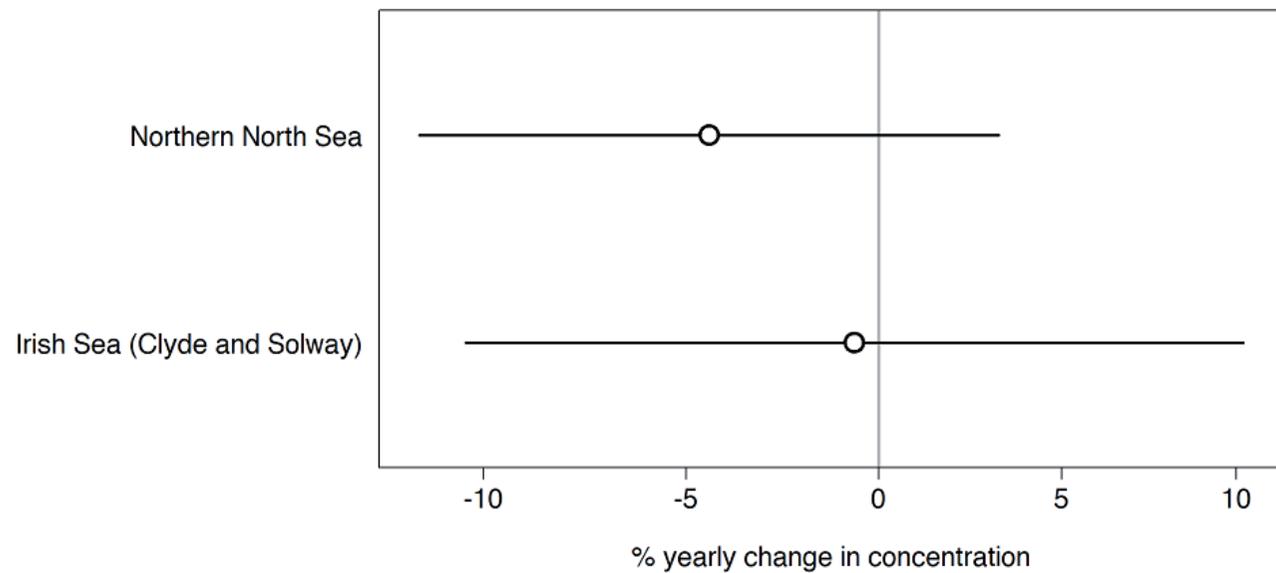


Figure 4:  
 Trend assessment; percentage yearly change in EROD activity in each Scottish biogeographic region. There is a significant trend if the confidence limits does not cut the vertical line at 0. Upward trends (upwards triangle), downward trends (downwards triangle), no change (circle) and 95% confidence limits (lines).

## Conclusion

This assessment has only been carried out for two biogeographic regions in Scottish seas. There were not enough sampling stations of the appropriate species in the Minches and Western Scotland and Scottish Continental Shelf for a regional assessment.

The status assessment showed that the levels of EROD in the Northern North Sea were below background, however, elevated levels of EROD activity were found in the Irish Sea (Clyde and Solway). This indicates exposure to organic contaminants in fish from the Irish Sea (Clyde and Solway), which is consistent with other assessments of contaminants.

The PAH assessment also found highest concentrations of PAHs and PAH bile metabolites in the Irish Sea (Clyde and Solway); and the PCB assessment reported that PCB concentrations in sediment and biota were highest in the Irish Sea (Clyde and Solway).

The trend assessment concluded that levels of EROD activity are stable in the two regions assessed (the Irish Sea (Clyde and Solway) and Northern North Sea) between 2002 and 2018..

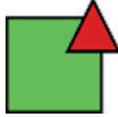
## Knowledge gaps

There is a lack of data to make a regional assessment for all Scottish biogeographic regions. To improve this, further fish sampling sites are required in the Minches and Western Scotland to give sufficient numbers of stations with good geographic spread. Another area lacking data is the Scottish Continental Shelf, a number of monitoring stations are required here for a regional assessment.

The analysis of EROD is only done on certain species of fish and it may not be possible to get sufficient number of sites with the appropriate species in all regions.

## Status and trend assessment

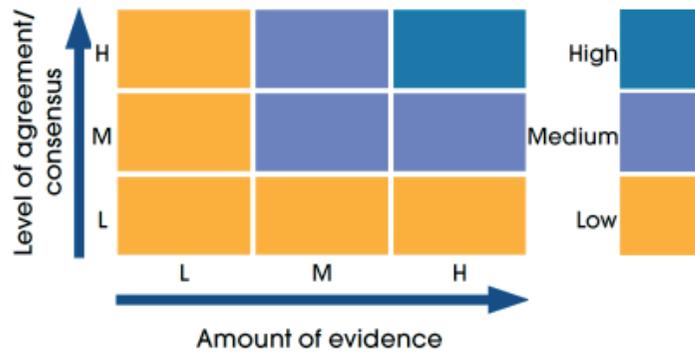
This status and trend assessment is an overall assessment for [Contaminants in sediment and biota](#) (PAHs, PCBs, PBDEs and metals in sediment and biota) and [Biological effects of contaminants](#).

Region assessed	Status with confidence	Trend with confidence	Comments
Irish sea	 ☆☆	 ☆☆	Green square with red triangle for status indicates few or no concerns as a whole, but many local concerns, particularly in the Clyde, with some sites exceeding the EAC/EAC-proxy. Two stars for confidence in the status is due to lack of suitable assessment criteria for some determinands (metals in biota and some biological effects measurements)
Northern North Sea	 ☆☆	 ☆☆	Two stars for confidence in the status is due to lack of suitable assessment criteria for some determinands (metals in biota and some biological effects measurements)

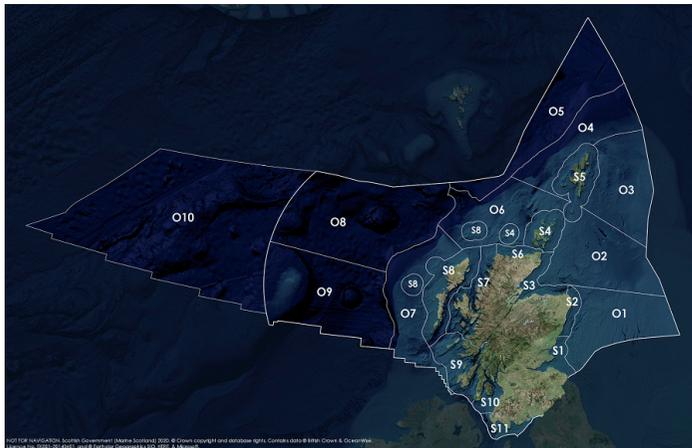
## Status and trend assessment legend

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	<b>Confidence assessment</b>	
	Lack of evidence / robust assessment criteria		
	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

## Overall confidence



## Assessment regions

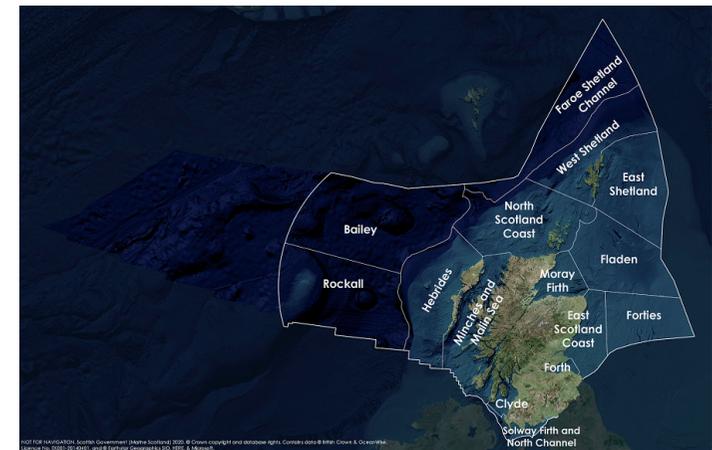


The Scottish Marine Regions (SMRs; S1 - S11) and the Scottish Offshore Marine Regions (OMRs, O1 - O10)

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.