Baltic Marine Environment Protection Commission

Joint Meeting of OSPAR's Intersessional Correspondence Group on Underwater Noise, HELCOM Expert Network on Underwater Noise and EU Technical Group on Underwater Noise
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Document title	Completed example assessment sheet
Code	2-2-Corr.1
Category	INF
Agenda Item	2 - Development of OSPAR/[HELCOM] Impulsive Noise Register
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Reference	

Background

OSPAR ICG-MAQ (3) 2015 agreed to produce an example of an indicator assessment sheet to demonstrate the application of the Assessment sheet template.

The example was undertaken for the indicator "*Trends in the levels of imposex in marine gastropods*".

An example of a completed assessment sheet template - as would be produced by the indicator lead/ indicator teams is presented at Annex 1.

All the associated files that would need to be sent with word template, e.g. image files, data for producing the tables and charts have been uploaded as a zip file (document 2-3), noting that the file names are numbered according to their reference in the text.

The data snap shot from this example can be accessed via this link: https://www.dropbox.com/s/tk4ct1u9yvs1i37/MIME_Imposex_2013_2014_assessment.zip?dl=0

Once the information above has been submitted, checked and edited the OSPAR Secretariat will produce the lay out for the 2 page summary, which would be made available with the online version as a printable summary. The example of the final summary assessment sheet is provided at Annex 2.

Please note: This example should be read in conjunction with Joint Noise Meeting 15/30-2/Info.1.

Action required

The Meeting is invited to note the completed example assessment sheet and online extended text provided in Annex 1 and 2.

Intermediate Assessment 2017

Common indicator example sheet: Imposex and TBT

Assessment sheet content

Field	Example content
Sheet reference	HASEC14/D8_imposex
Contracting Parties	☑ BE ☐ CH ☐ DE ☑ DK ☑ ES ☐ FI ☑ FR ☐ IS ☑ IE ☐ LU ☑ NL ☑ NO ☐ PT ☑ SE ☑ UK
Title	Trends in the levels of imposex in marine gastropods
Subtitle 1	☐ D1 - Biological Diversity ☐ D2 - Non-indigenous Species ☐ D4 - Marine Food Webs ☐ D5 - Eutrophication ☐ D6 - Seafloor Integrity ☑ D8 - Concentrations of Contaminants ☐ D9 - Contaminants in Fish and Seafood ☐ D10 - Marine Litter ☐ D11 - Introduction of Energy
Subtitle 2	D8.2 - Effects of contaminants Choose an item. Choose an item.
Subtitle 3	[to be completed when reporting units are finalised]
Key message	Imposex is an indicator of impairment in reproductive performance in marine snails (gastropods), caused by an antifouling paint containing TBT that used to be used on boats. Following bans on TBT the assessment shows there has been a decrease in imposex levels, implying improved reproduction in gastropods.
Background (brief)	Antifouling paints are widely used on vessels of all sizes to prevent the growth of marine organisms. Around the beginning of the 1980s tributyltin (TBT) began to be used. This compound proved extremely effective at preventing the attachment of algal slimes and other organisms. By the mid-1980s oyster growers in France and Great Britain were becoming extremely concerned about poor growth in their stocks; e.g. oysters were misshapen and contained little meat, so were not marketable. The cause was TBT in anti-fouling paints applied mainly to pleasure vessels used in estuaries and moored in marinas close to the commercial shellfish beds. TBT is toxic to many marine organisms at very low concentrations and is unequivocally linked to impairment of reproductive performance in a number of molluscan species, with some female marine snails (gastropods) developing male sex characteristics in response to TBT exposure; this is termed 'imposex'. TBT ultimately affects many creatures, but marine gastropods are among the most sensitive, making them important indicator species. Over the past decade, a range of national and international measures has resulted in a continuous phase-out in the OSPAR area of TBT-containing paints. A global ban on TBT in anti-fouling systems on large vessels came into effect in 2008. Assessment criteria in the form of background assessment criteria (BAC) and environmental assessment criteria (EAC) have been derived by OSPAR for imposex measurement in a variety of gastropods, that represent the most sensitive species (OSPAR, 2004). HansHilewaert(Whelk_photo).jpg
Background	The OSPAR Coordinated Environmental Monitoring Programme (CEMP) assessment measures progress towards the OSPAR objective of having concentrations of hazardous substances at background levels, or

Field	Example content
(extended)	close to zero, by 2020. The 2013 assessment of data collected under the CEMP was prepared by the OSPAR Working Group on Monitoring and on Trends and Effects of Substances in the Marine Environment (MIME) at, and following, its meeting in December 2013 and is based upon data reported by Contracting Parties to ICES and held in the ICES Environmental databases (OSPAR 2014a). This report focuses on assessments of tributyltin (TBT) and the imposex biological effect. The OSPAR CEMP is the monitoring under the OSPAR Joint Assessment and Monitoring Programme (OSPAR 2014b) where the national contributions overlap and are coordinated through adherence to commonly agreed monitoring guidelines, quality assurance tools and assessment tools. It covers temporal trend and spatial monitoring programmes for concentrations of selected chemicals and nutrients, and for biological effects. Monitoring under the CEMP aims to indicate the extent of contamination of fish, shellfish and sediments by hazardous substances and the intensity of their biological effects. The purpose is to support OSPAR assessments of the effectiveness of measures to reduce releases of hazardous substances to the environment. The assessment evaluates the status and trend of concentrations of hazardous substances in the marine environment for selected hazardous substances which have been prioritised for action by OSPAR due to their risk for the marine environment and which are being monitored under the CEMP. It builds on experience gained in the first comprehensive trend assessment of CEMP data in 2005 (OSPAR Commission, 2005), and the annual CEMP assessments undertaken in the period 2006–2009 (OSPAR, 2006; 2007; 2008; 2009a), which contributed to the OSPAR Quality Status Report 2010 (OSPAR, 2010). The OSPAR assessment for 2013 covers over 400 000 measurements in 73 parameters at 1223 stations. There were 8765 time series (station/parameter combinations with more than three years of data) that were assessed for trends in sediment, biota and for biological effects. Assessment products are presented in the Web assessment tool at http://dome.ices.dk/osparmime/main.html (Figure a). Assessment data are also available at this location together with supporting tables, plots, help files and methodological information. Although this particular indicator assessment report focuses on TBT, the imposex biological effect (from TBT) and copper, the contaminants covered by the CEMP are; the metals cadmium (Cd), mercury (Hg), lead (Pb), nickel (Ni), copper (Cu), zinc (Zn), chromium (Cr), arsenic (As) and the organic contaminants PCBs (congeners 28, 52, 101, 105, 118, 126, 138, 153, 156, 169, 180) and PAHs (naphthalene, phenanthrene, anthracene, dibenzothiophene, fluoranthene, pyrene, chrysene/triphenylene, benz[a]anthracene, benzo[a]pyrene, benzo[ghi]perylene, and indeno[12,3-cd]pyrene). The webtool assessment results are available for cadmium, mercury and lead, which are the metals selected by the OSPAR Commission for priority action. The other metals covered are either micronutrients (zinc and copper) or have other biological functions (arsenosugars, chromium, nickel). Further to the PAHs and CBs mentioned, the webtool assessment also covers the concentrations of selected indicators from other hazardous substances groups: four organochlorine pesticides, eleven selected organobromines, one dioxin and one furan. The available data for each substance in marine sediment, fish tissue (muscle and liver) and/or shellfish tissues are assessed. Finally nine biological effects are assessed, three imposex (TBT related) and six other, either general biologic effect or specific for PAH (metabolites) related biological effects. For some biological effects higher numbers indicate better status; this is reflected in the assessment criteria and colour scheme. *Dog whelk Oceana* (Filename: Dog_whelk_photo_Oceana.jpg) Antifouling paints are widely used on vessels of all sizes to prevent the growth of marine organisms. Historically, antifouling paints were primarily based on the use of copper, creating higher, toxic, concentrations close to the hull and so preventing the attachment of organisms. Around the beginning of the 1980s, a more effective component began to be used, TBT. This compound proved extremely effective at preventing the attachment of algal slimes, which are usually the first organisms to attach and which then provide a coating to which other organisms can attach. By the mid-1980s, oyster growers in both France and Great Britain were becoming extremely concerned about poor growth in their stocks. Cultured Pacific oysters, in particular, were misshapen and contained little meat, so were not marketable. Eventually, the cause was traced to the use of TBT in anti-fouling paints applied mainly to pleasure vessels used in estuaries and moored in marinas, close to the commercial shellfish beds. TBT is now known to be sufficiently toxic to harm many marine organisms at very low concentrations (e.g. Law et al., 2012) and is unequivocally linked to impairment of reproductive performance in a

Field	Example content
	number of molluscan species, with some female marine snails (gastropods) developing male sex characteristics in response to TBT exposure; this is termed 'imposex' (OSPAR Commission, 2000). TBT ultimately affects many creatures, but marine gastropods' sensitivity puts them at the front line making it an important indicator species giving an early warning of trouble to the marine ecosystem. Over the past decade, a range of national and international measures have resulted in a continuous phase-out in the OSPAR area of TBT containing paints and of their use on vessels, in aquaculture and on underwater structures. A global ban on TBT in anti-fouling systems on large vessels came into effect in 2008. Together, these measures address the main TBT-related pressures on the marine environment. Assessment criteria in the form of background assessment criteria (BAC) and environmental assessment criteria (EAC) have been derived by OSPAR for imposex measurement in a variety of gastropods, representing the most sensitive species used in the OSPAR monitoring guidelines. *Figure a: OSPAR assessment using data extracted from DOME on 31 October 2013 http://dome.ices.dk/osparmime/main.html* (Filename: Figure_a_OnlineAssessTool.jpg) **REFERENCES** Law, R.J., Bolam, T., James, D., Barry, J., Deaville, R., Reid, R.J., Penrose, R., Jepson, P.D. 2012. Butyltin compounds in liver of harbour porpoises (*Phocoena phocoena*) from the UK prior to and following the ban on the use of tributyltin in antifouling paints (1992-2005 & 2009). Marine Pollution Bulletin 64, 2576-2580. OSPAR Commission. 2004. Provisional JAMP Assessment Criteria for TBT – Specific Biological Effects. Agreement 2004-15. Available via 'Programmes and Measures / Agreements' on www.ospar.org OSPAR Commission. 2005. 2005 Assessment of data collected under the Coordinated Environmental Monitoring Programme (CEMP). OSPAR Publication 235/2005. ISBN 1-904426-77-8. Available via 'Publications' on www.ospar.org OSPAR Commission. 2006. 2005/2006 CEMP Assessment: Trends and concentrations of selected hazardous substances in the marine environment. OSPAR Publication 288/2006. ISBN 1-905859-26-0. Available via 'Publications' on www.ospar.org OSPAR Commission. 2007. 2006/2007 CEMP Assessment: Trends and concentrations of selected hazardous substances in the marine environment. OSPAR Publication 330/2007. ISBN 978-1-905859-69-6. Available via 'Publications' on www.ospar.org OSPAR Commission. 2008a. 2007/2008 CEMP Assessment: Trends and concentrations of selected hazardous substances in sediments and trends in TBT-specific biological effects. OSPAR Publication 378/2008. ISBN 978-1-906840-19-8. Available via 'Publications' on www.ospar.org OSPAR Commission. 2008b. 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. Available via 'Publications' on www.ospar.org OSPAR Commission. 2009a. CEMP assessment report: 2008/2009 Assessment of trends and concentrations of selected hazardous substances in sediments and biota. OSPAR Publication 390/2009. ISBN 978-1-906840-30-3. Available via 'Publications' on www.ospar.org OSPAR Commission. 2010. Quality Status Report 2010. OSPAR Commission, London 176 pp. http://qsr2010.ospar.org OSPAR Commission. 2014a. Draft Levels and trends in marine contaminants and their biological effects – CEMP Assessment report 2014. OSPAR Publication 390/2009. ISBN 978-1-909159-84-6. Available via 'Publications' on www.ospar.org OSPAR Commission. 2014b. Joint Assessment and Monitoring Programme. Agreement 2014-02. Available via 'Programmes and Measures / Agreements' on www.ospar.org
Background (figures & tables)	HansHilewaert(Whelk_photo).jpg Dog_whelk_photo_Oceana.jpg Figure_a_OnlineAssessTool.jpg

Field	Example content
Assessment Method (extended)	## Background Methods for data screening, treatment of quality assurance information, temporal trend assessment and assessment against criteria used previously by CEMP are described in the CEMP Assessment Manual (OSPAR, 2008b) and in the help files at http://dome.ices.dk/osparmime/help_methods_biota_imposex.html. Criteria used to assess environmental concentrations of hazardous substances are set out in the OSPAR agreement on CEMP Assessment Criteria for the QSR 2010 (OSPAR, 2009c). The derivation of these criteria for hazardous substances is discussed in a Background Document on CEMP Assessment Criteria for the QSR 2010 (OSPAR, 2009b; OSPAR 2011). These criteria reflect a two-stage process in which data are compared to concentrations yielding limited risks of biological effects (see Environmental Assessment Criteria, EACs) and then against Background Concentrations (BCs) or zero, expressed as Background Assessment Concentrations (BACs). The latter reflects the OSPAR Hazardous Substances Strategy that concentrations should be at or close to background levels for naturally occurring substances (thus zero for man-made substances). An overview of the assessment criteria is at Table a. *Table a: Assessment criteria used in the CEMP data assessment* (Filename: Table_a_Assess_Criteria.xls) This year the methods for configuration of the rollover assessment included: • time series were only considered if they contained data collected within the previous six monitoring years (2007-2012) instead of five; this is in line with the six-year reporting cycle for the European Union Marine Strategy Framework Directive (MSFD) , • trends in biota were considered over the most recent ten monitoring years. Revised JAMP Assessment Criteria for TBT – Specific Biological Effects (OSPAR, 2004a): Tributyltin (TBT) is on the OSPAR List of chemicals for priority action (OSPAR, 2004b). Monitoring of the concentrations in sediment, and the biological effects, of TBT are mandatory elements of the OSPAR Coordinated Environmental Monitoring Programme (CEMP) (OSPAR, 2010). OSPAR has adopted Joint Assessment and Monitoring Programme (JAMP) Guidelines for monitoring contaminant-specific biological effects (OSPAR, 2008a). Technical Annex 3 to these Guidelines sets out the guidance for monitoring TBT-specific biological effects (imposex/intersex) in the gastropod species *Nucella lapillus*, *Nassarius reticulata*, *Buccinum undatum*, *Neptunea antiqua* and *Littorina littorea*. ## Assessment criteria Two assessment criteria are used to assess imposex in snails: the • Background Assessment Concentration (BAC) • Environmental Assessment Criteria (EAC) The assessment criteria were developed within the Oslo and Paris Commission (OSPAR) framework with scientific advice from the International Council for the Exploration of the Sea. Mean values significantly below the BAC are said to be near background. Values below the EAC indicate no chronic effects of Tributyltin on snails. Full details can be found in OSPAR (2013). BACs and EACs are available for the following species and imposex measures *Table b: species and imposex measures* (Filename: Table_b_SpeciesImposexMeasures.xls) ## Assessment methodology for imposex Overview Time series of imposex measurements are assessed in three stages: 1. The imposex measurements each year are summarised by an annual index. 2. A generalised linear model is fitted to the annual indices. The type of model depends on the

Field	Example content
	number of years of data: • 1-2 years: no model • 3 years: mean • 4+ years: linear trend 3. The fitted models are used to assess environmental status against available assessment criteria and evidence of change in imposex levels over time. Calculating annual indices Let c_{ti}, $i = 1 \ldots n_t$ be the individual imposex measurements on female snails in year t, $t = 1 \ldots T$. The annual index in year t is the mean of these measurements: *Formula a: Calculation of annual index* (filename: Formula_a.jpg) Modelling the annual indices The annual indices are constrained to lie between 0 and 1 by dividing by the largest permissible value. For example, the indices for VDS in dog whelks are divided by 6 (Table c). *Table c: The indices for VDS in dog whelks* (Filename: Table_c_VDS_indicesDogWhelks.xls) The transformed indices are then modelled using a generalised linear model with a logistic link (McCullagh & Nelder, 1989). Usually, the data are assumed to have a quasi-binomial distribution with weights given by the number of female snails n_t. However, the distribution of VDS in dog whelks is specified by a more appropriate mean - variance relationship derived in Fryer & Gubbins (2007). The mean index is given by: $\text{logit}(E(yt)) = f(t)$ where $f(t)$ is a function of time that depends on the number of years of data: 1-2 years: no model is fitted as there are too few years for formal statistical analysis 3 years: mean model $f(t) = \mu$ there are too few years for a formal trend assessment, but the mean level is summarised by μ and is used to assess status 4+ years: linear trend $f(t) = \mu + \beta t$ the indices vary as a linear logistic function of time; the fitted model is used to assess status and evidence of temporal change Assessing environmental status and temporal trends Environmental status and temporal trends are assessed using the model fitted to the annual indices. Environmental status is assessed by comparing the upper one-sided 95% confidence limit on the fitted value in the most recent monitoring year to the available assessment criteria. For example, if the upper confidence limit is below the Background Assessment Concentration (BAC), then the mean index in the most recent monitoring year is significantly below the BAC and imposex levels are said to be 'at background'. No formal assessment of status is made when there are only 1 or 2 years of data. However, an *ad-hoc* assessment is made by comparing the index (1 year) or the larger of the two indices (2 years) to the assessment criteria. Temporal trends are assessed for time series with at least 4 years of data. There is evidence of a temporal trend if the slope β of the linear logistic regression of y_t on t is significant at the 5% level.

Field	Example content
	TABLES (filenames) Table_a_Assess_Criteria.xls Table_b_SpeciesImposexMeasures.xls Table_c_VDS_indicesDogWhelks.xls **FORMULA** (filename) Formula_a.jpeg **REFERENCES** Fryer, R., Gubbins, M. 2007. Modelling VDSI in *Nucella lapillus*. ICES Working Group on Statistical Aspects of Environmental Monitoring McCullagh, P., Nelder, J.A. 1989. Generalized Linear Models (second edition). Chapman & Hall, London. OSPAR Commission. 2004a. Provisional JAMP Assessment Criteria for TBT – Specific Biological Effects. Agreement 2004-15. Available via 'Programmes and Measures / Agreements' on www.ospar.org OSPAR Commission. 2004b. List of Chemicals for Priority Action (Revised 2013). OSPAR Agreement 2004-12. Available via 'Programmes and Measures / Agreements' on www.ospar.org OSPAR Commission. 2008a. JAMP Guidelines for Contaminant-Specific Biological Effects (Replaces Agreement 2003-10). OSPAR Agreement 2008-09. Available via 'Programmes and Measures / Agreements' on www.ospar.org OSPAR Commission. 2008b. 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. Available via 'Publications' on www.ospar.org OSPAR Commission. 2009b. Background Document on Assessment Criteria used for assessing CEMP Monitoring Data for the Concentrations of Hazardous Substances in Marine Sediments and Biota in the Context of QSR 2010. OSPAR Publication 461/2009. ISBN 978-1-907390-08-1. Available via 'Publications' on www.ospar.org OSPAR Commission. 2009c. Agreement on CEMP Assessment Criteria for the QSR 2010. OSPAR Agreement 2009-2. Available via 'Programmes and Measures / Agreements' on www.ospar.org OSPAR Commission. 2010. OSPAR Coordinated Environmental Monitoring Programme (CEMP). OSPAR Agreement 2010-1 (amended in 2011, 2012, 2013). OSPAR Agreement 2010-1. Available via 'Programmes and Measures / Agreements' on www.ospar.org OSPAR Commission. 2011. Background document on organic tin compounds. OSPAR Publication 535/2011. ISBN 978-1-907390-76-0. Available via 'Publications' on www.ospar.org OSPAR Commission. 2013. Background documents and technical annexes for biological effects monitoring (Update 2013). OSPAR Publication 589/2013, ISBN 978-1-909159-22-8. Available via 'Publications' on www.ospar.org
Results (brief)	The policy 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 (EACs), and ultimately reduction to 'close to zero' levels. Imposex is currently monitored at 386 sites (Figure 3) on up to six marine gastropod species (assessment criteria are under development for one of species). There is a diversity of approaches to selecting target sampling stations, although there is an emphasis on stations which are in, or near to, harbours, ports and marinas where effects are most likely to occur. Currently the OSPAR EAC set for TBT-specific effects is met at most sites (~65%). Improvement and non-improvement was measured at 145 sites using the Vas Deferens Stage Index (VDSI) – a 7-stage measurement based on degree of penis and Vas Deferens development in females. Improvement was detected at >80% of these sites, with non-improvement shown at 16% of locations,

Field	Example content
	while at 4% of sites the status is at background and continues to be stable. Dog whelks are the most common monitoring species and Figure 1 shows their improvement and non-improvement at 115 sites in five OSPAR regions. Similarly, Figure 2 shows improvement and non-improvement in five marine gastropod species sampled at 107 sites in one OSPAR. Overall improvement is evident (Figures 1 and 2). *Figure 1: Improvement (green) and non-improvement (red) in dog whelks (Nucella lapillus) at 115 sites in OSPAR Regions I to IV* (Filename: Figure_1_Whelks_map.jpg) *Figure 2: Improvement (green) and non-improvement (red) in 5 marine gastropod species sampled at 107 sites in OSPAR Region II* (Filename: Figure_2_VDSI_Diagram.jpg) *Figure 3: Current monitoring stations of imposex in marine gastropods for this assessment* (Filename: Figure_3_StatusMap.jpg)
Results (extended)	The data submissions by Contracting Parties are assessed from the ICES website (via http://info.ices.dk/datacentre/accessions/CommissionSummary.aspx?commission=OSPAR). The status of each submission is: X: the Contracting Party has submitted data and these data are available for use from the ICES database; P: the Contracting Party has submitted data, and the data are still being processed (quality checks etc., by the Contracting Party or by the data host ICES). The date stamp on this overview of data submissions is 17 February 2014. The parameters reported within the 2005-2011 period are listed in Tables d–h (only parameter groups assessed in MIME during the last years, others may occur). Data for each parameter are not necessarily reported every year for each station. *Table d: Imposex and other Biological Effects in Biota Data* (Filename: Table_d_Imposex&BioEffectsData.xld) *Table e: Contaminants in Biota Data* (Filename: Table_e_ContInBiotaData.xls) *Table f: Contaminants in Sediment Data* (Filename: Table_f_ContInSedData.xls) *Table g: Contaminants in Seawater Data* (Filename: Table_g_ContInSeawaterData.xls) *Table h: Analysed substances and significant trends in biota* (Filename: Table_h_Subs_and_SignificantTrendsInBiota.xls) The focus of the 2013 assessment was on the antifouling component tributyltin (TBT), and the effects of the ban on TBT with regard to both concentrations in the marine environment and the biological effects on marine snails (imposex). As TBT is phased out use of copper in antifouling products may increase. For biota and biological effects there were 4 604 time-series involving 46 parameters, with 827 significant trends of which 88% were downwards. ALAD biological effect and TCCD (2, 3, 7, 8-tetrachloro-dibenzo[b,e][1,4]dioxin) were the only parameters where all the trends were upwards, but both parameters only had three time series. Dioxin-like CB126 and the furan 2, 3, 7, 8-tetrachloro-dibenzofuran had one upward and one downward trend out of seven time series. Metals are the most commonly investigated parameters with between 250 and 300 time series each. Of these, between 10% (copper) and 20% (cadmium) were significant. Between 64% (mercury) and 88% (zinc) of the significant trends were downwards, so metals are reasonably well regulated. Although PCBs were monitored at a similar number of stations as metals there were fewer time series, typically between 100 and 250, due to concentrations close to detection limits. Between 12% (congeners 28, 153, 156) and 29% (congener 126) of the time series had significant trends. Of the significant trends, 96% were downwards, so in general PCB concentrations are declining. PAHs are monitored at around 270 stations, with typically between 80 and 170 time series. Between 8% (fluoranthene, pyrene) and 38% (naphthalene) of the time series had significant trends. Overall 87% of the significant trends were downwards. There were no upward trends for 22 of the 46 parameters with time series, including most dioxins, organotins and biological effects related to TBT (Vas Deferens Stage Index, imposex and intersex). The

Field	Example content
	reporting and coverage of other biological effects are still far behind that of the chemical parameters, with at most four time series available for any one parameter, and overall only three significant trends, all downwards. Four PAHs (naphthalene, anthracene, dibenzothiophene, pyrene) and four PCBs (congeners 101, 105, 156, 169) only had downward trends. Legacy chlorinated pesticides (HCB and -HCH) and BDE47 also only had downward trends, whereas DDE (DDT breakdown product) and gamma-HCH both had 2 upward trends.
Results (figures & tables)	(filenames) Figure_1_Whelks_map.jpg Figure_2_VDSI_Diagram.jpg Figure_3_LocationMap.jpg Table_d_Imposex&BioEffectsData.xls Table_e_ContInBiotaData.xls Table_f_ContInSedData.xls Table_g_ContInSeawaterData.xls Table_h_Subs_and_SignificantTrendsInBiota.xls
Conclusion (brief)	Ongoing monitoring in marine gastropods will continue to provide a good indicator for TBT pollution and help in identifying illegal use of stocks of TBT-containing antifouling paints or losses of TBT from dockyards, marinas and vessel maintenance activities. Monitoring will continue to see if there is a further decline in imposex levels. Most antifouling products have now reverted to the use of copper-based paints, in some cases with the addition of other chemicals, which enhance their efficacy. These have also been investigated for environmental persistence and effects and have also been banned. OSPAR needs to keep an eye on developments in this area and avoid adverse consequences of use of other compounds. Also, there is a large reservoir of TBT in sediments, particularly in estuaries, which may continue to provide a secondary source to the water column. Despite the evident significant downward trend in imposex from TBT, some areas are still subject to high imposex levels. Sites which show non-improvement should be subject to further monitoring. The continued monitoring of imposex in marine gastropods offers the most clear-cut tool for monitoring of a contaminant-specific pollution effect.
Conclusion (extended)	The CEMP assessment measured progress towards the OSPAR objective of having concentrations of hazardous substances at background levels, or close to zero, by 2020. Concentrations of metals, PCBs, and PAHs were generally stable or decreasing. In biota, 73, 87 and 96% of significant time trends were downwards for metals, PAHs and PCBs respectively. In sediment, the corresponding values were 72, 93 and 91%. For both biota and sediment, only about half of the parameters assessed showed any upward trends and only metal concentrations increased at more than four stations. Cadmium, mercury, lead, and copper concentrations increased at 20, 16, 12, and 8 biota stations respectively; arsenic, copper, chromium, nickel and lead concentrations increased at 14, 14, 7, 5 and 5 sediment stations respectively. Concentrations of the antifouling agent TBT and biological effects in marine gastropods resulting from its use have decreased following the ban on the use of TBT on pleasure boats in 1987 and on all ships in 2001. TBT concentrations decreased significantly in 55% of sediment time series and 81% of biota time series, and the biological effect Vas Deferens Stage Index decreased significantly in 61% of time series. The general trend for hazardous substances in the environment is downward, in many cases based on actions taken to reduce, minimise or ban use of specific chemicals in general or in specific applications within the individual countries, within the EU or on a worldwide basis. Some naturally occurring substances like metals and PAHs are not following this general trend and knowledge of the sources behind the upward trends are therefore required to make effective legislation or recommendations on future voluntary restrictions on the use or discharge of such substances. The OSPAR web-based tool for trends in the marine environment is one tool for following the OSPAR aim of reaching levels of contaminants not giving rise to pollution effects and the cessation of discharges, emissions and losses of hazardous substances by 2020. This indicator assessment report

Field	Example content
	outlines specific substances and the problems or solutions related to meeting these goals and will be produced and updated regularly in the yearly CEMP assessment processes.
Knowledge gaps (brief)	Some naturally occurring substances like metals and PAHs are not following the general downward trend and knowledge of the sources behind the upward trends are therefore required to make effective legislation or recommendations on future voluntary restrictions on the use or discharge of such substances.
Knowledge gaps (extended)	

Assessment Metadata

Metadata are "data about the content, quality, condition, and other characteristics of data"[1]. The objective of collecting standardised metadata is to provide a structure for describing the assessment that has been carried out. Metadata define a core set of elements which explain the assessment from a technical perspective; increasing confidence, allowing reuse and enabling users to evaluate applicability of the assessment to external functions. An added asset is the facilitation of discovery and reuse of the assessment and its underlying data because of the increased documentation of its technical characteristics.

Assessments will be handled in a semi-automated fashion; completion of the metadata and provision of associated files will allow the information to be uploaded and made available via the OSPAR Data and Information Management System (ODIMS).

Greyed cells in 'Explanation' are to be completed by the Secretariat.

Field	Data Type	Explanation
Sheet reference	Text	
Assessment type	Value List	Intermediate Assessment
Context (1)	Value list	Hazardous Substances
Context (2)	Text	OSPAR Publication 2005-235 2005 Assessment of data collected under the Co-ordinated Environmental Monitoring Programme (CEMP) OSPAR Publication 2006-288 2005/2006 CEMP Assessment: Trends and concentrations of selected hazardous substances in the marine environment OSPAR Publication 2007-330 2006/2007 CEMP Assessment: Trends and concentrations of selected hazardous substances in the marine environment OSPAR Publication 2008-378 2007/2008 CEMP Assessment: Trends and concentrations of selected hazardous substances in sediments and trends in TBT-specific biological effects OSPAR Publication 2008-379 CEMP Assessment Manual: Co-ordinated Environmental Monitoring Programme Assessment Manual for contaminants in sediment and biota OSPAR Publication 2009-390 CEMP assessment report: 2008/2009 Assessment of trends and concentrations of selected hazardous substances in sediments and biota OSPAR Publication 2009-461 Background Document on CEMP Assessment Criteria for the QSR 2010 OSPAR Publication 2011-535 Background Document on Organic tin compounds OSPAR Publication 2013-589 Background document and technical annexes for biological effects monitoring OSPAR Agreement 2004-12 OSPAR List of Chemicals for Priority Action (Update 2007) OSPAR Agreement 2004-15 Provisional JAMP Assessment Criteria for TBT – Specific Biological Effects. Amendments agreed by ASMO 2008 OSPAR Agreement 2008-09 JAMP Guidelines for Contaminant-Specific Biological Effects (Replaces Agreement 2003-10)

[1] FGDC Content Standard for Digital Geospatial Metadata Workbook, Ver 2.0, May 1, 2000

Field	Data Type	Explanation
		OSPAR Agreement 2009-2 Agreement on CEMP Assessment Criteria for the QSR 2010 OSPAR Agreement 2010-1 OSPAR Coordinated Environmental Monitoring Programme (CEMP). Update 2015. OSPAR Agreement 2014-02 OSPAR Joint Assessment and Monitoring Programme (JAMP) 2014 – 2021. Update 2015
Context (3)	Value list	☐ D1 - Biological Diversity ☐ D2 - Non-indigenous Species ☐ D4 - Marine Food Webs ☐ D5 - Eutrophication ☐ D6 - Seafloor Integrity ☑ D8 - Concentrations of Contaminants ☐ D9 - Contaminants in Fish and Seafood ☐ D10 - Marine Litter ☐ D11 - Introduction of Energy
Context (4)	Value list	D8.2 - Effects of contaminants Choose an item. Choose an item.
Point of contact	Text	Dr Rob Fryer, Marine Scotland Science, UK
Email	Text	ceu@scotland.gsi.gov.uk
Metadata date	Date	2015-09-01
Title	Text	Imposex and TBT: Status and trends in marine gastropods
Resource abstract	Text	Common indicator assessment of the biological effects caused by tributyltin; imposex. Applicable to OSPAR Regions I, II, III and IV.
Linkage	URL	http://www.ncbi.nlm.nih.gov/pubmed/22857710 http://ospar.org/html_documents/ospar/html/data/assessment_fact_sheets/ospar_assessment_sheet_cemp_imposex_2014.pdf http://ospar.org/v_measures/browse.asp?preset=1&menu=00530418000000_000000_000000&v0_0=&v1_0=title%2Creferencenumber%2Cdateofadoption&v2_0=&v0_1=Agreement+2004-15&v1_1=referencenumber&v2_1=&v0_2=&v1_2=dateofadoption&v2_2=&order=&v1_3=&v2_3= http://ospar.org/v_publications/browse.asp?preset=1&menu=00080800000000_000000_000000&v0_0=2006+CEMP+Assessment%3A+Trends+and+concentrations+of+selected+hazardous+substances+in+the+marine+environment&v1_0=n_code%2Ctitle%2Clanguage%2CISBNNumber%2CYearOfPublication%2CSeriesName%2Cpublicationnumber&v2_0=&v0_1=&v1_1=SeriesName&v2_1=&v0_2=&v1_2=ISBNNumber&v2_2=&order=YearOfPublication+desc%2CPublicationNumber+desc&v1_3=&v2_3= http://ospar.org/v_publications/browse.asp?preset=1&menu=00080800000000_000000_000000&v0_0=2007+CEMP+Assessment%3A+Trends+and+concentrations+of+selected+hazardous+substances+in+the+marine+environment&v1_0=n_code%2Ctitle%2Clanguage%2CISBNNumber%2CYearOfPublication%2CSeriesName%2Cpublicationnumber&v2_0=&v0_1=&v1_1=SeriesName&v2_1=&v0_2=&v1_2=ISBNNumber&v2_2=&order=YearOfPublication+desc%2CPublicationNumber+desc&v1_3=&v2_3= http://ospar.org/v_publications/browse.asp?preset=1&menu=00080800000000_000000_000000&v0_0=&v1_0=n_code%2Ctitle%2Clanguage%2CISBNNumber%2CYearOfPublication%2CSeriesName%2Cpublicationnumber&v2_0=&v0_1=&v1_1=SeriesName&v2_1=&v0_2=978-1-906840-19-8&v1_2=ISBNNumber&v2_2=&order=YearOfPublication+desc%2CPublicationNumber+desc&v1_3=&v2_3=

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Field	Data Type	Explanation
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Topic category	Value List	Environment
Indirect spatial reference	Text	(repeat of information listed in Assessment sheet content table, field “Subtitle 3”)
N Lat	Number	80,589697
E Lon	Number	29,744200
S Lat	Number	40,617184
W Lon	Number	-14,821521
Countries	Text	☑ BE ☐ CH ☐ DE ☑ DK ☑ ES ☐ FI ☑ FR ☐ IS ☑ IE ☐ LU ☑ NL ☑ NO ☐ PT ☑ SE ☐ UK
Start date	Date	2007-01-01
End date	Date	2012-12-31
Date of publication	Date	2014-07-31
Conditions applying to access and use	URL	http://ospar.org/html_documents/ospar/html/ospar_data_conditions_of_use.pdf
Lineage	URL	
Data Snapshot	URL	
Data Results	Zip	MIME_Imposex_2013_2014_assessment.zip (available at https://s3-eu-west-1.amazonaws.com/osparstorage/MIME_Imposex_2013_2014_assessment.zip)
Data Source	URL	http://ices.dk/marine-data/data-portals/Pages/DOME.aspx http://dome.ices.dk/views/ContaminantsBiota.aspx http://dome.ices.dk/views/ContaminantsSediment.aspx

Trends in the levels of imposex in marine gastropods

Common Indicator: D8 Imposex and TBT; Status and trends in marine molluscs
D8: Concentrations of contaminants
D8.2: Effects on contaminants

Imposex is an indicator of impairment in reproductive performance in marine snails (gastropods), caused by an antifouling paint containing TBT that used to be used on boats. Following bans on TBT the assessment shows there has been a decrease in imposex levels, implying improved reproduction in gastropods.

Background

Antifouling paints are widely used on vessels of all sizes to prevent the growth of marine organisms. Around the beginning of the 1980s tributyltin (TBT) began to be used. This compound proved extremely effective at preventing the attachment of algal slimes and other organisms. By the mid-1980s oyster growers in France and Great Britain were becoming extremely concerned about poor growth in their stocks; e.g. oysters were misshapen and contained little meat, so were not marketable. The cause was TBT in anti-fouling paints applied mainly to pleasure vessels used in estuaries and moored in marinas close to the commercial shellfish beds. TBT is toxic to many marine organisms at very low concentrations and is unequivocally linked to impairment of reproductive performance in a number of molluscan species, with some female marine snails (gastropods) developing male sex characteristics in response to TBT exposure; this is termed 'imposex'. TBT ultimately affects many creatures, but marine gastropods are among the most sensitive, making them important indicator species. Over the past decade, a range of national and international measures has resulted in a continuous phase-out in the OSPAR area of TBT-containing paints. A global ban on TBT in anti-fouling systems on large vessels came into effect in 2008. Assessment criteria in the form of background assessment criteria (BAC) and environmental assessment criteria (EAC) have been derived by OSPAR for imposex measurement in a variety of gastropods, that represent the most sensitive species (OSPAR, 2004).

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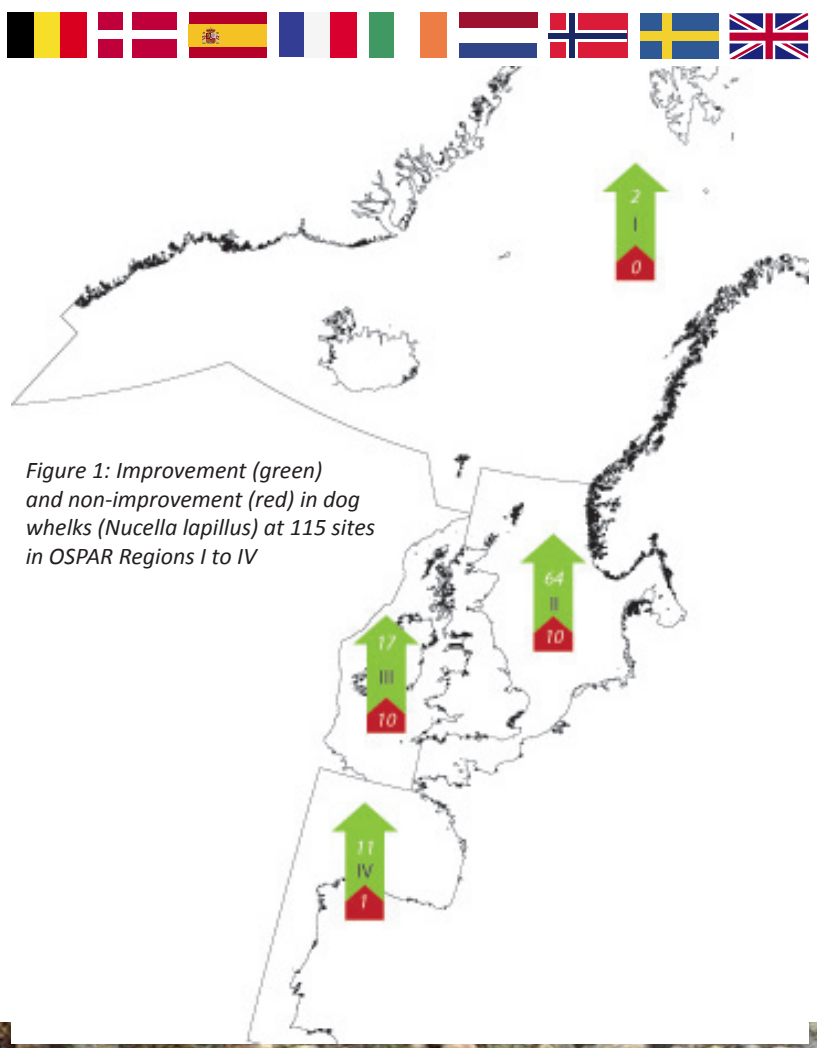

Figure 1: Improvement (green) and non-improvement (red) in dog whelks (Nucella lapillus) at 115 sites in OSPAR Regions I to IV

Results

The policy 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 (EACs), and ultimately reduction to 'close to zero' levels.
Imposex is currently monitored at 386 sites (Figure 3) on up to six marine gastropod species (assessment criteria are under development for one of species). There is a diversity of approaches to selecting target sampling stations, although there is an emphasis on stations which are in, or near to, harbours, ports and marinas where effects are most likely to occur.
Currently the OSPAR EAC set for TBT-specific effects is met at most sites (~65%).
Improvement and non-improvement was measured at 145 sites using the Vas Deferens Stage Index (VDSI) – a 7-stage measurement based on degree of penis and Vas Deferens development in females. Improvement was detected at >80% of these sites, with non-improvement shown at 16% of locations, while at 4% of sites the status is at background and continues to be stable. Dog whelks are the most common monitoring species and Figure 1 shows their improvement and non-improvement at 115 sites in five OSPAR regions. Similarly, Figure 2 shows improvement and non-improvement in five marine gastropod species sampled at 107 sites in one OSPAR. Overall improvement is evident (Figures 1 and 2).

Trends in the levels of imposex in marine gastropods

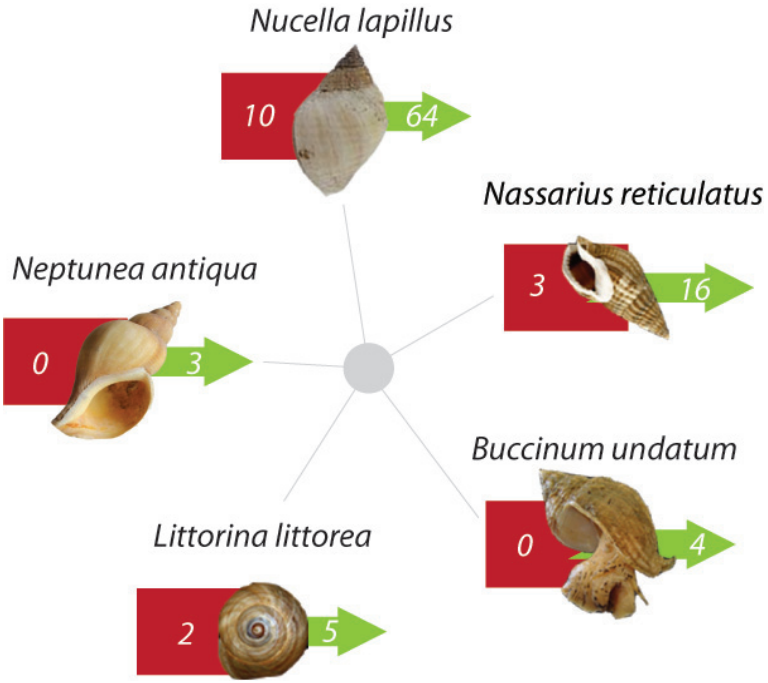

Figure 2: Improvement (green) and non-improvement (red) in 5 marine mollusc species sampled at 107 sites in OSPAR Region II

Knowledge Gaps

Some naturally occurring substances like metals and PAHs are not following the general downward trend and knowledge of the sources behind the upward trends are therefore required to make effective legislation or recommendations on future voluntary restrictions on the use or discharge of such substances.

Conclusion

Ongoing monitoring in marine gastropods will continue to provide a good indicator for TBT pollution and help in identifying illegal use of stocks of TBT-containing antifouling paints or losses of TBT from dockyards, marinas and vessel maintenance activities. Monitoring will continue to see if there is a further decline in imposex levels. Most antifouling products have now reverted to the use of copper-based paints, in some cases with the addition of other chemicals, which enhance their efficacy. These have also been investigated for environmental persistence and effects and have also been banned. OSPAR needs to keep an eye on developments in this area and avoid adverse consequences of use of other compounds. Also, there is a large reservoir of TBT in sediments, particularly in estuaries, which may continue to provide a secondary source to the water column. Despite the evident significant downward trend in imposex from TBT, some areas are still subject to high imposex levels. Sites which show non-improvement should be subject to further monitoring. The continued monitoring of imposex in marine gastropods offers the most clear-cut tool for monitoring of a contaminant-specific pollution effect.

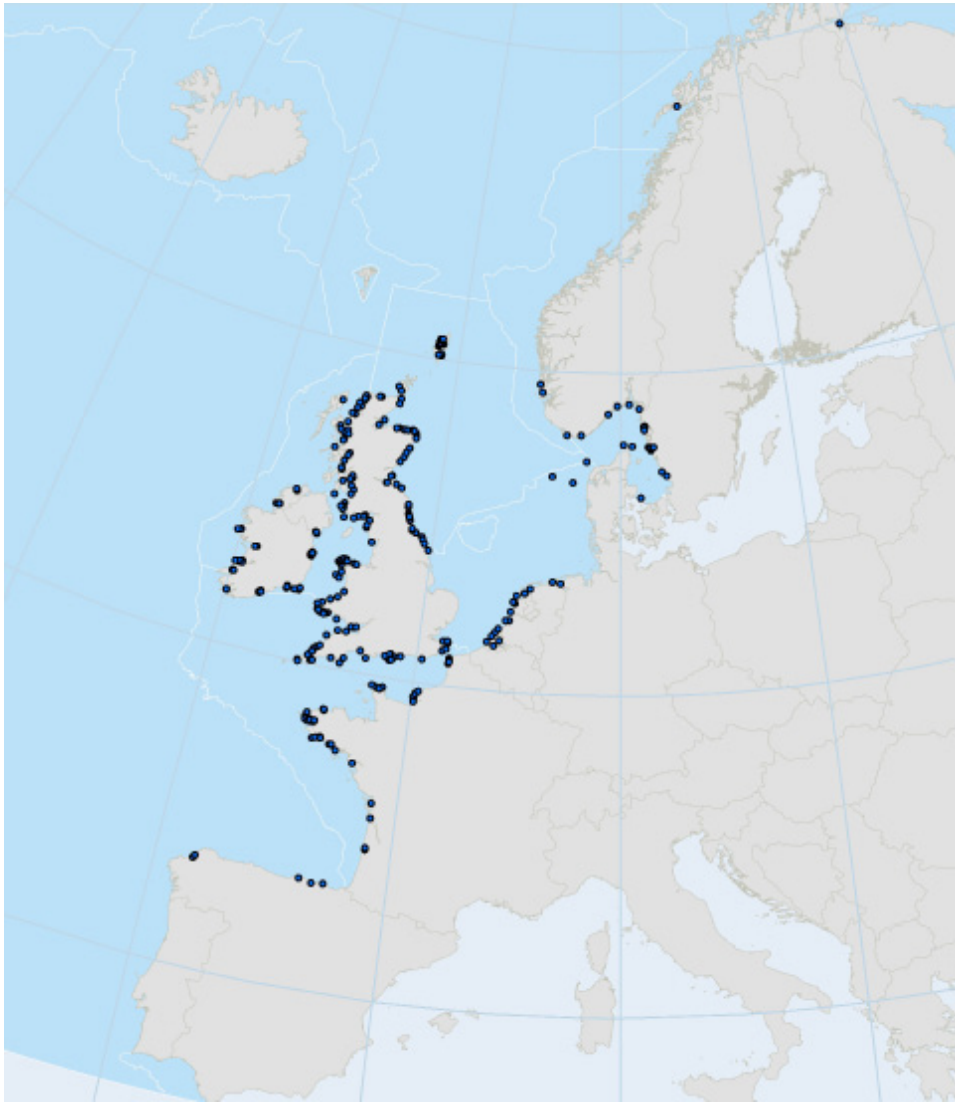

Figure 3: Current monitoring stations of imposex in marine gastropods for this assessment

The full assessment can be found at www.ospar/oat/imposex