1.5.5.1 Assessment of EROD[1] data and the associated background activity levels

Request

Assessment of the data collected by OSPAR Contracting Parties on EROD and the associated background activity levels (OSPAR 2-2009)

Taking account of:

a. the EROD data collected during WKIMON III

b . the analysis of the EROD data conducted by WKIMON III and the associated assessment criteria that were developed

c. [the review of the EROD assessment criteria undertaken by WGBEC]

and, based upon:

d. the data currently held on the ICES database

e. any data on EROD which has become available since WKIMON III

f. the assessment criteria on background activity levels to be further developed at a Workshop to be convened and hosted by Belgium in September 2008

to:

1. *assess the quality assurance associated with the EROD data currently held on the ICES database and used in the determination of the background activity levels, and;*
2. *make an assessment of EROD data from across the OSPAR Maritime area with the background activity levels and draw conclusions on whether there are unintended or unacceptable biological effects being detected through the measurement of EROD.*

This request from OSPAR is a continuation of work by ICES and OSPAR aimed at identifying biological techniques useful for assessing the level of contamination in marine environments. The work that was initiated in a series of four workshops, the ICES/OSPAR Workshops on Integrated Monitoring of Contaminants and their Effects in Coastal and Open-Sea Areas (WKIMON), is continuing in the ICES/OSPAR Study Group on Integrated Monitoring of Contaminants (SGIMC). The present advice focuses on potential approaches to assessing available data on EROD activity in marine fish.

ICES response

Summary

ICES evaluated two available EROD datasets – one comprised data collected and used at WKIMON III and IV and the other consisted of data submitted to the ICES Data Centre. These data were evaluated using either preliminary assessment criteria available for the data submitted to ICES or a statistical procedure developed at the January 2009 meeting of the ICES/OSPAR SGIMC. Both approaches indicated a general decrease in EROD activity over time and spatial differences in activity between OSPAR sub-regions. Although both approaches proved valuable for the current assessment, there is a clear scope for improvement of methods, e.g. through the development of a standardized criterion of EROD activity for each species.

Finally, a potential case study for the QSR 2010 is included as Annex 1: a report of the effectiveness of measuring EROD activity to follow recovery of the marine environment from the impacts of the "Prestige" oil spill.

Advice

Two assessments were conducted:

1. *An assessment of EROD activity in fish liver using data compiled at WKIMON IV*

A draft assessment of the data compiled at WKIMON IV was accomplished using the median value of the 90% quantiles of data within regions/sex/month as the assessment criterion. The assessment for EROD activity in fish (dab, *Limanda limanda*) liver for the period 1996–2000 showed differences between the assessment areas[2]. One area, the

[1] EROD – ethoxy-resorufin-O-deethylase, an enzyme system activated by exposure to planar organic compounds.

[2] For the assessment the data was divided into the following OSPAR sub-regions or areas: Irish Sea, Dogger Bank, S. Dutch/Belgian/Channel, Scottish Coast, East English Coast, N. Dutch/Belgian/Channel, and S. English Coast/Channel.

East England Coast, showed markedly higher EROD activity than the other areas. An enhanced level of EROD activity is an indicator of exposure to planar organic compounds including PAH (polycyclic aromatic hydrocarbons), dioxins/furans, and some CBs (chlorinated biphenyls). Data from three other areas, the Irish Sea, the Scottish Coast, and the southern coasts of the Netherlands, Belgium, and the English Channel, exhibited intermediate levels of exposure to planar organic compounds.

A reduction in EROD activity was detected between the periods 1996–2000 and 2001–2006, suggesting a reduction in exposure to planar organic compounds. This finding is consistent with the general downward temporal trends in contaminant concentrations in biota observed during the last decade and reported in the CEMP (Coordinated Environmental Monitoring Programme) assessment conducted during OSPAR MON (Working Group on Monitoring) 2008.

2. *An assessment of EROD data from the ICES Data Centre, using preliminary assessment criteria developed for cod, dab, and flounder separately.*

In the data available from the ICES Data Centre few statistically significant temporal trends were detected in EROD activity in cod, dab, flounder, and plaice. In cases where trends were significant they indicated reduced EROD activity. There was also evidence of an overall downward trend in EROD activity, but this was not statistically significant.

EROD activity in dab was higher in some coastal areas (such as SE Scotland, NE England, and the Irish Sea) than in other coastal and offshore areas. The lowest levels of EROD activity in dab of both sexes were seen in Cardigan Bay, west Wales, off a predominantly rural coastline. These concentrations were < 40 pmol min^{-1} mg $protein^{-1}$, below the candidate assessment criterion proposed by WKIMON III for EROD activity in August–November.

The lack of robust assessment criteria for significant biological effects in general makes it impossible to determine whether the observed levels of EROD activity are "indicative of unintended or unacceptable biological effects", as per the OSPAR request. Where comparisons with preliminary assessment criteria could be made, EROD activities in the liver of both cod and flounder are at or above background levels, indicating some exposure to planar organic contaminants.

Quality assurance

Analytical quality control data are currently not included in the ICES database and could therefore not be considered in relation to EROD measurements. Thus, in the analysis the data were not screened or weighted on the basis of QA performance.

Recommendations

The approach taken in the assessment of the available EROD data represents a useful step forwards and can be used to provide input to the OSPAR QSR 2010. Using the median value of the 90% quantiles of data within regions/sex/month as the assessment criterion extends the scope of data that can be used in the assessment. However, this approach requires further discussion and study especially if the underlying assumptions are to be validated or modified.

Greater flexibility and applicability would be achieved if future EROD data (after selection and standardization) were assessed using generally accepted criteria for baseline and effects levels. This will require revision of existing models to correct for seasonal variations and the effects of temperature on EROD activity. ICES will pursue this work during a workshop to be held in Aberdeen, UK, in October 2009. Work on assessment criteria for relevant methods will also be continued throughout 2009. It is likely that assessment criteria will need to be developed in the future for the assessment of "good environmental status" under the Marine Strategy Framework Directive.

A recent publication assessing the impact of the "Prestige" oil spill using temporal and spatial trends in EROD activity is recommended to OSPAR as a potential case study for the QSR 2010.

Scientific background

The topic of integrated chemical (contaminant) and biological effects methods for the assessment of pollution impacts has been taken forward within a joint ICES/OSPAR initiative, beginning with the WKIMON I workshop held in 2005. The aim was to create a series of packages of biological effects methods and supporting chemical analyses in order to allow assessment of the impact of specific contaminants and contaminant groups in the marine environment, for inclusion within the OSPAR JAMP (Joint Assessment and Monitoring Programme) and CEMP monitoring programmes. This process is continuing, and is also contributing preliminary assessment input for the OSPAR QSR 2010.

Sources of information

ICES. 2009. Draft report of the Joint ICES/OSPAR Study Group on Integrated Monitoring of Contaminants and Biological Effects (SGIMC, 2009), and RGIMC (Review Group on Integrated Monitoring of Contaminants and Biological Effects) deliberations.

Annex 1: Case study of EROD in relation to the "Prestige" oil spill

Case study for QSR 2010

Biological effect monitoring using fish biomarkers: the application of EROD activity for the assessment of the "Prestige oil spill" along the northern Iberian shelf[3]

After the "Prestige" oil spill (November 2002) in northwestern Spanish waters, a suite of hepatic biomarker responses in four-spotted megrim (*Lepidorhombus boscii*) and dragonet (*Callionymus lyra*) were monitored by the Spanish Institute of Oceanography (IEO). The two fish species occupy different depth zones on the continental shelf; *L. boscii* living mainly at depths of 120–500 m, whereas *C. lyra* is found in shallower water. Only immature specimens within a defined size range were analyzed. The biomarkers assayed were detoxification enzymes related to the MFO enzyme system for organic xenobiotic biotransformation phase I (ethoxy-resorufin-O-deethylase (EROD)), the conjugation and excretion phase II (gluthatione-S-transferase), and two antioxidant enzymes (glutathione reductase and catalase). The northern Spanish continental shelf was divided into seven sampling areas. The western Asturias area served as a reference as it was less affected by the spillage and is subject to minimal influence from human and industrial activity (OSPAR, 2000). The first survey was performed five months after the accident (Martínez-Gómez *et al.*, 2006), and subsequent annual samplings were conducted in the autumn of 2003, 2004, and 2005 to monitor biomarker responses over time.

Generally, significant reductions in biomarker activities were found two and three years after the oil spill in both species, indicating a recovery to baseline levels. Mean annual EROD activity by area in *L. boscii* ranged from 3.79 to 37.57 pmol min^{-1} mg $protein^{-1}$ and showed three- to six-fold variations between years/areas and a maximum value of 194.6 pmol min^{-1} mg $protein^{-1}$. The mean annual EROD activity in *C. lyra* ranged from 66.09 to 494.30 pmol min^{-1} mg $protein^{-1}$. (1.5- to 5-fold variation), with a maximum value of 915.27 pmol min^{-1} mg $protein^{-1}$. In both species, EROD activity was found to be the most discriminating biomarker. EROD showed responses sensitive enough to indicate different levels of exposure to organic compounds prevailing in different areas and environments of the northern Iberian shelf. The limited variation in bottom water temperature in the study area did not significantly influence the EROD responses. The observed temporal variations in EROD responses suggest decreasing exposure to "Prestige" oil-related hydrocarbons in the period studied (2003–2005).

Three years after the tanker spillage, the highest EROD activity was found in the southern Galicia and Finisterre inner shelf areas as well as in the Cantabrian and Basque country offshore areas (Figure 1). Such results are in agreement with the chemical characterization of the areas (OSPAR, 2000; Franco *et al.*, 2006). This study clearly shows the usefulness and applicability of EROD as a biological effect method to detect effects and trends of contaminants that induce the MFO enzyme system.

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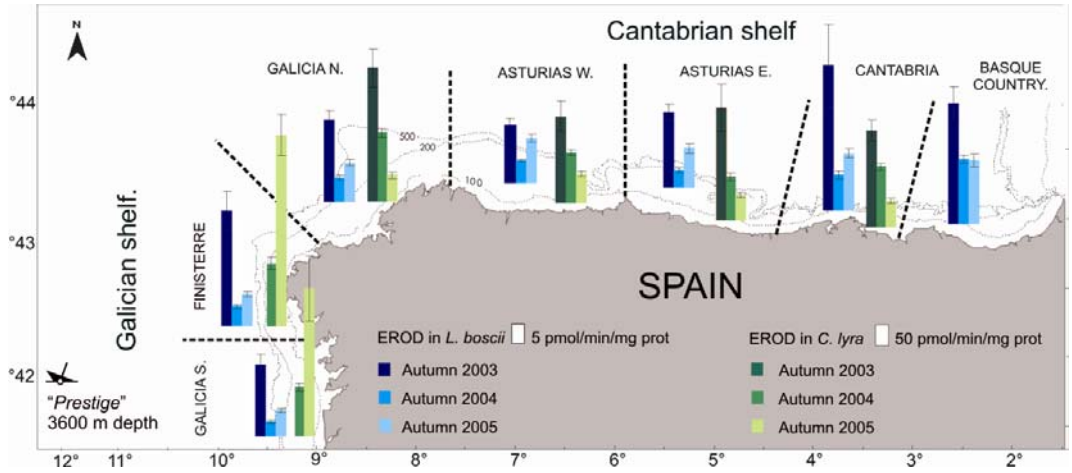

Figure 1 EROD activity values (Mean ± Standard Error) in four-spotted megrim (*Lepidorhombus boscii*) and dragonet (*Callionymus lyra*) from different areas of the northern Iberian shelf sampled in autumn 2003, 2004, and 2005.

References

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