OSPAR COMMISSION

Protecting and conserving the North-East Atlantic and its resources

Background Document for Dog whelk (*Nucella lapillus*) *2018* Update

Biodiversity and Ecosystems Series

2018

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 Community 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 la Communauté européenne et l'Espagne.

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This report has been updated by the UK from a version originally prepared by the Netherlands as lead country for *Nucella lapillus.*

Photo of Dogwhelk courtesy of Matt Gubbins

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Background document for *Nucella lapillus* (Dog whelk)

Executive Summary

This background document on the Dog whelk (*Nucella lapillus)* has been developed (2009) and updated (2018) by OSPAR following the inclusion of this species on the OSPAR List of threatened and/or declining species and habitats (OSPAR other agreement 2008-6). The document provides a compilation of the reviews and assessments that have been prepared concerning this species since the agreement to include it in the OSPAR List in 2003. The original evaluation used to justify the inclusion of *Nucella lapillus* in the OSPAR List is followed by an assessment of the most recent information on its status (distribution, population, condition), evidence of recovery following the international ban on use of oragno-tin antifoulant paints on all vessels in 2008 and the remaining key threats facing the species in the OSPAR region. Section 7 considers measures that could be taken to improve the conservation status of the species, and makes recommendations for the continued monitoring of populations to ensure the status of dog whelk continue to improve in the region. This will provide a basis for a future review of the need for further measures to ensure the protection of the species. This document may be updated to reflect further developments as more evidence on the status of dog whelk population trends emerge.

Récapitulatif

Le présent document de fond sur la Pourpre petite pierre (Nucella lapillus) a été élaboré (2009) et actualisé (2018) par OSPAR à la suite de l'inclusion de cette espèce dans la liste OSPAR des espèces et habitats menacés et/ou en déclin (Accord OSPAR 2008-6). Ce document comporte une compilation des revues et des évaluations concernant cette espèce qui ont été préparées depuis qu'il a été convenu de l'inclure dans la Liste OSPAR en 2003. L'évaluation d'origine permettant de justifier l'inclusion de la Pourpre petite pierre dans la Liste OSPAR est suivie d'une évaluation des informations les plus récentes sur son statut (distribution, population, condition), sur les preuves d'un rétablissement de l'espèce suite à l'interdiction internationale de l'utilisation de peintures antisalissures à base d'organo-étain sur tous les navires en 2008 et sur les menaces clés qui subsistent. Le chapitre 7 fournit des propositions d'actions et de mesures et fait des recommandations quant à la surveillance continue des populations afin de s'assurer que l'état de la Pourpre petite pierre continue de s'améliorer dans la région. Ce document pourra être actualisé pour tenir compte de nouvelles avancées ou de nouvelles informations au fur et à mesure que des preuves nouvelles sur l'état des tendances de la population de la Pourpre petite pierre apparaissent.

1. Background information

N.lapillus is a gastropod mollusc that is found on wave exposed to sheltered rocky shores. It is widely distributed on both sides of the North Atlantic where there is suitable habitat. In the OSPAR Maritime Area, its distribution extends from Iceland in the north, to Portugal in the south and includes Irish Sea and North Sea coasts.

2. Original evaluation against the Texel-Faial selection criteria

OSPAR Regions and Dinter biogeographic zones where the species occurs

OSPAR Regions: All

Dinter Biogeographic zones: Warm-temperate pelagic waters, Lusitanean (Cold/Warm) , Lusitanean-boreal, Boreal-lusitanean, Boreal, Norwegian Coast (Skagerrak)

OSPAR Regions where the species is under threat and/or in decline

Regions specified for decline and/or threat: II, III, IV

Original evaluation against the Texel-Faial criteria for which the species was included on the OSPAR List

N.lapillus was nominated for inclusion on the OSPAR list based on the criteria for decline and sensitivity, with information also provided on threat.

Decline: *N.lapillus* populations are known to have declined in certain locations throughout their range in the OSPAR Maritime Area. They used to be very common on the coast of Belgium but disappeared during the end of the 1970s and early 1980s (Kerckhof, 1988). In the UK, local declines have been reported by Bryan *et al*., (1986) in south-west England. The decline has been linked to contamination effects of tributyltin (TBT) compounds used in antifouling paints, which cause imposex in *N.lapillus* (see section on threats). Evans *et al*., (1996) concluded, for example, that the extinction of several populations in the UK and the east coast of the North Sea were due to TBT contamination.

Sensitivity: An assessment of the sensitivity of *N.lapillus*, based on a literature review by the Marine Life Information Network for Britain & Ireland (MarLIN), lists this species as being highly sensitive to synthetic compound contamination, changes in nutrient levels, and substratum loss (Tyler-Walters, 2002). The most extensively studied sensitivity is in relation to TBT, which is known to cause an irreversible condition known as 'imposex' where females develop male characteristics. The effects can be seen at very low concentrations.

Imposex in *N.lapillus* is fully developed at ambient TBT concentrations of 1-2 ng/l and at 3 ng/l or more females are fully sterilised (Gibbs & Bryan, 1996). The percentage of females in a locality falls with increasing degree of imposex, which puts additional pressure on the population (Bryan *et a*l., 1986). Sensitivity to changes in nutrient levels have been described by Gibbs *et al*. (1999) who reported a massive kill of *N.lapillus* in Bude Bay, north Cornwall, and suggested that the mass mortalities may have been caused by eutrophication and summer algal blooms linked to a new sewage outfall in the area. *N.lapillus* has also been shown to be severely affected by toxic algal blooms. These have been reported from south-west Ireland following a bloom of *Gyrodinium aureolum* in 1979 (Cross & Southgate, 1980), a bloom of *Chrysochromulina polylepis* in the Kattegat, Skagerrak and Norwegian coast of the North Sea in 1988 (Underdal *et al*., 1989), and up to 98-99% mortality of *N.lapillus* exposed to a toxic bloom of *Chrysochromulina polylepis* in Gullmar Fjord, west Sweden in June 1988 (Robertson, 1991). Climate change and associated ocean acidification are also known to have the potential to affect a variety of marine life, including gastropod molluscs such as the dogwhelk. It is thought that changing ocean carbonate chemistry could result in impacts on the shell development in larval and juvenile gastropods (Leung et al., 2017). While this effect might be expected under future high pCO2 scenarios it has not been demonstrated specifically for this species.

Threat: Imposex in *N.lapillus*, which has been linked to exposure to TBT from antifouling paints, is one of the most widely reported threats to *N.lapillus* in the OSPAR Maritime Area. It was first recognised in *N.lapillus* by Blaber (1970) in *N.lapillus* collected from the south coast of England. Significant changes were also noted between its prevalence in the late 1960s and 1985, with the prevalence of imposex rising from 5% and less than 0.1% at two sites studied, to 67% and 48% respectively. The effects of TBT have since been observed in *N.lapillus* from the coastal areas of all countries bordering the North Sea, the Atlantic coast of Spain and Portugal, as well as in the more remote northern shores around Iceland (OSPAR 2000; Harding et al., 1999; Svavarsson and Skarphéoinsdóttir, 1995; Skarphédinsdóttir et al., 1996). It has been accepted that imposex is induced almost typically by TBT used in antifouling paints, based on results of laboratory experiments using *N.lapillus* (Bryan *et al*., 1986). It has been suggested that the high levels of imposex in *N.lapillus* around marine European shipping and fishing ports are unlikely to decline until TBT is banned on all vessels (Minchin *et al*., 1995). Even then, there is the possibility of continued contamination as TBT is persistent in sediments (Bryan & Gibbs, 1991; Hawkins *et al*., 1994).

Relevant additional considerations

Sufficiency of data: There is a considerable body of information on *N.lapillus* populations as well as changes in population numbers following the discovery of a link between TBT contamination and imposex. These studies continue, and have shown recovery of the populations in some areas as well as no improvement in other areas.

Changes in relation to natural variability: The significant decline in *N.lapillus* populations reported in the 1980s and 1990s have been linked to TBT contamination rather than the result of natural fluctuations in population numbers. A reduction in recruitment caused by a lowered reproductive capacity, therefore appears to be responsible for the decline in *N.lapillus* numbers.

Expert judgement: A link between decline in *N.lapillus* populations, imposex, and TBT has been demonstrated clearly, both in the field and in the laboratory. There have also been documented declines in populations following oil spills and toxic blooms. Consideration of the case on the basis of expert judgement has therefore not been necessary.

Changes relevant to the original evaluation against criteria (2017 update)

Decline: There is now evidence that population decline has ceased and recovery happening at a small number of locations where population studies have taken place. See below for details.

Threat: TBT has since been banned on all vessels in 2008. Inputs from sources related to compliant vessel antifouling practice have therefore ceased and recovery of populations affected by imposex could be expected.

There is also some evidence that residual levels of imposex affecting populations are related to concentrations of TBT that persist in marine sediments adjacent to shoreline populations (Gubbins et al., 2013b).

3. Current status of the species

Distribution of the feature in the OSPAR maritime area

N.lapillus is distributed from Iceland in the north, to Portugal in the south, and includes the Irish Sea and North Sea coasts (i.e. all OSPAR Regions).

Where suitable substrate is present, it can be ubiquitous. The species is wide spread on the rocky shores of Iceland, the United Kingdom, Ireland, France, and Norway. It also occurs on some sites of the north-west coast of Denmark, around the island of Helgoland (Germany) and in the south-west of the Netherlands.

N.lapillus is largely absent from Belgium, its shoreline lacking the right natural substrate, but until 1981 was present on artificial hard substrates after which it was considered absent due to local population decline caused by imposex. In 2012 dogwhelks started reappearing at multiple locations. The species was also reported to be absent in Sweden, 20 years ago, but has since recovered and is present in scattered populations mostly in the offshore parts of the Skaggerak and Northern Kattegat.

Population (current/trends/future prospects)

The size of populations is hard to assess. The distribution along the coastline may be very patchy, and juveniles and adults may hide in different places (cracks). Furthermore, individuals migrate and different age groups may be found at different tidal heights at different seasons. These factors, among others, make it very difficult to make repeatable estimations of population densities or population size. This accounts for all hard substrate species, in general. However, the presence of populations may be well noticed.

Declines of *N.lapillus* populations have been noted from the 1970s to early 2000s. The species had completely disappeared from Belgium in 1981 (Kerckhof, 1988), and well documented declines were reported for other countries (e.g. Bryan *et al.,* 1986; Gubbins et al, 2013a; Herbert, 1988).

Re-establishment of populations may be slow as a result of the reproductive cycle of *N.lapillus*. Because juveniles emerge from egg capsules laid on the shore, their dispersal capability is poor. The species lacks a planktonic larval stage that may facilitate the re-colonisation of suitable substrates where TBT levels have declined..Following bans on the use of TBT in the 1980s in several countries and subsequently on all vessels in 2008 (see Section 5), the species has re-colonised several locations, and at several other locations previously declining populations have (partially) recovered since the 1990s (e.g. Colson and Hughes, 2004; Huet *et al*., 2004; Birchenough *et al.,* 2002; Moore *et al.,* 2000; Bray and Herbert, 1998; Evans *et al.,* 1994, 1995, 1996). Notably, 30 years of monitoring populations around Sullom Voe Oil Terminal in Shetland has shown decline in distribution and abundance of *N. lapillus* populations from locations near the terminal caused by imposex, followed by decline in indicators of imposex and reappearance of populations at sites previously heavily impacted locations (Gubbins et al, 2013a). Similarly on the Southeastern coast of England at Littlehampton, over a 5 year period 2004 – 2008 a population of dogwhelks increased 20-fold and showed increased reproductive potential and changed age size structure at the same time as substantially recovering indices of imposex (Morton, 2009).

Populations have been shown to be recovering in Belgium. Since 1981, populations on hard artificial intertidal structures along the Belgian coast had been expired (assumed due to TBT induced imposex) until in 2012 a number of live animals, including egg capsules were discovered on the outer harbour wall of Zeebrugge and subsequently reproducing populations were discovered at more locations along the coastline on groynes, including at Nieuport and Koksijde. The species is now abundant on the outer harbour walls of Zeebrugge. (De Blauwe & d'Udekem d'Acoz, 2012; Fabrice, 2015).

Sweden has also recently observed reappearance of populations extirpated in the 1980's as a result of harmful algal blooms. Populations on offshore parts of the Skaggerak and Northern Kattegat have reappeared leading Sweden to designate the species "least concern" in the countries 2010 Red List and appears stable, being designated as least concern again in 2015.

See Annex 1 for details of submissions per country

Condition (current/trends/future prospects)

Little information on population quality aspects, such as age and size structure, is available. The most widely measured aspect is the level of imposex in female *N.lapillus*, which has been directly related to reproductive potential and therefore population abundance. Imposex has been observed in *N.lapillus* from the coastal areas of all countries bordering the North Sea, the Atlantic coast of Spain and Portugal, as well as in the more remote northern shores around Iceland (see Section 4). Following the bans on TBT (see Section 5) imposex levels in many locations have been declining since the 1990s (e.g. Huet *et al.,* 2004; Birchenough *et al.,* 2002; Miller *et al.,* 1999; Evans *et al.,* 1996; Harding *et al.,* 1997; Gubbins 2013a). The initially reported effects of the early bans on TBT, were inconsistent across the OSPAR region, with apparently rapid effects in the UK (perhaps related to changes in shipping traffic at the same time in case study areas) than in other countries such as France, Portugal and Spain (Ruiz *et al.,* 2005*).* In Portugal levels of imposex remained high and increasing until 2000, then startedto decrease (Santos *et al.,* 2002).

More recently, information on the impact of TBT on *N.lapillus* (imposex) has become available from the monitoring activities under the OSPAR's Coordinated Environmental Monitoring Programme (CEMP) (see OSPAR publication 2009/390). These show that recovery of imposex condition in dogwhelk populations has become more widely reported, with 74% of 157 sites across the OSPAR region showing a significant improvement in the OSPAR intermediate assessment 2017 (OSPAR 2017). Regional assessment analysis shows that the majority of regions assessed across the OSPAR area were at or below the Environmental Assessment Criteria and nine out of 10 regions showing significant declining trends (except the Iberian Sea). (Figures 1 and 2).

Contracting Parties also report similar trends in dogwhelk imposex from national monitoring programmes eg France with a reported 36 out of 46 monitoring stations showing a decline in imposex in 2012. (Toxem, 2014).

There remain however, areas frequented by large vessels and sites in the proximity of large harbours which are still 'hot spots' of TBT contamination and where impsex levels can remain above assessment criteria thresholds (e.g. Minchin *et al.,* 1996; Morgan *et al.,* 1998; Jorundsdottir *et al.,* 2005; Galante-Oliviera *et al.*, 2006; Gubbins et al, 2013a). Most of these 'hot spots' are associated with commercial ports that often require regular maintenance dredging to ensure vessels can navigate freely (Galante-Oliviera *et al.,* 2006). This can lead to the secondary impact of TBT being released from sediments during dredging and spoil-disposal operations (Santos *et al.,* 2004). Furthermore, possible TBT pollution from illegal use of stocks of TBT-containing antifouling paints or losses of TBT from dockyards, marinas and vessel maintenance activities can have an effect on imposex levels (OSPAR, 2017)

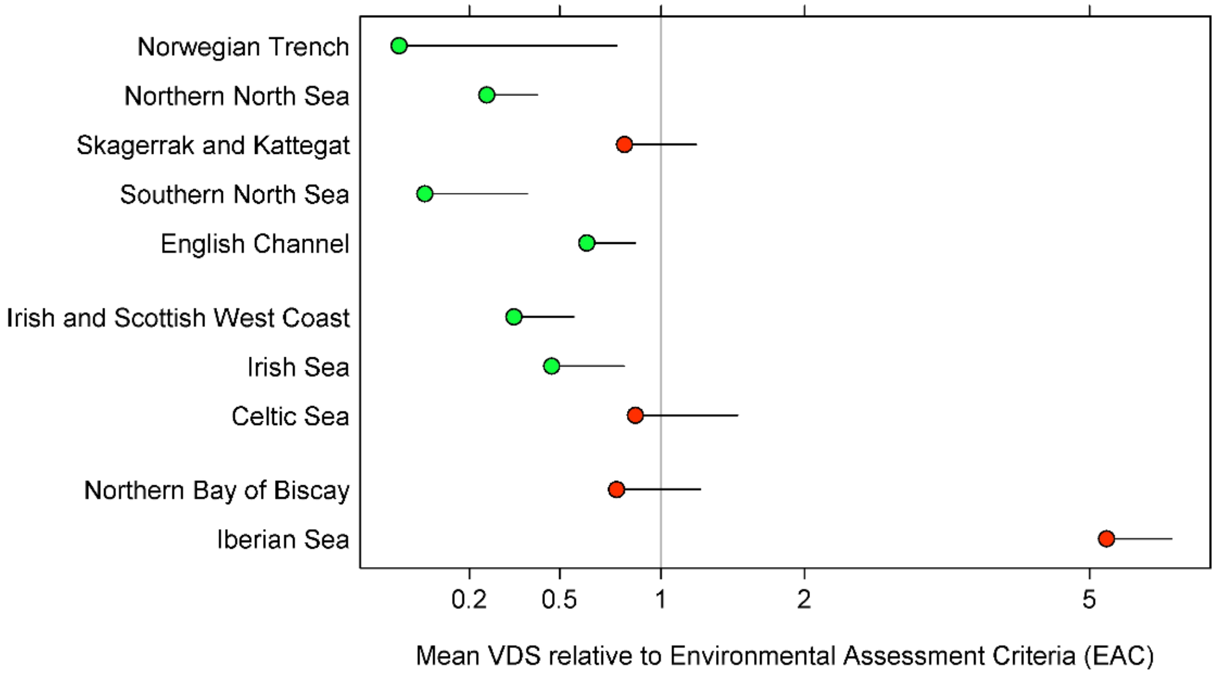


Figure 1 Mean vas deferens sequence (VDS) 2010-2015 in three species of gastropods in OSPAR assessment areas relative to the Environmental Assessment criteria (OSPAR, 2017)

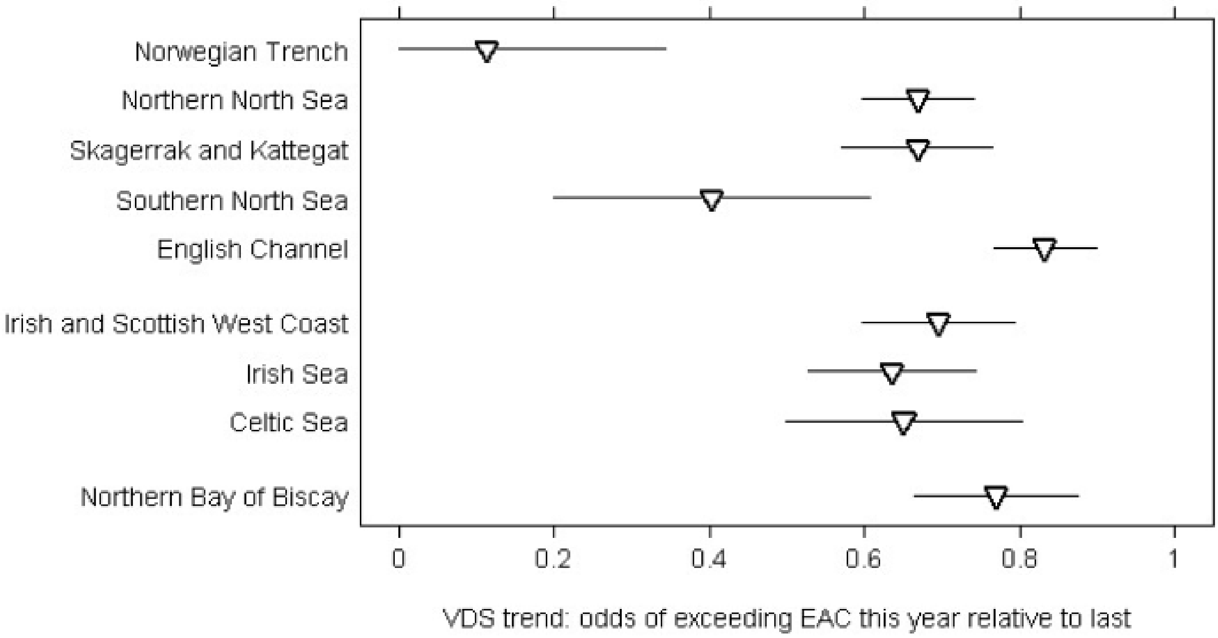


Figure 2. Temporal trends in imposex (vas deferens sequence (VDS) in gastropods (2010-2015) in each OSPAR assessment area (OSPAR, 2017)

Limitations in knowledge

Sources of information on the distribution of *N.lapillus* have been provided by most Contracting Parties in the form of publications or monitoring datasets submitted for assessment purposes. These publications provide overviews of the results of monitoring programmes or surveys for entire coastlines (national level) or regions (case studies), and may concern the distribution of the species and/or the health status as reflected by imposex (VDSI level). Since *N.lapillus* is absent or rare in some countries, some information is lacking.

In particular, data concerning the abundance and changes in distributional ranges of populations is lacking. This is because there is a strong reliance on established imposex / intersex monitoring programmes at fixed locations as a source of data. These monitoring programmes lack data collection concerning abundance and can only detect when populations in fixed locations expire or recolonize a certain area.

4. Evaluation of threats and impacts

Threat and link to human activities

Relevant human activities: Shipping and navigation; tourism and recreational activities;

Category of effect of human activity: Chemical – synthetic compound contamination.

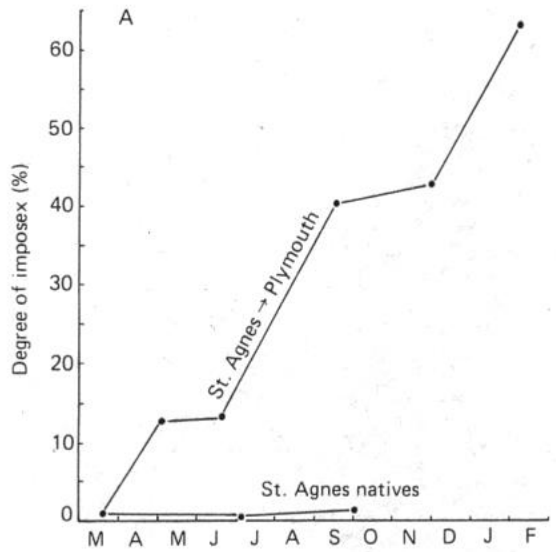
A direct link has been made between the decline in *N.lapillus* populations and the concentration of TBT in surrounding waters. There is evidence from field observations and laboratory studies that organotins originating from the TBT compounds used in antifouling paints cause imposex in *N.lapillus*, even at very low concentrations (e.g. Bryan *et al.,* 1986; Harding *et al.,* 1988; Gibbs *et al.,* 1991; Ruiz *et al.,* 1998; Santos *et al.,* 2005).

Further evidence for the relationship between imposex and TBT comes from transplantation experiments where *N.lapillus* were moved to areas where there was a high seawater concentration of tin (Smith *et al.,* 2006*;* Quintela *et al.,* 2000; Bryan *et al.,* 1986). This resulted in a gradual increase in the degree of imposex (Figure 3).

There is an increasing concern over the release of TBT from sediments through dredging or similar disturbance (Brack, 2002; Bray & Langston, 2006). Maritime ports require consistent maintenance dredging to ensure increasingly larger vessels to navigate freely. The impact of dumped dredged materials and resuspension may impact previously unaffected areas. In contrast to TBT in water, which was disappearing with a half-life of some three years after legislation, TBT in sediments is far more persistent and it is suggested that sediments may cause a problem for perhaps 20 to 30 years after a total ban (Macguire, 2000; Dowson *et al.,* 1996; Langston *et al.,* 1994). Dumping sites of dredged material containing TBT have been shown to have impact on imposex in gastropod populations (Santos *et al.,* 2004) and there is evidence of links between sediment concentrations and imposex levels of adjacent shoreline populations (Gubbins et al, 2013).

Oil pollution on rocky shores, and subsequent clean up operations are another potential threat to *N.lapillus* populations (e.g. IPIECA, 1995). Declines have been observed following contamination of rocky shore with varying times for recovery depending on factors such as the severity of the spill, type of contamination, exposure of the shore, weather conditions and status before the incident (e.g. Bryan, 1968; Baker, 1976).

FIGURE 2. Effect of transplantation on degree of imposex for *N.lapillus* moved from a relatively uncontaminated area (St. Agnes) to a contaminated area (Plymouth) (from Bryan *et al.,* 1986)



5. Existing management measures

Several measures have been taken to reduce the input of TBT into the marine environment. The use of TBT-based paints on vessels under 25 m was first banned by France in 1982 and was followed by other European countries between 1987 and 1991 with a similar ban throughout the North Sea

In 2001 the International Maritime Organisation (IMO) adopted 'The International Convention on the Control of Harmful Anti-fouling Systems on Ships' (AFS Convention) to work on a global legal instrument to ban TBT. The AFS Convention entered into force in 2008 and bans both the application and the presence on ships' hulls of TBT-based antifoulings.

In the meantime the European Union has, through Regulation (EC) No. 782/2003, banned the application of TBT-based paints on EU-flagged vessels and as of 1 January 2008 it is an offence for any ship visiting an EU port to have TBT present on its hull.

Another measure concerns the maximum concentrations of TBT for the dumping of dredged materials. According to the Overview of Contracting Parties' National Action Levels for Dredged Materials (OSPAR publication number 2004/211, updated in 2008 (publication number: 2008/363)), each country applies their own action levels concerning concentrations of TBT. OSPAR's Guidelines for the Management of Dredged Material (OSPAR agreement: 2009/4), which introduced the requirement of analyses of organic contaminants, came into force only in June 1998 (the Guidelines were revised in 2009).

IMO Convention	Effective Date	EC Regulation	Effective Date
Ships shall not apply or re-apply organotin compounds which act as biocides in anti-fouling systems	1 January 2003	Ships shall not apply or reapply Organotin compounds which act as biocides in anti-fouling systems	1 July 2003
Ships shall not bear such compounds on their hulls or external surfaces; or shall bear a coating that forms a barrier to such compounds leaching from the underlying non-compliant anti-fouling systems	1 January 2008	Ships whose anti-fouling system has been applied, changed or replaced after the relevant date shall not bear such compounds on their hulls or external surfaces; or shall bear a coating that forms a barrier to such compounds leaching from the underlying non-compliant anti-fouling systems	1 July 2003
		Ships shall not bear such compounds on their hulls or external surfaces; or shall bear a coating that forms a barrier to such compounds leaching from the underlying non-compliant anti-fouling systems	1 January 2008

6. Conclusions on overall status

Since the introduction of a ban on use of TBT on small craft and subsequent bans on the use of TBT on larger vessels, there have been widespread reports of both the recovery of imposex condition of populations from a very wide range of locations across the OSPAR region and in a smaller number of locations, recovery of populations from locations where they were either expired or at low abundance as a result of imposex. The OSPAR Intermediate Assessment 2017 clearly shows a widespread recovery in most assessment areas (except the Iberian Sea). There remain “hotspots” of concern where impsex levels are still above assessment levels and may continue to threaten populations, but there is also evidence to suggest many of these hotspot areas are now also showing declining levels of imposex.

Although data concerning populations are lacking to make a full assessment of abundance and distribution trends for the species across the region, it is clear from the evidence available that with inputs of TBT largely ceased and the key threat removed, over time populations are showing evidence of recovery. This should continue in the decade or so to come as degradation of historical burdens in marine sediments reduces available concentrations further. TBT releases from sediment may, however, influence *N.lapillus* populations close to ‘hot spots’ or dumping sites for dredged material for a much longer period.

7. What action should be taken at an OSPAR level?

Action/measures that OSPAR could take, subject to OSPAR agreement

Actions by OSPAR so far:

Monitoring of TBT–specific biological effects in *N.lapillus* and other gastropods has been a mandatory element of the CEMP since 2003 for the purpose of tracking the implementation of the International Antifouling Substances Convention and related European provisions.

Marine Protected Areas (MPAs): The following MPAs reported to the MPA database include *N.lapillus:* Sept Îles (Fr); Gullmarn fjord (Sw); Las Islas Atlánticas (Sp)

Proposed further actions/measures:

Since an international ban is already in place, and there is evidence of population recovery, further measures seem unnecessary at this time. Contracting Parties should maintain monitoring programmes to ensure the currently observed trends in recovery of dog whelk imposex condition and population abundance and distribution continue and are widespread across the region

Monitoring: OSPAR should urge Contracting Parties to maintain and improve data collection and evaluation of the CEMP monitoring programme.

Research: OSPAR should emphasise to relevant scientific funding bodies the need for further research into the release of TBT from dredged materials and the impact on *N.lapillus*. Following this research it may be necessary to adjust the national action levels for dredged materials for TBT.

Brief Summary of the proposed monitoring system

The proposed monitoring system includes both the spatial distribution and the condition of *N.lapillus*.

The proposed monitoring system builds further on the monitoring strategy described in the Joint Assessment and Monitoring Programme (JAMP) Guidelines for contaminant-specific biological effects monitoring (OSPAR agreement 2008-9). Contracting Parties where *N.lapillus* is rare or absent can instead monitor other gastropod species that are also affected by TBT. However, these species are less sensitive than *N.lapillus*.

The JAMP guideline focuses on the VDSI as the parameter to be monitored. However, at some locations *N.lapillus* may not be present at all as a result of exposure to TBT. Therefore, the presence and absence should be included.

The selection of locations is based on the following criteria:

- Populations of *N.lapillus* are currently absent, where they have been formerly present (extinction areas);
- *N.lapillus* populations are (potentially) exposed to increased concentrations of TBT.

Since the threats and decline result from TBT in antifouling, the locations to be monitored are around major marinas, shipyards, offshore installations and harbours, as is stated in the Technical Annex 3 (TBT-specific biological effect monitoring) of the JAMP Guidelines (OSPAR Ref. No: 2008-9).

Annex 3 of the JAMP Guidelines provides instructions for the selection of monitoring locations around point sources and in the surrounding areas, the measurement of temporal trends, field sampling, and the determination of imposex.

Annex 1. Overview of data and information provided by Contracting Parties

Contracting Party	Feature occurs in Contracting Party's Maritime Area	Contribution made to the assessment (e.g. data/information provided)	National reports References or weblinks
Belgium	Yes	Information on distribution	Kerckhof, F. (1988). Over het verdwijnen van de Purperslak *Nucella lapillus* (Linnaeus, 1758) langs de Belgische kust. De Strandvlo 8(2): 82-85. De Blauwe, H.; d'Udekem d'Acoz, C. (2012). Voortplantende populatie van de Purperslak (*Nucella lapillus*)in België na meer dan 30 jaar afwezigheid (Mollusca, Gastropoda, Muricidae). De Strandvlo 32(4): 127-131 Fabrice, A. (2015). Levende purperslakken *Nucella lapillus* met eikapsels gevonden te Nieuwpoort op 9 januari 2015. De Strandvlo 35(1): 27-28
Denmark	Yes	*Information on distribution and monitoring programme*	Ris, M.A. (1930). Den danske strand. Naturforhold, dyre- og planteliv ved vore ky-ster. C.A.Reitzels forlag, København, Danmark, 139pp (in Danish) Strand, J. 2003. Coupling marine monitoring and risk assessment by integrating exposure, bioaccumulation and effect studies. A case study using the contamination of organotin compounds in the Danish marine environment. PhD thesis. Roskilde University. 92 pp + papers. Available at: http://hdl.handle.net/1800/571. Strand 1998, Strand 2004, Strand unpubl. Faroe islands: Følsvik, N., E.M. Brevik, J.A. Berge & M. Dam (1998). Organotin and imposex in the Littoral Zone in the Faroe Isands, Fróðskaparrit. 46: 67-80.
European Commission			See report of the EU SCTEE with a chapter on imposex in marine snails including *N.lapillus*: Vos, JG, Dybing, E Greim, HA, Ladevoged, O, Lambré, C, Tarazona, JV, Brandt, I, Vethaak, AD (1999). CSTEE Opinion on Human and Wildlife Health Effects of Endocrine Disrupting Chemicals, with Emphasis on Wildlife and on Ecotoxicity Test Methods. Report of the Working Group on Endocrine Disrupters of the Scientific Committee on Toxicity, Ecotoxicity and the

			Environment (CSTEE) of DG XXIV, Consumers Policy and Consumer Health Protection, 96 pp. http://europe.eu.int/comm/dg24/health/sc/sct/out37_en.html
France	Yes	*Information on distribution and monitoring programme.* *Time series for Imposex.* *2012 initial assessment results for imposex, information on Dumpton syndrome confounding factor*	Huet M. & Paulet Y-M. 2006. Estimation de la pollution par le tributyletain en 2006 a l'aide de l'imposex. Réseau National d'Observation. Huet M., Y. M. Paulet & J. Clavier. 2004. Imposex in *Nucella lapillus:* a ten year survey in NW Brittany. Mar Ecol Prog Ser. Vol. 270: 153–161.
Germany	Yes	*Information on distribution*	
Iceland	Yes	*Information on distribution and monitoring programme.*	Ingolfsson, A. 1996. The distribution of intertidal macrofauna on the coasts of Iceland in relation to temperature. Sarsia 81: 29-44) Ingolfsson, A. 2006. The intertidal seashore of Iceland and its animal communities. Zoology of Iceland 1(7): 1-85. Jörundsdóttir K., Svavarsson J. & Leung K.M.Y. 2005. Imposex levels in the dogwhelk *Nucella lapillus* (L.)—continuing improvement at high latitudes. Marine Pollution Bulletin 51 (2005) 744–749,
Ireland	Yes	*Information on distribution and monitoring programme.*	
Netherlands	Yes	*Information on distribution and monitoring programme.*	Gmelig Meyling A.W., J. Willemsen & R.H. de Bruyne. 2006. Verspreiding en trend Purperslak *Nucella lapillus.* Stichting Anemoon. Available at: http://www.anemoon.org/anemoon/downloads/rapporten/PIMP_2006_10_20.pdf Gmelig Meyling A.W., Borren,H. & J.Willemsen. 2007. Purperslak *Nucella lapillus* Inventarisatie en Monitoringproject Jaarverslag 2007. Stichting Anemoon. Available at: http://www.anemoon.org/anemoon/downloads/rapporten/PIMP_2007.pdf Cor A. Schipper, Mathijs G.D. Smit, Nicholas H.B.M. Kaag, A. Dick Vethaak, (2008) , A weight-of-evidence approach to assessing the ecological impact of organotin pollution in

			Dutch marine and brackish waters; combining risk prognosis and field monitoring using common periwinkles (*Littorina littorea*), Mar. Env. Res., 66, 231–239
Norway	Yes	*Information on distribution and monitoring programme.* *Time series for Imposex.*	
Portugal	Yes		
Spain	Yes		
Sweden	Yes	Information on distribution and Red List status	Robertson, A., (1991). Effects of a toxic bloom of *Chrysochromulina polylepis*, on the Swedish west coast. J.Mar.Biol.Ass.UK, 71, 569-578. 1989-2008 Data in Swedish species gateway dataportal 2008-2012 National monitoring of vegetated bottoms in Skagerrak – Kattegatt. Data registered in national marine monitoring database Shark. 2013-2014 Odd recordings primarily from Marine biology courses
UK	Yes	*Information on distribution and monitoring programme.* *Time series for Imposex and populations*	Gubbins et al, 2013a; Gubbins et al, 2013b, Morton, 2009

Nucella Lapillus was nominated for inclusion in the OSPAR List by Belgium and WWF in 2001. (Contact Persons: Belgium: Jan Haelters & Francis Kerckhof, Management Unit of the North Sea Mathematical Models, 3e en 23e Linieregimentsplein, 8400 Oostende, Belgium. WWF: Sabine Christiansen, International WWF Centre for Marine Conservation, Hongkongstr.7., D-20457 Hamburg, Germany

Summaries of country-specific information provided

Belgium:

In Belgium *N.lapillus* had disappeared since 1981. Belgium expected that the species may re-colonise in the future from France on breakwaters along the coastline. In 2012 a number of live animals, including egg capsules were discovered on the outer harbour wall of Zeebrugge and subsequently reproducing populations were discovered at more locations along the coastline on groynes, including at Nieuport and Koksijde. The species is now abundant on the outer harbour walls of Zeebrugge. *N.lapillus* is not included in a monitoring programme, information is received from volunteers.

Denmark:

Conservation of *N.lapillus* is not a national objective. *N.lapillus* only occurs on the west coast of Denmark from Hvide Sande to Skagen, i.e. the coastlines of the North Sea and the Skagerrak. Before 1930 *N.lapillus* was also found in the Kattegat. *N.lapillus* are found only on artificial rocks, i.e. harbour piers and breakwaters for protection of the coast.

N.lapillus is a widespread species in the tidal zone at the Faroe Islands. The species is very uncommon in Greenland.

Nucella is included in the Danish monitoring programme, but only as an imposex indicator. In 1991, 1998/1999, 2004 and 2007 imposex in *N.lapillus* was assessed at 2-6 stations, both sites close to harbours and sites regarded as reference sites. Since 2013 only one station at Skagen with N.lapillus has been studied for imposex every second year. Data from an older survey from 1991 where UK researchers visited some of the Danish stations together with other North Sea stations also exists.

<u>France:</u>

Conservation of *N.lapillus* is not a national objective. In France *N.lapillus* is widely distributed along the Atlantic coast. Recent trends show a decline in imposex and recolonisation of harbours all over France. *N.lapillus* is included in the French monitoring programme only as an imposex indicator. 2012 initial assessment for MSFD suggests that while not at Good Environemntal Status, imposex indicators have declined at 36 out of 46 monitored stations, suggesting widespread recovery from the condition.

<u>Germany:</u>

Comprehensve data on the occurrence and abundance of *N.lapillus* in the German North Sea are limited. Rocky shores as suitable habitat for this species can only be found around the Island of Helgoland where *N.lapillus* is known to exist in small numbers. Hence, in Germany the species is included in the “Red List of Threatened Species” and categorized as “very rare”; with no signs of short-term positive changes in its abundance. *N.lapillus* is considered to be “highly threatened” (Category 2).

<u>Iceland:</u>

Conservation of *N.lapillus* is not a national objective. *N.lapillus* is common on the west coast of Iceland. The species had previously disappeared from one site, but has recently reappeared. There is a substantial recovery of the species near small harbours, recovery is slower but still continuing near larger harbours.

N.lapillus is included in the monitoring programme. Presence, length, distribution and imposex are monitored.

<u>Ireland:</u>

Conservation of *N.lapillus* is not a national objective. *N.lapillus* occurs everywhere along the coast on rocky substrates. *N.lapillus* is not yet included in the Irish monitoring programme, but imposex monitoring is under development for the Water Framework Directive.

<u>Netherlands:</u>

Conservation of *N.lapillus* is not a national objective. *N.lapillus* in the Netherlands only occurs on artificial substrates such as dykes and breakwaters. Its current distribution is limited to the south-west.

N.lapillus does not occur in the Wadden Sea region. In the North Sea coastal area, the number of localities with populations of *N.lapillus* has decreased between 1960 and 1997. At some of these localities, the habitat was drastically changed by silting up and the covering of basalt with asphalt/tar. In the Eastern Scheldt region, a marked decline in numbers occurred between 1970 and 1997. Numbers have recovered from 1998 onward. The populations once occurring in the mouth of the Western Scheldt have disappeared. This decline seems to have started in the 1960s.

N.lapillus is only monitored by volunteers. Time series data since the 1970s have been compiled. *Littorina littorea* is used as an imposex indicator because of its wider distribution.

Norway:

Conservation of *N.lapillus* is not a national objective. Distribution of the species has only been, semi-qualitatively assessed, along the southern coast.

Imposex in *N.lapillus* and TBT concentrations are included in the Annual Norwegian Coastal Monitoring Programme (NMCP)

Portugal:

No information

Spain:

No information

Sweden:

Sweden reports that *N.lapillus* used to be absent along the Swedish coast following extirpation of populations in the 1980s as a result of harmful algal blooms, but has recently observed reappearance of populations on offshore parts of the Skaggerak and Northern Kattegat leading Sweden to designate the species “least concern” in the countries 2010 Red List and appears stable, being designated as least concern again in 2015.

For imposex monitoring *Nassarius reticulatus* is used instead.

UK:

Conservation of *N.lapillus* is not a national objective. *N.lapillus* occurs everywhere along the coast on rocky substrates. The condition of the population continues to improve. Re-colonisation of locations is low and depends on the distribution of existing populations.

Imposex has been monitored in the National Marine Monitoring Programme and subsequently Cleand and Safe Seas Environmental Monitoring Programme of UKMMAS in 1991-2015. In the Shetlands, imposex has been monitored every 2-3 years for the past 30 years. The UK does not assess densities in all areas since it is very difficult to get repeatable estimations of hard substrate organisms for several reasons (patchy distribution, hide in cracks, accumulations of breeding and non-breeding individuals, juveniles hide in different places, seasonal differences) but has observed populations in Sullom Voe, Shetland and other case study areas, showing recovery of popualtions and increasing distributional range compared to before the TBT ban.

Annex 2. Description of the recommended monitoring and assessment strategy

Rationale

The species is recovering after a strong decline in the 1970s. However, areas frequented by large vessels and sites in the proximity of large harbours are still 'hot spots' of TBT contamination and recovery here is very slow or absent. Most of these 'hot spots' are associated with commercial ports that require consistent maintenance dredging to ensure vessels can navigate freely. This can lead to the secondary impact of TBT being released from sediments during dredging and spoil-disposal operations.

Following the worldwide ban on TBT-containing paints on all ships, levels of TBT are expected to fall further and an improvement in the condition of populations of *N.lapillus* is expected during the next 10 years. Good monitoring programmes are already in place in most contracting parties under the CEMP. It is recommended to continue monitoring to follow the effects of the world-wide ban on TBT.

Use of existing monitoring programmes

The OSPAR Coordinated Environmental Monitoring Programme (CEMP) currently covers monitoring and assessment criteria of the EcoQO on imposex in *N.lapillus* and other selected gastropods.

Guidelines for the TBT-specific biological effects monitoring are described in the Technical Annex 3 of the JAMP Guidelines for Contaminant-specific Biological Effects Monitoring. (OSPAR Reference number 2008-9).

Synergies with monitoring of other species or habitats

N.lapillus is found on wave exposed to sheltered rocky shores. Its distribution is not shared by other intertidal rocky shore organisms or habitats on the OSPAR list of threatened and declining species and habitats.

The monitoring of the status of the population of *N.lapillus* may coincide with the monitoring of the EcoQO imposex in *N.lapillus*.

For the TBT-specific biological effect monitoring, alternative gastropod species may be used where *N.lapillus* does not occur. For rocky shores these species are *Nassarius reticulatus* and *Littorina littorea*, and for offshore areas *Buccinum undatum* and *Neptunea antiqua*.

Assessment criteria

The only agreed conservation objective concerns the level of imposex in gastropods (VDSI<2). *N.lapillus* is the preferred species for the monitoring of imposex since it is most sensitive. However, if the species is rare or absent other species may be used.

The following criteria for imposex / intersex related to the Environmental Assessment Criteria and effects on reproductive capacity for gastropod species have been established (OSPAR Reference Number 2004-15):

The Ecological Quality Objective relates to a VDSI for *N.lapillus* <2.

No conservation objectives on the distribution of populations have been established.

Assessment class	***Nucella***	***Nassarius***	***Buccinum~***	***Neptunea#***	***Littorina***
	VDSI	VDSI	PCI	VDSI	ISI
A	< 0.3	< 0.3[1]	< 0.3[1]	< 0.3	< 0.3[2]
B	0.3 - <2.0			0.3 - <2.0	
C	2.0 < 4.0	0.3 < 2.0	0.3 < 2.0	2.0 < 4.0[3]	
D	4.0 - 5.0	2.0 - 3.5	2.0 - 3.5	4.0[3]	0.3 - < 0.5
E	>5.0	> 3.5[4]	> 3.5[4]		0.5 - 1.2
F	-				> 1.2
		Stroben *et al.*, 1995	Stroben *et al.*, 1995, and field evidence that *Buccinum* has similar sensitivity as *Nassarius*, ~ No correlation established	# field evidence that *Neptunea* has similar sensitivity as *Nucella*, ^ highest value possible ~ No correlation established	Oehlmann, 2002 ASMO 02/4/8

[1] This species cannot be used to distinguish between class A and class B. The assessment class is therefore by definition B.

[2] This species cannot be used to distinguish between classes A, B and C. The assessment class is therefore by definition C.

[3] This species cannot be used to distinguish between class C and higher classes. If a VDSI of 4.0 is reached, additional observations are required to determine the assessment class e.g. by using another species. If a VDSI of 4.0 is observed, the assessment class is therefore by definition F.

[4] These species cannot be used to distinguish between class E and class F. Therefore, additional observations are required to determine the assessment class e.g. by using another species If the VDSI (*Nassarius*) or the PCI (*Buccinum*) is >3.5, the assessment class is therefore by definition F.

Techniques/approaches:

Baseline

Baseline requirements would include the implementation of the CEMP monitoring, i.e. TBT-specific biological effects monitoring, around point sources and regional surveys.

Enhanced

Since exposure to TBT may have lead to the complete disappearance of *N.lapillus* populations, the monitoring of the spatial presence (or absence) of *N.lapillus* will give insight in the locations that are still under threat of high TBT concentrations, or where re-colonisation has not (yet) occurred because of the absence of populations in the vicinity of these locations.

Additional requirements would be the chemical analysis of TBT in tissue of *N.lapillus*, and if desired in other environmental compartments (water, suspended matter, sediment). This may help to identify the main sources of threat.

Selection of monitoring locations

Guidance on the selection of monitoring locations is provided by the CEMP. The selection includes both impacted and unimpacted locations.

Timing and Frequency of monitoring.

Since the monitoring should be able to show improvement of the condition of *N.lapillus*, monitoring activities should be able to detect temporal changes. It is therefore recommended to sample locations for imposex at least every 2 years. It would be better to select a limited number of locations that are monitored frequently, than to select a high number of locations that can only be monitored at a low frequency (e.g. once in 5 years).

Spatial distribution (at a regional level) could be monitored less frequently, since the recolonisation rate of *N.lapillus* is rather slow.

Data collection and reporting

The OSPAR JAMP guidelines for Contaminant-specific biological effects monitoring (OSPAR agreement 2008-9) provides the following reporting requirements:

Data reporting should be in accordance with the requirements for national comments and with the latest ICES reporting formats. The following data are required:

Contaminants

- TBT, DBT and MBT concentrations in tissues (mg/kg);
- TPhT, DPhT, MPhT concentrations in tissues (mg/kg) when relevant;
- wet weight or dry weight basis;

Biological effects measurements

Imposex

- proportion of females displaying imposex;
- vas deferens sequence index;
- relative penis size
- proportion of sterile females in stages 5 and 6 .

Supporting parameters

- site code;
- taxonomic identification;
- date of sample collection;
- number of individuals in sample
- presence/absence of juveniles and/or egg capsules*;*
- population size & frequency distribution, if considered useful supplementary information.

Quality assurance

International Laboratory Performance Studies of imposex (and intersex for other species than *N. lapillus*) measurements are available through QUASIMEME and provide a formal framework for external quality assurance.

Annex 3. References

OSPAR Publications:

OSPAR 2004/211. Overview of Contracting Parties' National Action Levels for Dredged Material.

OSPAR 2004-15. Provisional JAMP Assessment Criteria for TBT – Specific Biological Effects. OSPAR Commission 2004.

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OSPAR 2008-9. JAMP Guidelines for Contaminant-specific Biological Effects Monitoring. OSPAR Commission 2008.

OSPAR 2008/363. Update of the Overview of Contracting Parties' National Action Levels for Dredged Material

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