OSPAR COMMISSION

Background Document on Organic tin compounds

Hazardous Substances Series

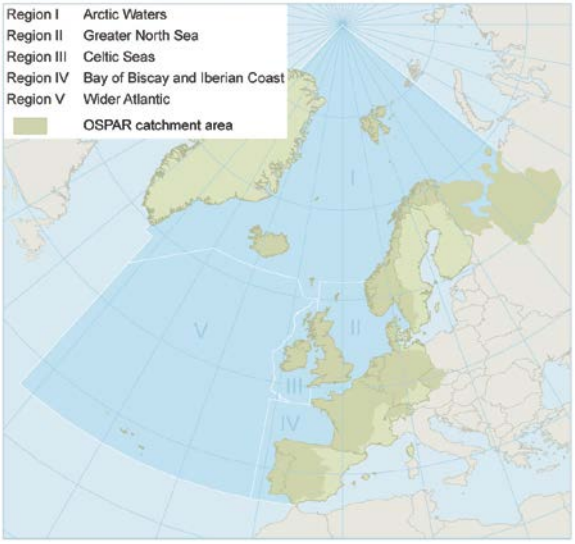
2011

OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the “OSPAR Convention”) was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. It has been ratified by Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, Netherlands, Norway, Portugal, Sweden, Switzerland and the United Kingdom and approved by the European Union and Spain.

Convention OSPAR

La Convention pour la protection du milieu marin de l'Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d'Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998.
La Convention a été ratifiée par l'Allemagne, la Belgique, le Danemark, la Finlande, la France, l’Irlande, l’Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume-Uni de Grande Bretagne et d’Irlande du Nord, la Suède et la Suisse et approuvée par l’Union européenne et l’Espagne.



The OSPAR maritime area and its five Regions.

Acknowledgement

This report has been prepared by Mr Reinier Goud, Rijkswaterstaat Centre for Water Management, task manager for the Netherlands as lead country.

Secretariat note

This background document was first adopted in 2000. A monitoring strategy for organic tin compounds was added in 2004 (Annex 1). The background document and the monitoring strategy were updated in 2011.

Contents

Executive Summary

Organic tin compounds, identified in 1998 on the OSPAR List of Chemicals for Priority Action, and in particular tributyl tin, has affected marine wildlife not only in the OSPAR maritime area but all over the world.

The 2000 OSPAR Background Document recommended actions with regard to the phasing out of the use organic tin compounds as antifouling systems on ship hulls, which was the major source of pollution. It also acknowledged relevant agreed and developing EU legislation for the application of organic tin compounds such as pesticides, biocides and for the regulation of discharges from the production of organic tin compounds. It furthermore recommended action within OSPAR such as reporting on the implementation of existing measures (e.g. on shipyards) and continued reporting on the dumping of dredged material. Finally it promoted the continued application of already existing monitoring and assessment tools for TBT and their further development such as TBT-specific biological effects monitoring.

In the last decade measures have been taken worldwide and in the EU for the phasing out of organic tin compounds used as antifouling agent on ship hulls. The IMO AFS, 2001 Convention introduced a ban per 1 January 2003 and came into force on 17 September 2008 whilst now covering 75% of the world shipping fleet. Under EU legislation almost all uses of organic tin compounds have been phased out or largely restricted. The EU restrictions in 2010 on those compounds used in consumer products are the most recent measures that will take stepwise effect until 2015.

With all these measures, there is clear movement towards the OSPAR cessation target. Whether the target will be achieved in 2020, cannot as yet be confirmed. Past uses of TBT as antifouling agent left a long-lasting legacy in the form of contaminated sediments. The further cessation of uses of tri-substituted organic tin compounds in the EC will contribute to achieving the cessation target, but, although of minor significance as a pollution source, they do not imply a full phase out and uses outside the EU and the OSPAR Convention area may remain a relevant source.

Quantification of effects has shown that contaminant levels in dredged material have decreased and that a reduction of imposex in gastropods, mainly due to the progressive reduction of TBT in antifouling systems, has been evident at the vast majority of monitoring locations. Although the overall status is improving, gastropods still show pollution effects from TBT over large parts of the OSPAR area, especially Regions II (Greater North Sea), III (Celtic Seas) and IV (Bay of Biscay and Iberian Coast). The effective implementation of the IMO AFS Convention is therefore important and the obligations of the Water Framework Directive and the Marine Strategy Framework Directive are also necessary for moving towards the cessation target for organic tin compounds.

Therefore, the recommended actions in this background document focus on the continued monitoring and assessment of organic tin compounds, especially TBT, for the implementation of IMO and EU measures, on the levels in contaminated dredged material, and in biota, including TBT specific biological effects. A further review should be carried out within five years.

Récapitulatif

Les composés organostanniques, inscrits en 1998 sur la Liste OSPAR des produits chimiques prioritaires, et en particulier le tributylétain (TBT), affectent la flore et la faune sauvages marines, non seulement dans la zone maritime OSPAR mais également dans le monde entier.

Le document de fond OSPAR de 2000 recommande des mesures sur l'abandon progressif de l'utilisation de composés organostanniques à titre de systèmes antisalissures sur les coques des navires, qui représente une source importante de pollution. Il reconnait également la législation pertinente, convenue et en cours de développement, de l'UE sur l'application des composés organostanniques, tels que pesticides, biocides et pour la réglementation des rejets provenant de la production de composés organostanniques. Il recommande de plus des mesures, au sein d'OSPAR, telles que la notification de la mise en œuvre des mesures existantes (par exemple sur les chantiers navals) et la notification continuelle sur l'immersion des matériaux de dragage. Il promeut l'application continuelle d'outils d'évaluation qui existent déjà pour le TBT et leur développement plus poussé tel que la surveillance d'effets biologiques propres au TBT.

Au cours de la dernière décennie, des mesures ont été prises à l'échelle mondiale et de l'UE quant à l'abandon progressif des composés organostanniques utilisés à titre d'agents antisalissures sur les coques des navires. La Convention AFS de 2001 de l'OMI a lancé une interdiction, au 1er janvier 2003, et elle est entrée en vigueur le 17 septembre 2008, tandis qu'elle couvre maintenant 75% de la flotte mondiale. Dans le cadre de la législation de l'UE, presque toutes les utilisations des composés organostanniques ont été progressivement abandonnées ou extrêmement restreintes. Les restrictions par l'UE, en 2010, de l'utilisation de ces composés dans les produits de consommation sont les mesures les plus récentes qui prendront effet jusqu'en 2015.

Toutes ces mesures indiquent une avancée dans le sens de l'objectif de cessation d'OSPAR. Il n'est pas encore possible de confirmer si cet objectif sera atteint en 2020. Les utilisations antérieures du TBT à titre d'agent antisalissure ont laissé un héritage durable sous forme de sédiments contaminés. L'arrêt supplémentaire de l'utilisation des composés organostanniques trisubstitués dans la CE permettra de réaliser l'objectif de cessation, mais bien qu'ils représentent une source de pollution de moindre importance, il n'est pas nécessaire d'arrêter complètement leur utilisation et celle-ci risque de demeurer une source pertinente dans l'UE et la zone de la Convention OSPAR.

La quantification des effets révèle que les niveaux des contaminants dans les matériaux de dragage ont diminué et la réduction de l'imposex chez les gastéropodes, essentiellement due à la réduction progressive des systèmes antisalissures au TBT, est évidente dans la vaste majorité des sites de surveillance. Bien que l'état général se soit amélioré, on note que les gastéropodes sont encore affectés par les effets du TBT dans de grandes parties de la zone OSPAR, en particulier les Régions II (Mer du Nord au sens large), III (Mers celtiques) et IV (Golfe de Gascogne et côtes ibériques). Il est donc important de mettre en œuvre efficacement la Convention AFS de l'OMI et les obligations de la Directive cadre « stratégie pour le milieu marin » permettent également de progresser dans le sens de l'objectif de cessation de l'utilisation des composés organostanniques.

Les mesures recommandées dans le présent document de fond se concentrent donc sur la surveillance et l'évaluation continuelles des composés organostanniques, en particulier le TBT, en ce qui concerne la mise en œuvre des mesures de l'OMI et de l'UE, sur les niveaux dans les matériaux de dragage contaminés, et le milieu vivant, notamment les effets biologiques propres au TBT. Une autre revue sera réalisée au cours des cinq prochaines années.

1. Introduction

In 1998, the OSPAR Commission identified organic tin compounds as a group of substances on the OSPAR List of Chemicals for Priority Action (*Reference Number 2004-12, revised 2009*). In 2000, the OSPAR Commission adopted the Background Document on Organic Tin Compounds, with an addition in 2004 of a monitoring strategy for organic tin compounds. The background document proposed action to be taken by OSPAR with regard to the following issues: shipping, agriculture, dredged materials, shipyards, inputs to the marine environment and monitoring and assessment in the marine environment. This background document is a review and update of the previous background document and identifies actions to support the achievement of the OSPAR objective with regard to hazardous substances, in particular for organic tin compounds (OSPAR North-East Atlantic Strategy 2010, *Reference Number 2010-3*).

2. Identification of all sources of organic tin compounds and their pathways to the marine environment

2.1 The group of organic tin compounds

The group of organic tin compounds identified by OSPAR for priority action comprises mono-, di-, tri- and tetrabutyl and triphenyl tin compounds. Of all these, tributyl tin compounds are considered to be the most hazardous of all tin compounds. The most well-known effects of tributyl tin compounds are shell malformations of oysters, imposex in marine snails, reduced resistance to infection (e.g. flounder), and effects on the human immune system. Tributyl tin has affected marine wildlife all over the world. Triphenyl tin has similar effects. As other organic tin compounds (e.g. mono- and dibutyl tin) are considered to be of less importance from a marine environmental point of view, the OSPAR Background Document from 2000 focused on the tri-organic tin compounds (OSPAR, 2000).

The substance stannane, tributyl(1-oxododecyl)oxy- (CAS No. 3090366) belonging to the group of organic tin compounds has been deselected from the OSPAR List of Substances of Possible Concern in 2004 on the grounds that it does not meet the cut-off value for persistence in the Selection Criteria used in the Initial Selection Procedure adopted by OSPAR 2001 (*Reference Number: 2001-1*) and is therefore not considered to be a priority for action by OSPAR.

A further four individual organic tin compounds (belonging to the prioritised group of organic tin compounds) are still included in the OSPAR List of Substances of Possible Concern. In 2009 the OSPAR Commission confirmed the recommendation of the Hazardous Substance Committee that those individual substances that have not been evaluated for their intrinsic properties and risk for the environment in a Background Document, warrant further work under Section A of the List of Substances of Possible Concern. They will be addressed under chapter 5 in order to confirm or amend their status on the List.

2.2 Use of organic tin compounds

Insight in the uses, markets and economic profiles of organic tin compounds has increased since 2000 and these are described in the Impact Assessment of Potential Restrictions on the Marketing and Use of Certain Organotin Compounds (RPA, 2007) (OSPAR, 2008).

There is a wide range of organic tin compounds that can be manufactured and placed on the market and these are used in a variety of industrial applications. Di-substituted organotins (usually in

combination with mono-substituted organotins and, to a lesser extent, tri-substituted compounds) are used as stabilisers for PVC and as catalysts for various products. Historically (prior to the introduction of a number of use restrictions), tri-substituted organotins were used as biocides in anti-fouling paints applied to ship hulls, in consumer products, in wood treatment and in pesticides (RPA, 2005). In the more recent 2007 RPA study, particular consideration is given to di- and tri-substituted organotins with, respectively, two and three organic groups bound to the tin atom. Table 2.1 below provides a summary of the uses of organotin and quantities sold in the EU in 2002 and 2007, where the latter estimates are based on information made available by industry for the purposes of the 2007 study while the former are from the 2005 risk assessment report (RPA, 2005).

Table 2.1: Uses of organic tin compounds and quantities sold in the EU in 2002 and 2007 (tonnes per year). Source: RPA, 2007

Applications	**Quantity (t/Yr) 2002**	**Quantity (t/Yr) 2007**
PVC stabilizers	15,000	>16,000
Catalysts	1,300 to 1,650	~2,000
• Plasticisers	150 – 350[1]	
• Silicones	50 – 100	
• Electrodeposition coatings	700 – 800	950
• Polyurethanes	400	750
Other uses		
• Glass coating	760 to 800	Same
• Biocide in antifouling paints	1,250	Phased out globally
• Synthesis	< 150	~500
• Biocide (other)[2]	< 100	Reduced
• Pesticide	100	Unknown
• Intermediate in synthesis (tetra-substituted)[3]	N/A	Unknown
All uses	**Approx. 19,000**	**Approx. 21,000**

1. Derived by subtracting sub-totals for silicones, EDC and polyurethanes from total for 'catalysts'.
2. Use of tributyltin compounds for these applications is now prohibited within the EU as they have not been notified under the Biocides Directive (98/8/EC).
3. The European Tin Stabilisers Association has advised that the total quantity of tri-substituted tins for use as an intermediate in 2004 was substantially higher than the estimate for 2002. Although not clarified, this could perhaps be because the quantities present in the tetra-substituted tins had been excluded.

2.3 Identified sources and pathways

As main inputs of TBT and TPT into the environment the 2000 background document indicated, with reference to a variety of reports in literature. This list has been completed with additional sources of past and present uses identified in later years:

- leaching/eroding from antifouling paints used on underwater structures and ships (TBT);[1]
- discharges and losses from docking activities (TBT);
- disposal at sea of organic tin contaminated dredged material from sea ports (DBT, TBT);
- industrial discharges from production/formulation of all organic tin compounds;[2]
- the use of DBT and DOT compounds as stabilizer in plastics and as catalytic agents in soft foam production;[3]
- the use of TBT for wood conservation: application, leaching, dumping of treated wood as waste;[3 4]

- the use of organic tins (DOT and DBT) in consumer PVC products e.g. toys, baking papers, beach balls, non-allergenic pillows, cycling shorts, shoe insoles, sandals and PVC prints on clothing e.g. T-shirts;[3]
- the use as antiseptic or disinfectant in canvas, carpet, cuttings, nappies, female hygiene products, athletes foot spray, dental moulds, 2-part silicone moulds and uses to prevent odours and mildew in clothing;[3]
- agricultural use of TPT in potato growing (surface run off, illegal dumping of the remainder of spraying agents, cleaning of the spraying machines, spray drift after airplane application and atmospheric deposition).[5]

Notes

[1] reduced by restrictions under EU (1999, 2002, 2003) and IMO (2001)

[2] reduced under EU IPPC (2008)

[3] reduced under restrictions by EU (2009)

[4] The company which produced tri-substituted tins for use in wood preservatives has advised the EU that it would be withdrawing these products from the market; no longer authorised as biocide

[5] No longer authorised in the EU (2002) as pesticide

The main pathways of organic tin compounds to the marine environment are direct releases from anti-fouling on ships, discharges to water from industry, waste water treatment plants and waste treatment and, hence riverine inputs. Besides there is re-location and re-suspension through dumping of dredged sediments.

3. Monitoring data, quantification of sources and assessment of the extent of the problem

3.1 Monitoring

Under the OSPAR Joint Assessment and Monitoring Programme (JAMP) the following monitoring methods and assessment criteria are available for organic tin compounds, in particular for TBT:

a. Agreed ecotoxicological assessment criteria for trace metals, PCBs, PAHs, TBT and some organochlorine pesticides (Reference Number 1997-5);

b. JAMP Guidelines for Monitoring Contaminants in Biota and its Technical Annex 7 on organotin compounds in biota (*Reference Number: 1999-02, Update 2010*);

c. JAMP Guidelines for Monitoring Contaminants in Sediments and its Technical Annex 4 on the determination of mono-, di- and tributyltin in sediments: Analytical methods (*Reference Number: 2002-16, Updates 2009 and 2010*);

d. JAMP Guidelines for Contaminant-Specific Biological Effects and its Technical Annex 3 on TBT-specific biological effects monitoring (*Reference Number: 2008-09*);

e. North Sea Ecological Quality Objective on imposex in dog whelks (*Nucella lapillus*) cf. Agreement on the Application of the EcoQO System (*Reference Number: 2006-04, Update 2007*);

f. Provisional JAMP Assessment Criteria for TBT – Specific Biological Effects *(Reference Number 2004-15, Update 2008)*

The OSPAR Coordinated Environmental Monitoring Programme (CEMP, *Reference number: 2010-1*) contains, amongst others, the following components of the CEMP to be measured by Contracting Parties on a mandatory basis (unless "opting out" for individual components of the JAMP if they are able to justify that these are not of relevance to them): TBT-specific biological effects and TBT in sediment or biota; monitoring of TBT concentrations in the marine environment in either sediments or biota should be carried out in parallel with monitoring of TBT-specific biological effects. With respect to TBT assessment criteria for biota exist (interim solution) on the basis of Agreement on CEMP Assessment Criteria for the QSR 2010 (*Reference number: 2009-2*) (OSPAR Quality Status Report 2010; OSPAR, 2010a).

The Agreement on Monitoring Strategies for OSPAR Chemicals for Priority Action (*Reference Number: 2004-14, update 2006*) identifies the following strands for monitoring of organic tin compounds:

- monitoring of biota, sediment and biological effects under CEMP (section 3);
- collection and evaluation of information from the European Pollutant Release and Transfer Register (E-PRTR) in respect of discharges from installations subject to the EC Integrated Pollution and Prevention and Control Directive (section 5);
- reports on concentrations in dredged materials disposed to the OSPAR maritime area (section 7);
- any reports on the implementation of EC or OSPAR measures regulating the marketing and/or use, or emission and/or discharge (section 8);
- information gathered under the EC Water Framework Directive relating to concentrations in the marine environment (in some or all of the water column, sediments and biota or all of transitional, coastal and territorial waters) and to levels of riverine and direct inputs into the marine environment (section 11);
- information from one-off surveys by Contracting Parties (section 12).

3.2 Quantification of sources

The 2000 Background Document identified estimated inputs to water from nine OSPAR countries of TBT of ca. 70 tonnes per year for 1995 (NSC 4, 1995). These figures are likely to reflect the use of TBT in antifouling paints which was at that time still common practice. Five countries had indicated that they had achieved the reduction target of 50% or more, compared to 1985. Further information in 2002 (NSC 5, 2002) revealed that this situation had not changed. However, not all countries had submitted information in both cases.

Industrial and domestic discharges

More recent data is included in the European Pollutant Release and Transfer Register (E-PRTR: EC, 2006; previously called EPER). Total organic tin discharges reported by Germany, Portugal, Spain and the United Kingdom in 2001 and 2004 indicate discharges of organic tin compounds of 1.6 and 3.4 tonnes, respectively. The reported discharges related mainly to the metal industry, the basic organic chemicals industry and the pulp and paper industry. Discharges of these compounds in 2007 and 2008 account for 1.4 and 1.7 tonnes, respectively. These discharges are reported for Germany and the UK, mainly from waste water treatment plants and, to a lesser extent from refineries. While uncertainties in the exact discharges exist due to inconsistencies in reporting and do not allow conclusions on trends, the data still give an indication that discharges from heavily regulated point sources continue. In 2008, TPT releases accounted for ca. 75 kg in EU countries.

Docking activities

For the period 2000-2003 the Netherlands reported estimated national discharges from docking activities of 1.5 tonnes Sn per year due to removing existing coatings from ship hulls. These discharges are likely to reduce over time due to reduced use of TBT in antifouling paints. A problem with estimating discharges is the determination of the amount of waste water containing TBT and other contaminants. Therefore, table 3.1 shows concentrations of those contaminants in waste water from docks and slipways of shipyards, including those substances used as substitutes for TBT in antifouling paints. Abatement measures taken at these shipyards are good house keeping (cleaning dock areas) and sedimentation tanks. TBT en Sn concentrations are low due to the phase-out of the use of TBT. The alternative component in antifouling paint, Irgarol is present in waste water of three shipyards. Diuron, the use of which is prohibited as a component in antifouling paint, is present in some cases (RWS, 2010).

Table 3.1: Results of analysis of waste water from shipyards in the Netherlands in µg/l (2009)

Area	Shipyard	Diuron	eSn [1]	TBT	Sn	Irgarol
North	1	30	1	0.5	5.8	35
North	2	-	0.05	0.03	-	-
East	3	1.5	-	-	0.8	2.5
Northwest	4	35	-	-	4.8	1.3
West	5	0.9	-	-	1.3	0.6
West	6	0.1	-	-	0.3	0
Southwest	7	43	-	-	3	110
Southwest	8	3.5	-	-	2.1	80

[1] extractable Sn

Antifouling paint from shipping

As mentioned before, estimated inputs to water from nine OSPAR countries of TBT were ca. 70 tonnes per year in 1995, mainly due to the use of antifouling paints on ships. The Netherlands' Pollutant Release and Transfer Register (PRTR, 2010) presents estimates for releases of organic tin compounds from ships in Dutch waters (stationary in ports, sailing to and from ports and sailing on the Dutch Continental Shelf). Shipping includes recreational boating, fishing vessels and sea-going vessels. These figures take into account estimates of substitution of TBT in antifouling paints by alternative active components or methods, e.g. copper and non-stick coatings (PRTR, 2008). For further information see Annex 2.

Table 3.2: Releases of organic tin compounds from antifouling paint on ship hulls in the Dutch Continental Shelf (tonnes Sn/year)

Year	1990	1995	2000	2005	2007	2008
Sn releases	8.3	8.5	6.8	3.4	1.4	0.4

OSPAR publication 462/2009 (OSPAR, 2009) presents the results of how estimations of releases by sea shipping can be improved by using AIS (Automatic Identification System) data. Walraven (2006) had estimated the input of copper, zinc, cadmium, tributyltin and biocides from shipping to the Greater North Sea. The 2006 figures have been improved where possible based on an improved method and emission factors and the most up-to-date actual shipping data available for the Dutch part of the North Sea. The results are presented for TBT and Cu in figure 3.1. The figures have then been extrapolated to the Greater North Sea (OSPAR Region II) on the basis that ship movements in the region are in average 5.8 times higher than the Dutch Continental Shelf, taking into account different types and sizes of ships where appropriate. The results of these modelled releases of TBT compounds are presented in table 3.3, including other leaching coatings and corrosion of anodes from ships. TBT releases from moving ships account for 8 tonnes/year in the Greater North Sea.

Figure 3.1: Estimated losses of TBT and copper from ships coatings at sea on the Continental Shelf of the Netherlands in 2007 (excluding fishing vessels).

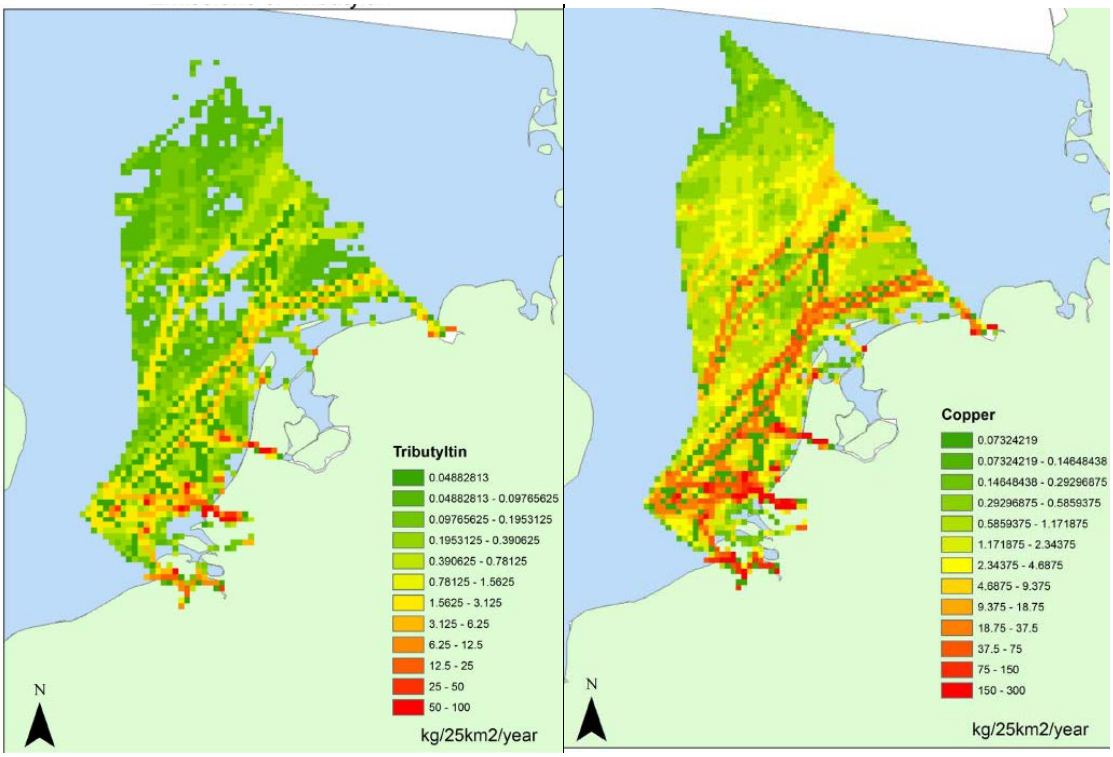


Table 3.3: Emissions of coatings and anodes in kg/year for the Greater North Sea, OSPAR Region II; only moving ships at sea, fishing vessels excluded.

Substance	Process	Emissions in kg/year at sea by moving ships
Aluminium	Corrosion anodes hull	19,745
	Corrosion anodes ballast tanks	17,684
	Aluminium total	37,429
Cadmium	Corrosion anodes hull	191
	Corrosion anodes ballast tanks	10
	Cadmium total	201
Dichlofluanide	Leaching coatings	1,827
Irgarol	Leaching coatings	1,827
Copper	Leaching coatings	98,986
Copperthiocyanate	Leaching coatings	1,827
Seasine-211 (kathon)	Leaching coatings	1,827
Tolylfluanide	Leaching coatings	1,827
Tributyltin compounds	Leaching coatings	8,058
Zineb	Leaching coatings	1,827
Zinc	Corrosion anodes hull	382,352
	Corrosion anodes ballast tanks	20,388
	Zinc total	402,739
Zincpyrithion	Leaching coatings	1,827

Riverine inputs

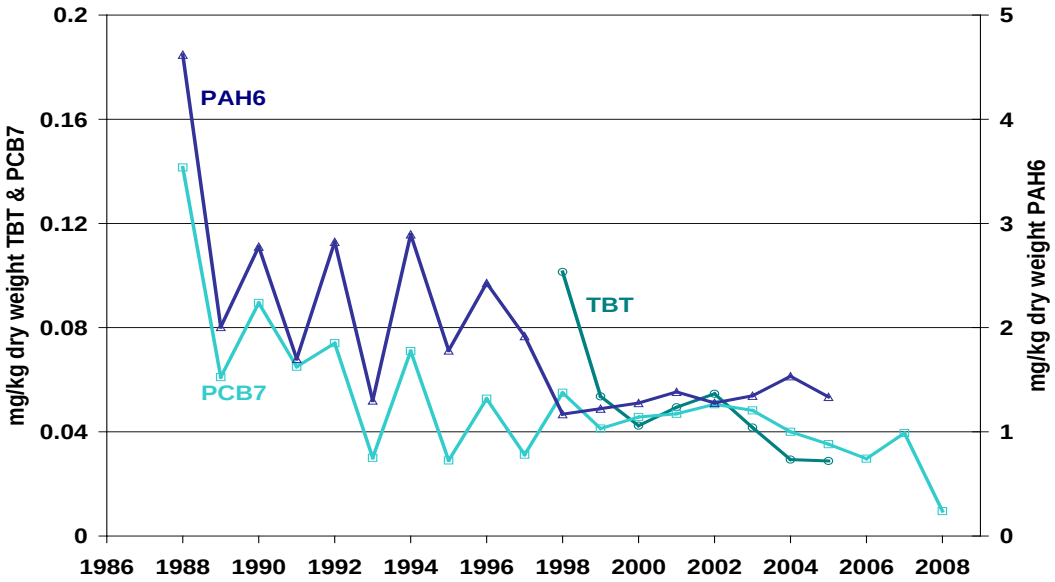
In 2007 OSPAR's Assessment and Monitoring Committee has assessed the priority of a one-off survey on riverine inputs of organic tin compounds. Data from the Netherlands and Norway had shown that all values where below detection limits (1 ng/l) and it was therefore concluded that a one-off survey should not be given priority at that moment. On the basis of some specific measurements at the mouth of the river Rhine and the average discharge of the river, the Netherlands estimates that the annual riverine input organic tin compounds to Dutch coastal waters is in the order of some tens kg/year.

Dumping of dredged material

As disposal of dredged material may have physical impacts on the marine environment, total amounts of material disposed of are included in the JAMP assessment of the environmental impact of dumping of wastes at sea (OSPAR, 2009a). The overall amounts of material disposed of at sea have varied significantly between approximately 100 – 131 million tonnes per year (dry weight) in the period 1995 - 2007. No real trends in the overall amounts can be observed in this period. About 90% of the dredged material reported to OSPAR is generally dumped by only five Contracting Parties (Belgium, France, Germany, the Netherlands, the United Kingdom). Because the quantity of dredged material to be dumped is influenced by natural conditions, dumping strategies, sediment disposal criteria and episodic capital dredging activities (which occasionally contribute huge amounts to the total amount of dredged material disposed of at sea), trends in the amounts dumped are difficult to predict.

The JAMP assessment does not present trends in loads of organic tin compounds from the dumping of dredged material. On the basis of the annual OSPAR reports it is estimated that in the period 1999 - 2008 the TBT load from dredged material dispersed in the OSPAR maritime area by dumping activities lies within a range of 0.7 – 3.4 tonnes per year (excluding one outlier for 2006). In order to have an indication of trend, the JAMP assessment presents in figure 3.2, amongst others, TBT concentrations in dredged material disposed of from the Port of Rotterdam which shows a decreasing trend, likely due to less pollution from decreasing use of TBT in antifouling paint on ship hulls.

Figure 3.2: PCB, PAH and TBT concentrations in dredged material disposed of in Rotterdam Harbour (average concentrations in sediment fraction < 2mm). Source: Annual OSPAR Reports on Dumping of Wastes at Sea



3.3 Quantification of effects

Existing national and international measures have resulted in a continuous phase-out of paints containing TBT in the OSPAR area and their use on vessels, aquaculture and underwater structures over the last decade. The global ban of TBT in antifouling systems on large vessels under the International Convention on the Control of Harmful Anti-fouling Systems on Ships (AFS Convention) took effect in 2008 and addresses the main TBT-related pressure on the marine environment (OSPAR, 2009b).

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 (see box) (OSPAR, 2009c). A small yacht painted with a TBT-based antifouling coating could release enough TBT in the course of a season to give theoretically ten million cubic meter water a TBT concentration sufficient to affect sensitive gastropod species. A similar amount could be leached from a large tanker in an hour.

Since 2003, imposex and related effects of TBT in gastropods have been regularly monitored in OSPAR Regions I, II, III and IV. In the period 1998 to 2007, a reduction in imposex has been evident at the vast majority of monitoring locations. No locations that have been monitored show a significant upward trend in the level of imposex. This is consistent with progressive reduction in the inputs of TBT to coastal waters from shipping and historically contaminated sediments (Figure 3.3).

Although the overall status is improving, gastropods still show pollution effects from TBT over large parts of the OSPAR area, especially Regions II, III and IV. There is a clear relationship between shipping and imposex with levels high in the vicinity of some large harbours (*e.g.* Rotterdam, Clydeport, Vigo). The situation is markedly better where there is less large vessel traffic *e.g.* the west coast of Scotland and in the northern part of Norway (Charting Progress 2, 2010 and 2010a).
However, even in these areas, harbours can have a detectable impact, highlighting the importance of local factors.

These results emphasise the need to continue marine monitoring. This will provide surveillance against illegal use of stocks of TBT in antifouling paints, and losses of TBT from dockyards, shipyards and vessel maintenance activities (*e.g.* sandblasting). It should also promote good practice in dealing with historical contamination of sediment, particularly from harbours, which continues to present a problem.

The use of the main substitutes for TBT, copper and Irgarol (cybutryne), started on smaller vessels and has now continued for over a decade. These new antifouling components, though not as detrimental as TBT, can have certain adverse effects on biota. For example, Irgarol has been shown to reversibly affect the growth rate of marine algae (Buma *et al.*, 2009). The rapid growth

Box

Ecological Quality Objective for TBT related effects in the North Sea

As an ecological quality objective for TBT related biological effects in the North Sea, OSPAR has agreed that the level of imposex in a sample of not less than 10 female dogwhelks (*Nucella lapillus*) (OSPAR, 2009d) should be consistent with exposure to TBT concentrations that do not pose a risk of significant biological effects. Where *Nucella lapillus* does not occur naturally or where it has become extinct, other species may be used. Such a situation indicates however, that the sensitive species may already have disappeared.

➥ *Evaluation of the OSPAR North Sea EcoQOs (OSPAR, 2009e)*

in use of copper-based antifouling systems in aquaculture over the past decade has markedly increased the release of copper to the sea in northern Scotland and west and north Norway. It is necessary for OSPAR surveys and environmental monitoring programmes to be aware of, and adapt to, the changing uses of the sea and the chemicals involved.

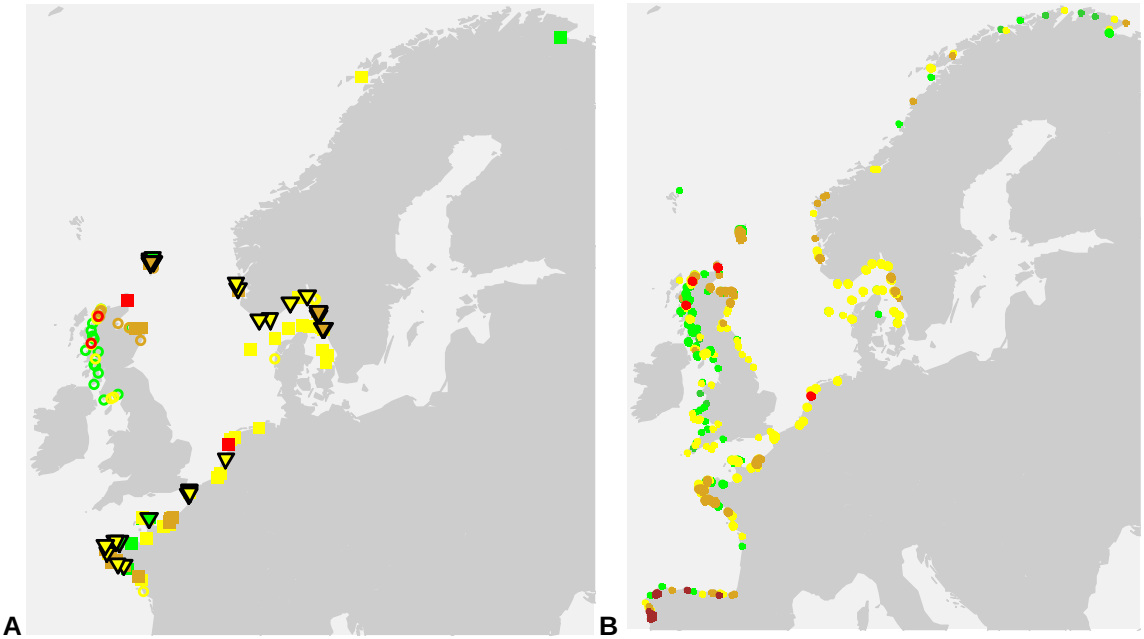


Figure 3.3: The colour coding refers to the six assessment classes for TBT effects with dark and light green indicating that the OSPAR EcoQO on imposex in dogwhelks and other related gastropods is met (good status). All other observed effects levels are above the EcoQO from light and dark yellow (moderate status) to light and dark red for highest effects levels (bad status). Panel A shows significant downward trends (triangle) of imposex in the period 1998 – 2007; circles indicate insufficient data to assess trends. Panel B shows the status of imposex measurements; large symbols = 3 or more years of data; smaller symbols = 1 or 2 years of data (trends and concentrations in sediments and biota (OSPAR, 2009b and 2009f). Zooming in further, the Clean and Safe Seas Feeder Report for Charting Progress 2, 2010, shows a markedly improvement of imposex in dogwhelks on all sampling sites in UK marine waters (table 3.4 below).

Table 3.4: Percentage of sites in each OSPAR class for imposex in dogwhelks for each reporting year: 1992, 1998, 2004 and 2007 (Charting Progress 2, 2010a). For assessment classes see table 3.5.

Year	Percentage of sites in each OSPAR class				
	Class E	Class D	Class C	Class B	Class A
1992	0	55.0	40	5	0
1997/8	0.8	17.9	43.9	37.4	0
2004	0	12.7	47.7	41	7.6
2007	0	2.6	28.4	52.2	16.8

The Feeder Report also presents the case study below, which shows improvements in a specific area of UK waters (Gubbins *et al.*, 2010).

Case Study: Spatial and temporal trends of TBT-specific effects on dogwhelks at Sullom Voe oil terminal, Shetland

The oil terminal at Sullom Voe in Shetland has been operating since 1978 and receives a large number of oil and gas tankers. The use of TBT antifouling paints on these tankers has been a source of TBT contamination in Sullom Voe and the surrounding area for over 20 years. Since 1987, FRS in conjunction with the Shetland Oil Terminal Environmental Advisory Group (SOTEAG) has monitored populations of dogwhelks in Sullom Voe and the surrounding Yell Sound area for imposex. Dogwhelks from sites close to the oil terminal in Sullom Voe show the highest levels of imposex (larger dots on the map) and some female dogwhelks have become sterilised (VDSI >4) at several of the sites within Sullom Voe (dark blue dots Figure 3.5). Since 1987, the level of imposex in dogwhelks from sites within Sullom Voe has decreased (Figure 3.6) due to changes in the types of TBT antifouling paints used and decreases in the numbers of tankers visiting the terminal. Monitoring of gastropods at these sites will continue to assess how they recover after the use of TBT as an antifoulant was banned on large vessels in 2008.

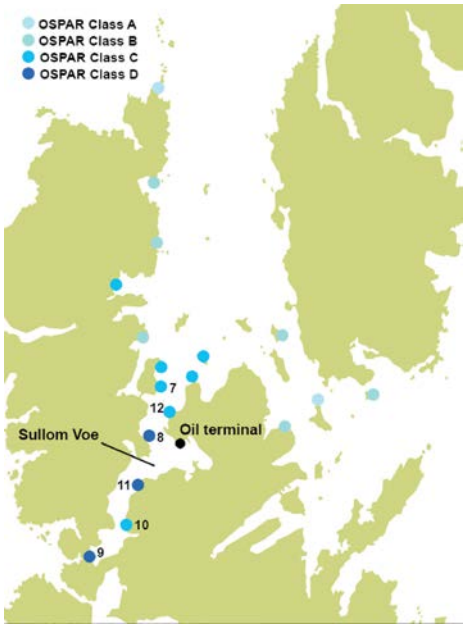


Figure 3.5: OSPAR classification of sampled sites in Yell Sound and Sullom Voe, 2007. © Marine Scotland Science.

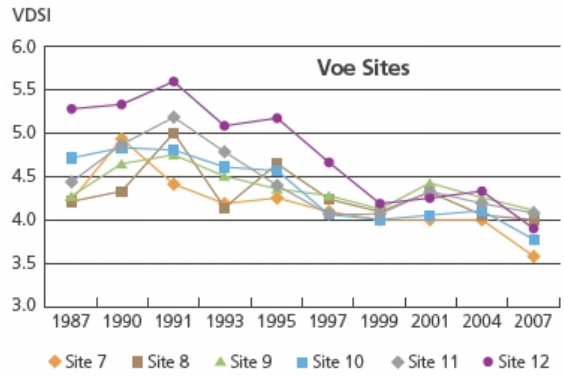


Figure 3.6: Trend in imposex (VDSI) of dogwhelks from sites within Sullom Voe between 1987 and 2007. © Marine Scotland Science.

As described in the 2008− 2009 Assessment of CEMP Monitoring Data (OSPAR, 2009f), it is possible to integrate the assessment of imposex/intersex with concentrations of TBT in sediment (and potentially biota), as shown in table 3.5 below. Few data were available for TBT concentrations in biota, but sufficient data for TBT in sediment were available for an assessment to be made (see also Thain *et al.*, 2010). The results are also shown in figure 3.7.

Table 3.5: Integrated assessment classes linking TBT effects in gastropod species with concentrations of TBT in water and sediment, and comparisons with EACs and EQSs in biota and water.

Assessment class	*Nucella*	*Nassarius*	*Buccinum*	*Neptunea*	*Littorina*	*TBT Water*	*TBT mussel*	*TBT sediment*	*EAC water*	*EAC mussel*	*EAC sediment*	*EQS (water)*	
												AA	*MAC*
	VDSI	VDSI	PCI	VDSI	ISI	(ng TBT/l)	(µg TBT /kg dw)	(µg TBT/ kg dw)	(ng TBT/l)	(µg TBT/ kg dw)	(µg TBT/ kg dw)	(ng TBT/l)	(ng TBT/l)
A	< 0.3	< 0.3[1]	< 0.3[1]	< 0.3	< 0.3[2]	<0.025	< 3	n.d.			0.01		
B	0.3 - <2.0			0.3 - <2.0		0.025-0.25	3-30	< 2	0.1	12		0.2	
C	2.0 - < 4.0	0.3 - <2.0	0.3 - <2.0	2.0 - 4.0[3]		0.25-5	30 - <600	2 - <50					1.5
D	4.0 - 5.0	2.0 – 3.5	2.0 - 3.5		0.3 - < 0.5	5-7.5	600 - < 900	50-<200					
E	>5.0[4]	> 3.5[4]	>3.5[4]		0.5 - 1.2	7.5-37.5	900 - 4200	200 -500					
F					> 1.2	>37.5	>4200	>500					

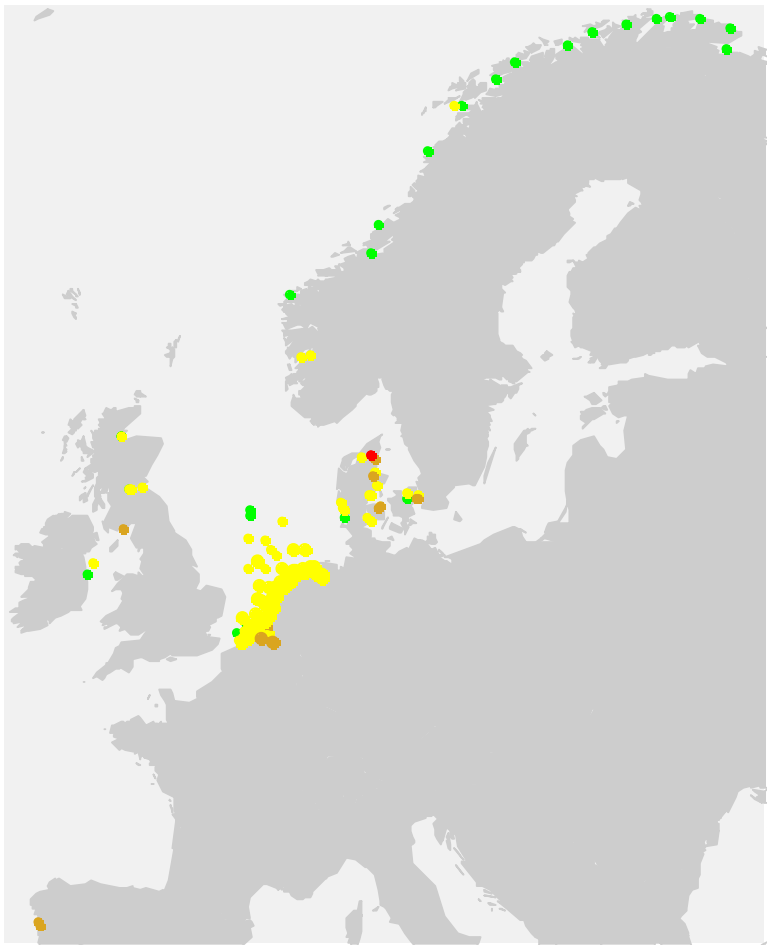


Figure 3.7: Integrated assessment of TBT-specific biological effects and TBT in sediments.

The potential role of historically contaminated sediment to act as a source of TBT for sensitive gastropod species has been mentioned above. Data on the concentrations of TBT in sediment are available from both coastal and offshore locations, particularly in the southern bight of the North Sea. The large majority of the concentrations fall into assessment classes B and C, and would not be expected to affect the reproductive capability of sensitive gastropod species. This is consistent with the imposex results, as are the scattered occurrences of concentrations in higher assessment classes.

4. Desired reduction

The OSPAR Commission's strategic objective with regard to hazardous substances is to prevent pollution of the OSPAR maritime area by continuously reducing discharges, emissions and losses of hazardous substances, with the ultimate aim to achieve concentrations in the marine environment near background values for naturally occurring substances and close to zero for man-made synthetic substances. The Hazardous Substances Strategy will be implemented progressively by making every endeavour, through appropriate actions and measures:

a. to achieve concentrations of contaminants at levels not giving rise to pollution effects, and contaminants in fish and other seafood for human consumption not exceeding levels established by EU legislation or other relevant standards, and finally;

b. to move towards the targets of the cessation of discharges, emissions and losses of hazardous substances by the year 2020.

In order to meet the targets specified in the OSPAR objective and timeframe, it is necessary to:

- assess the need for further reductions from the various sources and the practicability of such reductions;
- review existing regulations and controls in the light of the need for further reductions;
- decide which organisation is responsible and/or best placed for carrying out detailed assessments and/or implementing controls;
- inform the relevant organisation (if not OSPAR) of the OSPAR ministerial commitments with regard to hazardous substances and the need for action to address OSPAR concerns;
- set up mechanisms for monitoring the compliance with measures adopted in the relevant forum;
- set up mechanisms to monitor inputs to the marine environment;
- review progress (quantify inputs and assess concentrations in the marine environment and biota) and identify the need for further action.

5. Identification of regulations and possible measures

5.1 OSPAR

Existing measures are PARCOM Recommendation 87/1 on the Use of Tributyltin Compounds and PARCOM Recommendation 88/1 on Measures to Reduce Organic Tin Compounds reaching the Aquatic Environment through Docking Activities In 2006, OSPAR has published an overview assessment of the implementation of those measures, which concluded that, in general, Contracting

Parties have adopted measures to effectively implement them in their territories and that the coverage of those measures had been taken over by IMO and EU instruments (OSPAR, 2006). Therefore, OSPAR agreed that further implementation reporting on PARCOM Recommendations 87/1 and 88/1 could cease for all Contracting Parties but that there was a need to ensure that the necessary information on discharges, emissions and losses of TBT becomes available through the monitoring strategies for OSPAR chemicals for priority action (*Reference Number: 2004-14, update 2006*).

5.2 International Maritime Organisation

The International Convention on the Control of Harmful Anti-Fouling Systems on Ships, 2001 (AFS 2001) prohibits the use of harmful organotins in antifouling paints used on ships and establishes a mechanism to prevent the potential future use of other harmful substances in anti-fouling systems. This Convention was adopted on 5 October 2001. Under the terms of this Convention, Parties to the Convention are required to prohibit and/or restrict the use of harmful anti-fouling systems on ships flying their flag, as well as ships not entitled to fly their flag but which operate under their authority and all ships that enter a port, shipyard or offshore terminal of a Party.

Anti-fouling systems which are prohibited or controlled are listed in Annex 1 to the Convention, which will be updated as and when necessary. Annex I states that by 1 January 2003 all ships shall not apply or re-apply organic tin compounds which act as biocides in anti-fouling systems. By 1 January 2008 (effective date), ships either: (a) shall not bear such compounds on their hulls or external parts or surfaces; or (b) shall bear a coating that forms a barrier to such compounds leaching from the underlying non-compliant anti-fouling systems. This applies to all ships (except fixed and floating platforms that have been constructed prior to 1 January 2003 and that have not been in dry-dock on or after 1 January 2003).

After the ratification of the 25th Contracting State (Panama) the Convention entered into force on 17 September 2008. The status of ratification as of 28 February 2011 shows that 49 Contracting States have ratified the Convention, whereby 75% of world tonnage is now subject to the restrictions of organic tin compounds in anti-fouling systems. The Convention has been ratified by all OSPAR Contracting Parties except Portugal and Switzerland, and by all other EU Member States except Austria, the Czech Republic, Italy and Slovakia. So far, the Convention has not been ratified by the USA, the Russian Federation and a number of Asian countries.

5.3 European Union

Biocides

The marketing and use of organic tin compounds as antifouling was first restricted under the Commission Directive Directive 1999/51/EC of 26 May 1999 (EC, 1999) as follows:

> *"Organostannic compounds*
>
> *1. May not be placed on the market for use as substances and constituents of preparations when acting as biocides in free association antifouling paint.*
>
> *2. May not be used as substances and constituents of preparations when acting as biocides to prevent the fouling by microorganisms, plants or animals of:*
>
> *(a) the hulls of:*
>
> *- boats of an overall length, as defined by ISO 8666, of less than 25 metres;*
>
> *- vessels of any length for use predominantly on inland waterways and lakes;*
>
> *(b) cages, floats, net and any other appliances or equipment used for fish or shellfish farming;*
>
> *(c) any totally or partly submerged appliance or equipment.*
>
> *Such substances and preparations*
>
> *- may be placed on the market only in packages of a capacity equal to or greater than 20 litres;*
>
> *- may not be sold to the general public but only to professional users.*

Without prejudice to the application of other Community provisions on the classification, packaging and labelling of dangerous substances and preparations, the packaging of such preparations shall be legible and indelibly marked as follows:

"Not to be used on boats of an overall length of less than 25 metres, or on vessels of any length for use predominantly on inland waterways and lakes, or any appliances or equipment used in fish or shellfish farming."

"Restricted to professional users".

3. *The provisions referred to in Section 2(a) and the special labelling provisions of Section 2 are applicable to Sweden and Austria from 1 January 2003 and will be reviewed by the Commission in cooperation with Member States and stakeholders before this date.*
4. *May not be used as substances and constituents of preparations intended for the use in the treatment of industrial waters."*

Commission Decision 2002/62/EC then implemented further measures on the restriction of marketing and use, by adding to Annex I of Directive 76/769/EEC the following (EC, 2002):

"Organostannic compounds

1. *May not be placed on the market for use as substances and constituents of preparations when acting as biocides in free association paint.*
2. *May not be placed on the market or used as substances and constituents of preparations which act as biocides to prevent the fouling by microorganisms, plants or animals of:*
   - *(a) tall craft irrespective of their length intended for use in marine, coastal, estuarine and inland waterways and lakes;*
   - *(b) cages, floats, nets and any other appliances or equipment use for fish or shellfish farming;*
   - *(c) any totally or partly submerged appliance or equipment.*
3. *May not be used as substances and constituents of preparations intended for use in the treatment of industrial waters."*

Following the adoption by the IMO of the AFS 2001 Convention, the EU adopted Regulation (EC) No 782/2003 of the European Parliament and of the Council of 14 April 2003 on the prohibition of organic tin compounds on ships, which implemented the AFS 2001 Convention for EU Member States by 10 May 2003 for (EC, 2003):

(a) ships flying the flag of a Member State;

(b) ships not flying the flag of a Member State but operating under the authority of a Member State.

The Regulation also ensured that there are procedures concerning survey and certification, and state port control, and that if the AFS 2001 Convention had not entered into force by 1 January 2007 the Commission shall adopt appropriate measures in order to allow ships flying the flag of a third State to demonstrate their compliance with the AFS 2001 prohibitions as from 1 July 2003 and 1 January 2008. This has been given effect by Commission Regulation (EC) No 536/2008 of 13 June 2008 (EC, 2008).

Pursuant to at Article 16(2) of Directive 98/8/EC of the European Parliament and of the Council concerning the placing of biocidal products on the market, a 10-year programme of work is carried out for the review of all existing active substances. This programme of work was intended to identify the existing active substances and determine those to be evaluated under the review programme with a view to their possible inclusion in Annex I, IA or IB to Directive 98/8/EC. Commission Regulation (EC) No 1451/2007 of 4 December 2007 for the second phase of the 10-year work programme identified in its Annex I the following active substances as existing (EC, 2007):

- bis(tributyltin) oxide (CAS No 56-35-9);
- tributyltin acetate (CAS No 56-36-0);

- 4-oxo-4-[(tributylstannyl)oxy]but-2-enoic acid/Tributyltin maleate (CAS No 4027-18-3);
- tributylstannyl salicylate/Tributyltin salicylate (CAS No 4342-30-7);
- tributylstannyl benzoate/Tributyltin benzoate (CAS No 4342-36-3);
- stannane, tributyl-, mono(naphthenoyloxy) derivs. (CAS No 85409-17-2), also on the OSPAR List of Substances of Possible Concern;
- tributyltin coPolymer (TBT-coPolymer) (EC Polymer);

As these substances are not listed in Annex II of Regulation 1451/2007 (Active substances to be reviewed under the work programme) or in Annex I or IA to Directive 98/8/EC, they are no longer placed on the market, and there is therefore no current use of these substances.

Pesticides

Concerning triphenyltin (TPT) used as a pesticide, Commission Decisions 2002/478/EC and 2002/479/EC of 20 June 2002 withdrew the application of fentin acetate (CAS No 668-34-8) and fentin hydroxide (CAS No 76-87-9) in order to ensure that (EC, 2002a; EC, 2002b):

(1) authorisations for plant protection products containing these substances are withdrawn within a period of six months from the date of the adoption of the Decisions;

(2) from the date of adoption of these Decisions no authorisations for plant protection products containing these substances will be granted or renewed under the derogation provided for in Article 8(2) of Directive 91/414/EEC.

Both substances are on the OSPAR List of Substances of Possible Concern but there is no current use of these substances.

Commission Regulation (EC) No 2076/2002 of 20 November 2002 concerns the non-inclusion of amongst others tributyltin oxide (CAS No 56-35-9) in Annex I to Council Directive 91/414/EEC and the subsequent withdrawal of the authorisation for plant protection products containing this active substance (EC, 2002c).

The use of fenbutatin oxide (CAS No 13356-08-6), also on the OSPAR List of Substances of Possible Concern, is further restricted in Annex I to Council Directive 91/414/EEC). Commission Directive 2011/30/EU of 7 March 2011 regulates that fenbutatin oxide only used as acaricide in greenhouses may be authorised (EC, 2011).

The acaricide cyhexatin (CAS No 13121-70-5), also on the OSPAR List of Substances of Possible Concern, is not included in Annex I to Council Directive 91/414/EEC and its use may therefore not be authorised.

Consumer products

With regard to organostannic compounds in consumer products the Commission Decision 2009/425/EC of 28 May 2009 was adopted amending Annex I of Council Directive 76/769/EEC (SCHER, 2006; EC, 2009), the restrictions of which have now been included in Commission Regulation (EU) No 276/2010 of 31 March 2010 (EC, 2010) 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. The restrictions include:

'4. Tri-substituted organostannic compounds:

(a) Tri-substituted organostannic compounds such as tributyltin (TBT) compounds and triphenyltin (TPT) compounds shall not be used after 1 July 2010 in articles where the concentration in the article, or part thereof, is greater than the equivalent of 0,1 % by weight of tin.

(b) Articles not complying with point (a) shall not be placed on the market after 1 July 2010, except for articles that were already in use in the Community before that date.

5. Dibutyltin (DBT) compounds:

(a) Dibutyltin (DBT) compounds shall not be used after 1 January 2012 in mixtures and articles for supply to the general public where the concentration in the mixture or the article, or part thereof, is greater than the equivalent of 0,1 % by weight of tin.

(b) Articles and mixtures not complying with point (a) shall not be placed on the market after 1 January 2012, except for articles that were already in use in the Community before that date.

(c) By way of derogation, points (a) and (b) shall not apply until 1 January 2015 to the following articles and mixtures for supply to the general public:

- *one-component and two-component room temperature vulcanisation sealants (RTV-1 and RTV-2 sealants) and adhesives,*
- *paints and coatings containing DBT compounds as catalysts when applied on articles,*
- *soft polyvinyl chloride (PVC) profiles whether by themselves or coextruded with hard PVC,*
- *fabrics coated with PVC containing DBT compounds as stabilisers when intended for outdoor applications,*
- *outdoor rainwater pipes, gutters and fittings, as well as covering material for roofing and façades,*

(d) By way of derogation, points (a) and (b) shall not apply to materials and articles regulated under Regulation (EC) No 1935/2004.

6. Dioctyltin (DOT) compound:

(a) Dioctyltin (DOT) compounds shall not be used after 1 January 2012 in the following articles for supply to, or use by, the general public, where the concentration in the article, or part thereof, is greater than the equivalent of 0,1 % by weight of tin:

- *textile articles intended to come into contact with the skin,*
- *gloves,*
- *footwear or part of footwear intended to come into contact with the skin,*
- *wall and floor coverings,*
- *childcare articles,*
- *female hygiene products,*
- *nappies,*
- *two-component room temperature vulcanisation moulding kits (RTV-2 moulding kits).*

(b) Articles not complying with point (a) shall not be placed on the market after 1 January 2012, except for articles that were already in use in the Community before that date.'

Discharges from industrial installations

Due to the increased phasing out of the use of organic tin compounds as described in the previous paragraphs, it is likely that production of these substances will reduce or stop in the EU. Where production or formulation still takes place, discharges will be subject to regulations under Directive 2008/1/EC of the European Parliament and of the Council of 15 January 2008 concerning integrated pollution prevention and control (EC, 2008a). Emission limit values are set in permits based on best available techniques, thereby preventing and controlling pollution to water, air and land. Member States have to report discharges of organic tin compounds on a regular basis to the European Pollutant Release and Transfer Register (E-PRTR, EC, 2006, previously called EPER).

Water Framework Directive

Under Directive 2000/60/EC establishing a framework for the Community action in the field of water policy (WFD), Directive 2008/105/EC of 16 December 2008 lays down environmental quality standards (EQS) for amongst others tributyltin compounds (tributyltin-cation: CAS No 36643-28-4): for inland and other surface waters an annual average of 0.0002 µg/l and a maximum allowable concentration of 0.0015 µg/l. Tributyltin compounds and tributyltin-cation are identified as priority hazardous substances on Annex X of Directive 2000/60/EC "List of priority substances in the field of water policy" (EC, 2000 and EC, 2008b).

Directive 2008/105/EC also requires Member States to establish an inventory, including maps, if available, of emissions, discharges and losses of amongst others tributyltin compounds listed in Part A of Annex I to this Directive (the list of EQS for priority substance and certain other pollutants). The reference period for this inventory is one year between 2008 and 2010. Member States shall publish their inventories for the first time in 2015 in the updated river basin management plans. The inventories may cover discharges of organic tin compounds from installations not subject to the IPPC Directive and E-PRTR, e.g. from shipyards and docking activities.

In the EU a review process has started in 2010 for priority (hazardous) substances to be included in Annex X of the WFD and cybutryne is one of those substances. Cybutryne (CAS No 28159-98-0) is a herbal biocide used as an antifouling agent in paints for boats and vessels. Although banned in the UK, Sweden and Denmark for use on vessels less than 25m (ACP, 2000, Konstantinou *et al*, 2004), it still appears to be able to be used in other countries and on larger vessels. It is used in Irgarol ®, designed for use in manufacture of aqueous and solvent coating compositions (for outdoor use) and to inhibit or control growth of algae. Cybutryne is used in the transportation (freshwater and marine boats) and recreation (freshwater and marine boats) industries. Cybutryne is not listed under Annex I of the Pesticides Directive 91/414/EEC and so is not used as a plant protection product. Under the Biocides Directive 98/8/EC, it is not included in Annex I, but is included in Commission Decision 2010/72/EU of 8 February 2010 concerning the non-inclusion of certain substances in Annex I, IA or IB to Directive 98/8/EC regarding use in Product-type 9: Fibre, leather, rubber and polymerised materials preservatives. Its main use, under Product-type 21: antifouling products, is currently under review.

Marine Strategy Framework Directive

Under Directive 2008/56/EC establishing a framework for community action in the field of marine environmental policy Member States are currently working on the establishment by 15 July 2012 of the initial assessment of the status of their marine waters (EC, 2008c). At the same time they have to determine characteristics for good environmental status, and establish environmental targets and associated indicators in order to achieve good environmental status by 2020. One of the qualitative descriptors in Annex I of the Directive for good environmental status is "(8) Concentrations of contaminants are at levels not giving rise to pollution effects". Commission Decision 2010/477/EU lays down criteria and methodological standards on good environmental status of marine waters in the form of concentration levels and biological effect parameters (EC, 2010a). A coordinated monitoring programme should be in place by 15 July 2014, and a programme of measures needs to be developed by 2015, which should be operational by 2016.

The Directive requires Members States to cooperate and coordinate their actions for the marine strategy, and work together with third countries, in the framework of regional sea conventions, such as OSPAR for the marine region North-East Atlantic. Currently, OSPAR is working on methods for characterising GES and the setting of environmental targets and indicators. Before mid 2012, Member States also have to coordinate within OSPAR the outcome of their work on the determination of GES and targets.

6. Choice for action

Conclusions

The ban of the use of TBT as antifouling agent and biocide in the EU and the restrictions of the use of TBT in paints on ships worldwide through the IMO AFS Convention, 2001 have sufficiently regulated the most pertinent sources of marine pollution with organic tin compounds. A further reduction of releases will depend on the ratification by States of the IMO Convention representing the remaining 25% of world tonnage of maritime shipping, and of control and enforcement of the restrictions. Abatement and control measures are also in place for the main industrial discharges of organic tin compounds to the aquatic environment.

It is expected that locally, ship docks removing coatings from ship hulls containing TBT still continue to be a source of TBT pollution. Good housekeeping and abatement measures e.g. sedimentation tanks at shipyards can minimise discharges. Redistribution and re-suspension of TBT and DBT through dumping of contaminated sediments, especially from harbours, add to pollution in other areas and availability of those substances to living organisms in the marine environment. Releases of organic tin compounds from industrial processes and products also continue, but to a lesser extent. Riverine loads of TBT seem to be a very minor input to the marine environment.

Restrictions on the main remaining uses of tri-substituted organic tin compounds, DBT and DOT compounds in consumer products have now also been regulated in the EU. Restrictions came into effect in 2010 and further restrictions will take effect from 2012 and 2015. The contribution of those uses to total releases of organic tin compounds to water (inland and sea) are estimated to be fairly small but the potential impact of waste streams need continued attention. It is as yet not expected that those remaining diffuse releases may reach levels of pollution and concern comparable to that of TBT pollution.

With the ban of TBT as antifouling agent and biocide in place, there is clear movement towards the OSPAR cessation target. Whether the target will be achieved in 2020, cannot as yet be confirmed. Past uses of TBT as antifouling agent left a long-lasting legacy in the form of contaminated sediments. The further cessation of uses of tri-substituted organic tin compounds in the EC will contribute to achieving the cessation target, but uses outside the OSPAR Convention area may remain a relevant source. The effective implementation of the IMO AFS Convention and of the obligations of the Water Framework Directive and the Marine Strategy Framework Directive is necessary for moving towards the cessation target for TBT. The OSPAR Ecological Quality Objective for TBT-related imposex of gastropods will provide one of the means to monitor progress.

Based on the EU risk assessment on organic tin compounds in consumer products, measures have been adopted to support the cessation target. Restrictions will not immediately stop releases as organic tin containing products are expected to be on the market for some more time and releases from products may continue for many more years due to their long lifetime. Current restrictions of the use of di-substituted organic tin compounds in the EU do not imply a full phase-out. However, the loads of (di-substituted) organic tin compounds entering the sea due to the current uses are much smaller than the TBT loads which caused the environmental harm drawing attention to the organic tins compounds.

Summary of actions

Based on the evaluation in chapters 4 and 5 and the conclusions above, the identified actions can be summarised as follows:

Source/Issue	**Actions to be taken by OSPAR**
Shipping	1 to continue to monitor progress achieved within the IMO (AFS, 2001 Convention) and the EU (marketing and use) of the implementation of the ban on organic tin compounds (including progress on substitutes for organic tin compounds);
Shipyards	2 by 2015/2016, Contracting Parties to provide information on, if any, remaining discharges and losses of organic tin compounds from national inventories carried out under art. 5 of Directive 2008/105/EC, including information on substitutes where available;
Dredged material	3 to continue to collect information on levels of organic tin compounds in dredged material and sediment in ports/harbours on the basis of the annual reporting of wastes and other matter dumped at sea;
Other sources	4a to continue to keep a watching brief of EU legislation concerning the restrictions of the use of organic tin compounds as plant protection products, biocides and consumer products; 4b to continue to collect information on discharges of organic tin compounds from industrial installations in OSPAR and EU countries on the basis of the European Pollutant and Transfer Register;
Monitoring and assessment in the marine environment	5a Contracting Parties to continue to monitor (on a mandatory basis) organic tin compounds in sediment and biota, and on TBT-specific biological effects; 5b where available, Contracting Parties to provide additional data on TBT from the monitoring requirements under Directive 2008/105/EC; 5c Contracting Parties to consider to include alternative antifouling components in their monitoring programmes;
General	6a to inform IMO and the European Commission on progress made since the 2000 Background Document by submitting the 2011 Update to these international organisations; 6b to produce a review statement of the 2011 Background Document not later than 2016.

References

ACP, 2000. Minutes of the 278th meeting of the Advisory Committee on Pesticides (ACP) held on 7 September 2001

Buma *et al.* (2009). Buma, A.J.G., Sjollema, S.B., van de Poll, W.H., Klamer, J.C., Bakker, J.F., 2009. Impact on antifouling agent Irgarol 1051 on marine phytoplankton species. Journal Sea Research 61: pages 133-139.

Charting Progess 2 (2010). An assessment of the state of UK Seas. Prepared by the UK Marine Monitoring and Assessment Strategy (UKMMAS) community. Published by the Department for Environment, Food and Rural Areas. July 2010

Charting Progress 2 (2010a). The Clean and Safe Seas Feeder Report for Charting Progress 2, 2010. Prepared by the UK Marine Monitoring and Assessment Strategy (UKMMAS) community. Published by the Department for Environment, Food and Rural Areas. July 2010

EC (1999). Commission Directive 1999/51/EC of 26 May 1999 adapting to technical progress for the fifth time Annex I to Council Directive 76/769/EEC on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations (tin, PCP and cadmium), OJ L 142/22, 5.6.1999

EC (2000).Council Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy. OJ. L 327/1, 22.12.2000

EC (2002). Commission Directive 2002/62/EC of 9 July 2002 adapting to technical progress for the ninth time Annex I to Council Directive 76/769/EEC on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations (organostannic compounds), OJ L 183/59, 12.7.2002

EC (2002a). Commission Decision 2002/478/EC of 20 June 2002 concerning the non-inclusion of fentin acetate in Annex I to Council Directive 91/414/EEC and the withdrawal of authorisations for plant protection products containing this active substance, OJ L 164/41, 22.6.2002

EC (2002b). Commission Decision 2002/479/EC of 20 June 2002 concerning the non-inclusion of fentin hydroxide in Annex I to Council Directive 91/414/EEC and the withdrawal of authorisations for plant protection products containing this active substance, OJ L 164/43, 22.6.2002

EC (2002c). Commission Regulation (EC) No 2076/2002 of 20 November 2002 extending the time period referred to in Article 8(2) of Council Directive 91/414/EEC and concerning the non-inclusion of certain active substances in Annex I to that Directive and the withdrawal of authorisations for plant protection products containing these substances

EC (2003). Regulation (EC) No 782/2003 of the European Parliament and of the Council of 14 April 2003 on the prohibition of organic tin compounds on ships, OJ L 115/1, 9.5.2003

EC (2006). Regulation (EC) No 166/2006 of the European Parliament and the Council of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EC, OJ L 33/1, 4.2.2006

EC (2007). Commission Regulation (EC) No 1451/2007 of 4 December 2007 on the second phase of the 10-year work programme referred to in Article 16(2) of Directive 98/8/EC of the European Parliament and of the Council concerning the placing of biocidal products on the market

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 of 14 April 2003 on the prohibition of organic tin compounds on ships and amending that Regulation, OJ L 156/10, 14.6.2008

EC (2008a). Directive 2008/1/EC of the European Parliament and of the Council of 15 January 2008 concerning integrated pollution prevention and control, OJ L 24/8, 29.1.2008

EC (2008b). 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, OJ L 348/84, 24.12.2008

EC (2008c). 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), OJ L 164/19, 25.6.2008

EC (2009). Commission Decision (2009/425/EC) of 28 May 2009 amending Council Directive 76/769/EEC as regards restrictions on the marketing and use of organostannic compounds for the purpose of adapting its Annex I to technical progress. OJ L 138/11, 4.6.2009

EC (2010). Commission Regulation (EU) No 276/2010 of 31 March 2010 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 (dichloromethane, lamp oils and grill lighter fluids and organostannic compounds. OJ L 86/7, 1.4.2010

EC (2010a). Commission Decision 2010/477/EU of 1 September 2010 on criteria and methodological standards on good environmental status of marine waters. OJ L 232-14, 2.9.2010

EC (2011). Commission Directive 2011/30/EU of 7 March 2011 amending Council Directive 91/414/EEC to include fenbutatin oxide as active substance and amending Commission Decision 2008/934/EC. OJ L 61/14, 8.3.2011

Gubbins *et al*. (2010). Gubbins, M., Moore, J., Fryer, R., Davies, I. Long time series data showing recent recovery of gastropod populations from effects of tri-butyl tin at the Shetland Oil Terminal, 2010

Konstantinou, I.K., Albanis, T.A., 2004. Worldwide occurrence and effects of antifouling paint booster biocides in the aquatic environment: a review. Environment International 30, 235–248

OSPAR (2000). OSPAR Background Document on Organic Tin Compounds (update 2004; publication nr. 103/2000)

OSPAR (2005). North Sea Pilot Project on Ecological Quality Objectives Background Document on the Ecological Quality Objective on imposex in dog whelks Nucella lapillus (Publication nr. 247/2005)

OSPAR (2006). Overview assessment of the implementation of PARCOM Recommendation 87/1 on the Use of Tributyltin Compounds and PARCOM Recommendation 88/1 on Measures to Reduce Organic Tin Compounds reaching the Aquatic Environment through Docking Activities (Publication nr. 253/2006)

OSPAR (2008). Towards the cessation target. Emissions, discharges, losses of OSPAR chemicals for priority action (publication nr. 354/2008)

OSPAR (2009). Emissions of coatings and anodes by shipping in the Greater North Sea (OSPAR Region II), based on AIS-Data (publication nr. 462/2009)

OSPAR (2009a). JAMP Assessment of the environmental impact of dumping of wastes at sea (publication nr. 433/2009)

OSPAR (2009b). Status and trends of marine chemical pollution (Publication nr. 395/2009)

OSPAR (2009c). Background document for *Nucella lapillus* (Dog whelk) (Publication nr. 408/2009)

OSPAR (2009d). Handbook for the application of Ecological Quality Objectives in the North Sea. Second Edition 2009 (Publication nr. 307/2009)

OSPAR (2009e). Evaluation of the OSPAR Ecological Quality Objectives for the North Sea (publication nr. 409/2009)

OSPAR (2009f). Trends and concentrations of selected hazardous substances in sediments and biota. CEMP 2008/2009 report (publication nr. 390/2009)

OSPAR (2010). Quality Status Report 2010 (publication nr, 497/2010)

NSC 4 (1995). Progress Report. Fourth International Conference on the Protection of the North Sea. Esbjerg, Denmark. 8-9 June 1995

NSC 5 (2002). Progress Report Fifth International Conference on the Protection of the North Sea. Bergen, Norway. 20-21 March 2002

PRTR (2008 and 2010). Anti-foulants in marine coatings, merchant shipping and fisheries, June 2008 (2010 update only available in Dutch)

PRTR (2010). The Netherlands' Pollutant Release and Transfer Register PRTR: http://www.emissieregistratie.nl/ERPUBLIEK/bumper.en.aspx

RPA (2005). Risk Assessment Studies on Targeted Consumer Applications of Certain Organotin Compounds

RPA (2007). Impact Assessment of Potential Restrictions on the Marketing and Use of Certain Organotin Compounds

RWS (2010). Rijkswaterstaat, Centre for Water Management, Waste water survey at shipyards (internal note).

Thain, *et al*. (2010). Thain, J.E., Lyons, B., Gubbins, M., Stentiford, G., Leverett, D. Biological effects monitoring in the UK: results from OSPAR JAMP activities, 2010

SCHER (2006). Revised assessment of the risks to health and the environment associated with the use of the four organotin compounds TBT, DBT, DOT and TPT. EC DG Health & Consumer Protection, 30.11.2006

Walraven, N. (2006). Assessing the input of various sources (riverine, direct, discharge, atmospheric and sea shipping) of Cu, Zn, Cd, TBT and biocides to the Greater North Sea, Annex 1 of meeting document INPUT 06/4/1 (31 January – 2 February 2006)

Annex 1: Monitoring strategy for organic tin compounds

As part of the Joint Assessment and Monitoring Programme (*Reference Number 2010-3*), OSPAR adopted an Agreement on monitoring strategies for OSPAR Chemicals for Priority Chemicals (*Reference Number 2004-14, Update 2006*) to implement the following monitoring for tracking progress towards the objectives of the OSPAR North-East Atlantic Environment Strategy (*Reference Number 2010-03*) with regard to hazardous substances and in particular organic tin compounds.

The Monitoring Strategy for organic tin compounds will be updated as and when necessary, and redirected in the light of subsequent experience.

A. Explanatory Note and Supporting Considerations

Nature of the substances that are addressed

The OSPAR list of Chemicals for Priority Action includes organic tin compounds as a group with no further specification on individual substances. The OSPAR Background Document on organic tin compounds as adopted in 2000 focuses on tributyltins (TBT) and triphenyltins (TPT). At a later stage, attention has also been paid to other organic tin compounds such as mono- and dibutyltins (DBT). This monitoring strategy addresses TBT, TPT and DBT. Organic tin compounds are man-made substances; the subsequent objectives that have to be checked are the cessation target for discharges, emissions and losses and a concentration close to zero in the marine environment.

Analytical methods

Suitable methods for chemical analyses of organic tin compounds and for related biological effects are available and appropriate quality assurance is already in place within OSPAR for measurements in sediments and for measurements of biological effects:

a. JAMP Guidelines for Monitoring Contaminants in Biota and its Technical Annex 7 on organotin compounds in biota (*Reference Number: 1999-02, Update 2010*);

b. JAMP Guidelines for Monitoring Contaminants in Sediments and its Technical Annex 4 on the determination of mono-, di- and tributyltin in sediments: Analytical methods (*Reference Number: 2002-16, Updates 2009 and 2010*);

c. JAMP Guidelines for Contaminant-Specific Biological Effects and its Technical Annex 3 on TBT-specific biological effects monitoring (*Reference Number: 2008-09*);

As a consequence, there are no obstacles of an analytical nature preventing the application of a broad monitoring strategy for organic tin compounds. Ongoing technical improvements e.g. on the sensitivity of the method, will find their way to revised JAMP guidelines. Organic tin compounds analyses are expensive, costs are 250-500 Euro per analysis.

Production and use

At the moment, production and (some) use of organic tin compounds takes place in OSPAR countries and will continue for a while. Therefore, the monitoring strategy for organic compounds addresses both releases to the environment and the concentrations and effects in the marine environment.

Source monitoring

In the Background Document, various relevant sources and pathways for organic tin releases have been identified. Releases to ambient air of organic tin compounds are negligible. Releases to water concern both diffuse and point sources and land-based and sea-based sources, i.e.

a. losses due to antifouling use (and removal of antifouling) – main source in the past;

b. losses due to pesticide and biocide use;

c. losses due to use as stabiliser in plastics;

d. losses due to use as consumer products;

e. discharges at production sites.

These sources are considered in paragraphs 5-10. The major uses (as antifouling and pesticide) have been banned recently. These bans make it more complicated to collect data on use in practice, as the only correct formal information on use data is 'use is zero'.

LOSSES DUE TO USE AS ANTIFOULING – LEACHING FROM SHIPS IN FRESH AND MARINE WATERS

Since 2003, a general ban exists on the use of TBT as antifouling on all ships. This is laid down in an IMO Convention and also implemented by EU legislation; the IMO Convention is in force as from 17 September 2008; almost 50 Contracting States have ratified it, which covers 75% of the world maritime shipping fleet. Within OSPAR, implementation reporting on PARCOM Recommendations 87/1 and 88/1 has ceased in 2006. Implementation reporting resulted in some quantitative information on use and sale statistics. Use and sale statistics seems the most appropriate instrument to trace progress in reaching the cessation target for losses due to antifouling use. However, as use as antifouling is at least not allowed anymore in the EU, it is probably more realistic not to focus on collection of use/sale data (as use should be zero) but to obtain qualitative information on problems in the implementation and enforcement of the IMO Convention and the related EU legislation. For antifouling leaching in fresh water, a one-off survey of riverine input of TBT via the main rivers was intended to verify whether the ban is well implemented by every single (inland) ship, which should result in a decline in riverine TBT input into the marine area. However, due to low concentrations in river water, it has not been possible to obtain plausible results. Information on the TBT content of sediments in ports and of dredged materials dumped into the marine area is also an instrument to trace progress on the ban on sea ships.

LOSSES/DISCHARGES AT SHIPYARDS DUE TO THE REMOVAL OF ANTIFOULING SYSTEMS

Implementation reports on PARCOM recommendations 87/1 and 88/1 contain mainly qualitative descriptions on the use as antifouling and releases via shipyards. A very limited set of discharge figures concerning shipyards was received during implementation reporting (2001 and 2006).

Shipyards are not addressed in E-PRTR and the IPPC Directive and might be addressed at European level via the WFD in relation to the priority substance TBT. Formally, in 2008 all organotin antifouling has to be removed from all ships due to the IMO convention and no organotin discharges/losses should have occurred from shipyards from 2008 onwards. In practice, the presence of some ships with organic tin antifouling has continued also after 2008 due to no timely ratification of the IMO Convention by all relevant countries in the world and the consequent implementation and enforcement.

In order to assess the progress in reaching the cessation target for organic tin releases from shipyards there is a need (to continue) to collect information on organic discharges and losses via national inventories of discharges and losses under Directive 2008/105/EC. Contracting Parties are therefore invited to provide information on this basis.

LOSSES DUE TO PESTICIDE USE

Most of the pesticide use of organic tin compounds has been banned within the EU framework. Information on the use and losses to the environment of the pesticide TPT has been collected in the past within the North Sea Ministerial Conference (NSMC) framework. Due to the bans, it was already proposed in 2004 not to start within OSPAR the collection of the same information on TPT as has been done within the NSMC-framework. In order to assess the implementation of the ban and the achievement of the cessation target for the many widespread diffuse losses, it was intended to organise a one-off survey of riverine input data of TPT of main rivers. However, due to low concentrations in river water, it has not been possible to obtain plausible results.

DISCHARGES AT PRODUCTION SITES FOR ORGANIC TIN COMPOUNDS AND AT PRODUCTION SITES FOR PRODUCTS CONTAINING ORGANIC TIN COMPOUNDS

The production of organic tin compounds and (consumer) products containing organic tin compounds is covered by the IPPC Directive.

TBT and organic tin compounds are part of E-PRTR, the reporting system under the IPPC-Directive. TBT in the discharges of the production sites can be considered as a marker and representative for other organic tin compounds. OSPAR will therefore examine the E-PRTR information to assess whether the cessation target has been achieved.

RELEASES TO WATER DUE TO THE USE OF PLASTICS AND OTHER CONSUMER PRODUCTS WITH ORGANIC TIN BASED STABILISERS

This identified source has only been regulated recently. The losses to the environment seem to be minor. A further assessment of whether this source needs attention in relation to the cessation target for organic tin compounds, if monitoring seems to be necessary at a later stage, could be based on use and sales statistics or information of the presence of organic tin compounds in effluents of urban waste water treatment plants.

DISCHARGE LIMIT VALUES

There are no discharge or emission limit values for organic tin compounds in OSPAR Decisions or Recommendations, or in relevant EU legislation. Assessment of information on discharges and losses should be carried out in the light of the cessation target.

Environmental monitoring

No emissions to ambient air are expected and as a consequence atmospheric deposition of organic tin compounds is not relevant. Organic tin compounds are not part of CAMP and there is no need to change this situation.

As leaching from antifouling from sea ships are sea based diffuse sources, concentrations in the marine environment of organic tin compounds and related biological effects have been measured in the past. This should at least continue as long as there are sea ships with organic tin antifouling systems in the OSPAR Convention area or related releases from contaminated sediments and dumped dredged materials from harbours. Under the CEMP monitoring (section 3 of the monitoring strategy) of TBT in sediments, biota and of biological effects of TBT will continue. No Background/Reference Concentration (B/RC) has been determined for TBT but OSPAR Ecotoxicological Assessment Criteria (EAC) have been set for TBT in water, sediment and mussels (*Reference Number 1997-15*). Provisional assessment criteria for TBT-specific biological effects exist (*Reference Number 2004-15, Update 2008*).

Sources of organic tin compounds other than TBT are mainly land-based. For these compounds, it is considered to be not appropriate to start monitoring in the marine environment.

In accordance with section 7 on antifouling use, OSPAR will continue the reporting on organic tin loads via dredged material dumped in the marine environment within the framework of the annual OSPAR reporting on dumping of wastes or other matter.

Due to low concentrations, it has not been possible to collect information on riverine inputs in accordance with section 12 to be able to check progress on some widespread diffuse sources, where associated uses have been banned. TBT is on the list of Priority Hazardous substances of the EU Water Framework Directive (Annex X of this Directive) and an environmental quality standard has been set for TBT in Directive 2008/105/EC. As a consequence TBT has to be measured in fresh waters, transitional waters and coastal waters.

Assessment tools

There is no need to develop further assessment tools. The present EAC and the cessation target for discharges and losses are sufficient and it is not appropriate to formulate discharge and emission limit values other than the cessation target.

B. Resulting monitoring strategy

ORGANIC TIN COMPOUNDS MONITORING STRATEGY (REF. TO RELEVANT SECTIONS OF AGREEMENT 2004-14, UPDATE 2006)	
Implementation of actions and measures	Examination of progress in the implementation of regulations on marketing and use of TBT, specifically the IMO Convention and related EU legislation (section 8)
Discharges and losses to water	Examination and assessment of trends in data on discharges from production sites reported annually by Contracting Parties to E-PRTR (section 5) Collection of information on organic tin discharges and losses from shipyards, through inventories under art. 5 of Directive 2008/105/EC (section 11)
Maritime area:	
Dredged materials	Continued reporting to OSPAR of the concentrations of TBT in dredged materials disposed to the maritime area (section 7)
Concentrations in sediments or biota	Monitoring of TBT will continue under the CEMP (section 3) Where available, data should be compiled from monitoring under Directive2008/105/EC (section 11)
Concentrations in water	Where available, data should be compiled from monitoring under Directive 2008/105/EC (section 11)
Biological effects	Monitoring of the biological effects of TBT will continue under the CEMP (section 3)

Annex 2: Changes in application of coating types for antifouling systems on ship hulls (PRTR, 2008)

Application of coating types is changing constantly, driven by changes in regulations, increasing environmental consciousness among paint manufacturers and ship owners and technological innovation in coatings. An estimate of the application of the three types of coatings over time is shown in figures 1, 2 and 3.

In 1998, an estimated 70% of the coating used was TBT-based (Meijerink, 2003; DNV, 1998). According to the industry (van Hattum), at that time 85% of ships were equipped with TBT-based coating, with a slight decline in the pre-2003 period.

In the period of 1998-2003, application of TBT-based coatings was already an issue of discussion, as a result of which some shipping companies were already switching over to Cu-based coatings. Greenpeace (2000) reported that in 2000, investigation at the ports of Antwerp, Rotterdam and Hamburg revealed that of 6 major shipping companies, two were entirely TBT-free, two were partially TBT-free and two still had TBT in general use (one of these being Maersk). In spring of 2000, Maersk announced that it was switching to TBT-free coatings, and as of 2006 claimed to be entirely TBT-free (Maersk, 2006).

The worldwide ban on TBT-based coatings came into effect in 2003. Although this ban has not, as of this writing (2007), been ratified worldwide, for the paint manufacturing sector this was reason enough to proactively develop alternatives and take TBT-based coatings out of production. As a result, from 2001-2003 there was almost no further production of TBT-based antifouling coatings, and after that time existing stocks were most likely exhausted. The lifetime of TBT-based coatings is approximately 3-5 years, so full phase-out of TBT-based antifouling on ship shells can be expected by the 2008-2010 period.

Initial reports of successful trials with non-stick coatings, in particular on fast-moving ships, began appearing around 2005. At this point, so much confidence in this type of paint has been generated that high-profile ships such as the “Emma Maersk” (world's largest container ship) are using it. Another indication of the success of non-stick coatings is that the “APL Jeddah” is certified for sailing with Hempasil with a maintenance interval of 10 years. Non-stick coatings are also being given a boost by the rise in fuel costs. Although this coating is somewhat more expensive than copper-based coatings, its good antifouling properties mean savings on fuel, earning back the higher cost fairly quickly. Non-stick coatings seem to become a success story. Consequently, we assume that in 2020, 95% of all fast-moving ships and 15% of all other ships (40% of the total fleet) will be equipped with non-stick coatings.

In the fisheries sector, the switch to TBT-free paints was probably made faster. The Dutch fisheries sector signed a covenant agreeing that no TBT-based coating would be used as from 2000 and that as from 2003, no TBT-based coating would be permitted in the active top layer (O&C, 2000). However, compliance with this commitment was not monitored (Meijerink, 2003a,b), so no quantitative data on implementation are known. Consequently, Meijerink assumes a limited effect for 2001 and 2002. In view of the relatively short maintenance interval for fishing vessels and the difficulty of obtaining TBT-based paint, a sharp drop in the use of TBT on fishing vessels after 2003 is assumed.

Figure 1: Development of application of various antifouling coatings for fast-moving ships and forecast for future developments

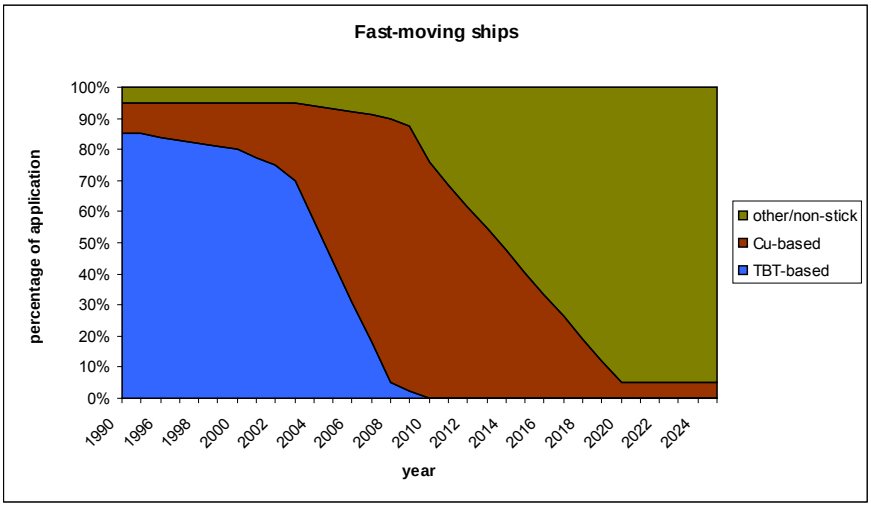


Figure 2: Development of application of various antifouling coatings for slow-moving ships and forecast for future developments

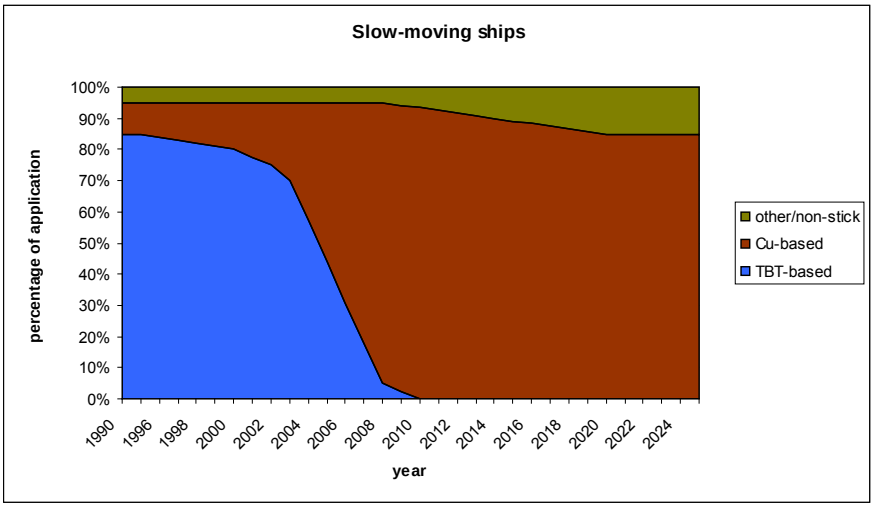
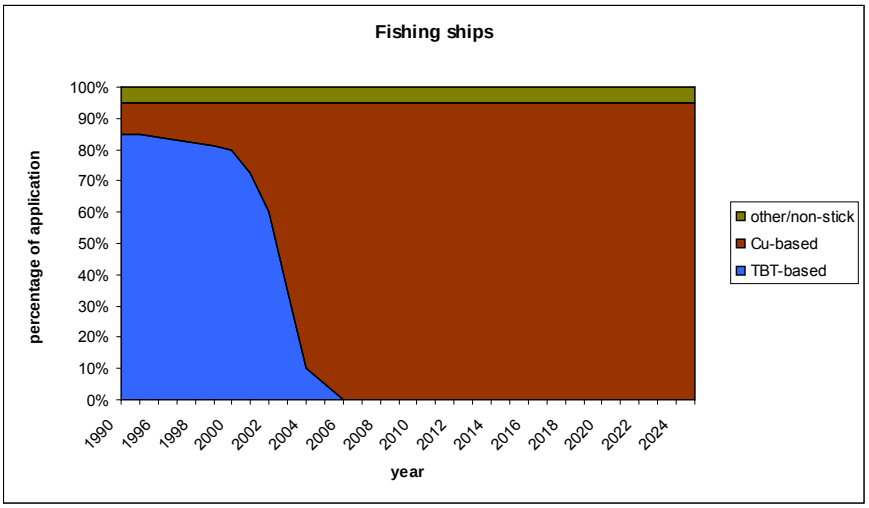


Figure 3: Development of application of various antifouling coatings for fishing vessels and forecast for future developments



New Court
48 Carey Street
London WC2A 2JQ
United Kingdom

t: +44 (0)20 7430 5200
f: +44 (0)20 7430 5225
e: secretariat@ospar.org
www.ospar.org

OSPAR's vision is of a healthy and diverse North-East Atlantic ecosystem, used sustainably

ISBN 978-1-907390-76-0
Publication Number: 535/2011