Assessment and Monitoring Series

Background document on the EcoQO on mercury and organohalogens in seabird eggs

OSPAR Commission
2007

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.

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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Contents

Executive summary

This background document reports on the development of ecological quality objectives (EcoQOs) for contaminants in seabird eggs. This work responds to the agreement at the 5th North Sea Conference that EcoQOs should be developed and applied in the framework of OSPAR for ecological quality elements on: (i) mercury concentrations in seabird eggs (ii) organochlorine concentrations in seabird eggs).

In 2005 OSPAR agreed, following advice from ICES, on the following EcoQOs for these elements:

- *Mercury concentrations in seabird eggs:* The average concentrations of mercury in the fresh mass of ten eggs from separate clutches of common tern (*Sterna hirundo*) and Eurasian oystercatcher (*Haematopus ostralegus*) breeding adjacent to the estuaries of the Rivers Elbe, Weser, Ems, Rhine/Scheldt, Thames, Humber, Tees, and Forth, should not significantly exceed concentrations in the fresh mass of ten eggs from separate clutches of the same species breeding in similar (but not industrial) habitats in south-western Norway and in the Moray Firth.
- *Organochlorine concentrations in the eggs of North Sea seabirds:* For each site, the average concentrations in fresh mass of the eggs of common tern (*Sterna hirundo*) and Eurasian oystercatcher (*Haematopus ostralegus*) should not exceed: 20 ng g^{-1} of PCBs; 10 ng g^{-1} of DDT and metabolites; and 2 ng g^{-1} of HCB and of HCH. Sampling should be of ten eggs of each species, which should be sampled from separate clutches of birds breeding adjacent to the estuaries of the Rivers Elbe, Weser, Ems, Rhine/Scheldt, Thames, Humber, Tees, and Forth, and in similar (but not industrial) habitats in south-western Norway and in the Moray Firth.

This document reviews the role of seabird eggs as bioindicators for chemicals in the environment by providing a matrix that integrates pollutant signals over time and space. A summary is given of the extent of current monitoring of chemical contamination of seabird eggs across the OSPAR area highlighting monitoring under the Trilateral Monitoring and Assessment Programme in the Wadden Sea, the Combine programme of HELCOM, and in the predatory bird programme of the UK. Synergies between EcoQOs for seabird eggs and other monitoring and assessment requirements are reviewed. Background information is also given on the selection of bird species for the EcoQO and the development of assessment criteria. Finally recommendations are given for the further development of the EcoQOs and the organisation of a pilot project in the period 2008-2009.

Récapitulatif

Le présent document de fond comporte un rapport sur le développement d'objectifs de qualité écologique (EcoQO) pour les contaminants dans les oeufs des oiseaux de mer. Ces travaux font suite à l'accord de la Cinquième conférence sur la mer du Nord, à savoir qu'il y a lieu de développer et d'appliquer des EcoQO dans le cadre d'OSPAR pour les éléments de qualité écologique sur: (i) les teneurs en mercure dans les oeufs des oiseaux de mer (ii) les teneurs en organochlorés dans les oeufs des oiseaux de mer.

En 2005, OSPAR est convenue, à la suite des conseils du CIEM, des EcoQO suivants pour ces éléments:

- *Teneurs en mercure dans les oeufs des oiseaux de mer:* Les teneurs moyennes en mercure dans la masse fraîche de dix oeufs provenant de couvées différentes de la sterne pierregarin (*Sterna hirundo*) et de l'huîtrier pie (*Haematopus ostralegus*) se reproduisant près de l'estuaire des fleuves suivants: Elbe, Weser, Ems, Rhin/Escaut, Tamise, Humber, Tees, et Forth, ne devraient pas dépasser de manière significative les teneurs dans la masse fraîche de dix œufs provenant de couvées différentes de la même espèce se reproduisant dans des habitats similaires (mais pas industriels) dans le Sud-ouest de la Norvège et dans le Moray Firth.
- *Teneurs en organochlorés dans les oeufs des oiseaux de mer de la mer du Nord:* Pour chaque site, les teneurs moyennes dans la masse fraîche d'oeufs de la sterne pierregarin (*Sterna hirundo*) et de l'huîtrier pie (*Haematopus ostralegus*) ne devraient pas dépasser: 20 ng g^{-1} de PCB; 10 ng g^{-1} de DDT et de métabolites; et 2 ng g^{-1} de HCB et de HCH. L'échantillonnage s'effectuera sur dix œufs de la même espèce, prélevés de couvées différentes d'oiseaux se reproduisant prés de l'estuaire des fleuves suivants Elbe, Weser, Ems, Rhin/Escaut, Tamise, Humber, Tees, et Forth, et dans des habitats similaires (mais pas industriels) dans le Sud-ouest de la Norvège et dans le Moray Firth.

Le présent document passe en revue le rôle des oeufs d'oiseaux de mer en tant qu'indicateurs biologiques des produits chimiques dans l'environnement. Ils représentent un compartiment qui intègre des signaux de

polluants dans le temps et dans l'espace. Il comporte un récapitulatif de la portée de la surveillance actuelle de la contamination chimique des œufs d'oiseaux de mer dans l'ensemble de la zone OSPAR. Ce récapitulatif met en évidence la surveillance dans le cadre du programme trilatéral de surveillance et d'évaluation dans la mer des Wadden, le programme combiné d'HELCOM, et dans le programme sur les oiseaux prédateurs du Royaume-Uni. Les synergies entre les EcoQO pour les oeufs des oiseaux de mer et les autres exigences de surveillance et d'évaluation sont passées en revue. On trouve également des informations contextuelles sur la sélection des espèces d'oiseaux pour l'EcoQO et le développement de critères d'évaluation. Il comporte enfin des recommandations sur le développement futur d'EcoQO et l'organisation d'un projet pilote en 2008-2009.

1. Introduction

Under the Bergen Declaration 5th North Sea Conference in 2002 agreed to implement an ecosystem approach to the management of human activities that affect the North Sea. To deliver this ecosystem approach, the Conference agreed on a set of issues and related elements for the development of ecological quality objectives. For the issue of seabirds ecological quality elements were identified on (i) mercury concentrations in seabird eggs and feathers (ii) organochlorine concentrations in seabird eggs. The Conference agreed that ecological quality objectives for these elements in should be developed an applied in the framework of OSPAR.

In 2005 following advice from ICES, OSPAR agreed that the EcoQOs for these two ecological quality elements should be as follows:

- *3.2 Mercury concentrations in seabird eggs,*
- EcoQO: The average concentrations of mercury in the fresh mass of ten eggs from separate clutches of common tern (*Sterna hirundo*) and Eurasian oystercatcher (*Haematopus ostralegus*) breeding adjacent to the estuaries of the Rivers Elbe, Weser, Ems, Rhine/Scheldt, Thames, Humber, Tees, and Forth, should not significantly exceed concentrations in the fresh mass of ten eggs from separate clutches of the same species breeding in similar (but not industrial) habitats in south-western Norway and in the Moray Firth.
- *3.3 Organochlorine concentrations in the eggs of North Sea seabird*
- EcoQO For each site, the average concentrations in fresh mass of the eggs of common tern (*Sterna hirundo*) and Eurasian oystercatcher (*Haematopus ostralegus*) should not exceed: 20 ng g^{-1} of PCBs; 10 ng g^{-1} of DDT and metabolites; and 2 ng g^{-1} of HCB and of HCH. Sampling should be of ten eggs of each species which should be sampled from separate clutches of birds breeding adjacent to the estuaries of the Rivers Elbe, Weser, Ems, Rhine/Scheldt, Thames, Humber, Tees, and Forth, and in similar (but not industrial) habitats in south-western Norway and in the Moray Firth

Following advice from ICES it was agreed not to continue work on an EcoQO on mercury in seabird feathers. OSPAR also agreed that these EcoQOs required further development in order to bring them to the stage reached by the advanced EcoQOs (OSPAR 2005). OSPAR 2006 welcomed the offer of the Common Wadden Sea Secretariat (CWSS) to prepare a background document for the EcoQOs on contaminants (mercury and organohalogens) in seabird eggs.

This report has been prepared by the Common Wadden Sea Secretariat (CWSS) in the framework of the EU Interreg IIIB project "HARBASINS (www.harbasins.org). The aim of HARBASINS is to support the integration of monitoring requirements of the various EU Directives and other relevant agreements such as OSPAR and the Trilateral Wadden Sea Cooperation for North Sea coastal areas.

2. Birds as bioindicators

Birds have often played an important role as indicators of environmental problems and attract public attention (e.g. Becker 2003). Examples are mass mortality of marine birds as a result of oil spills resulting from ship accidents, high mortality in several species together with reproductive failures caused by pesticides and destruction of habitats such as wetlands.

Birds are preferably used as bioindicators because they are conspicuous organisms and easy to observe and an object of considerable public attention, so that changes in their biology seldom go unremarked. This is also because a large number of volunteers are involved in monitoring and protections of birds. In addition, species which are at a high position in the food chain are affected by toxic and persistent compounds. Among the advantages birds have as bioindicators (see for a review Becker 2003), non-invasive techniques such as sampling of eggs or feathers qualify birds as ideal indicators of chemicals and as bio-monitors.

3. Seabird eggs as bioindicators for chemicals in the environment

Many coastal areas are important habitats for seabirds and protected as SPA or SAC under the EC Birds and Habitats Directive. On the other hand, these areas are under pressure from pollution of environmental chemicals (OSPAR 2000). This contamination affects the coastal food web and especially the species in the higher trophic level such as birds. The clearest examples for the value of birds as monitor of the environment originate from their use over the last four decades as indicator of pesticides in food webs.

The bird egg has been proven to be a favourable matrix for analysing environmental chemicals and has been used as sample unit in numerous studies and monitoring projects. The removal of eggs is less damaging than that of adults, having only a minor impact on the breeding success of the studied population. Several studies have shown seabird eggs to be good indicators of local pollutant contamination, even in migrating species like terns, since concentrations in eggs tend to reflect pollutant uptake by the female foraging close to the colony in the few days prior to egg laying. E.g. in Common Terns, during the breeding season the average foraging distance between colony and feeding site is 6.3 km (Becker et al. 1993b). During the 14 days of courtship before egg laying, females increase their mass by 30-50% (Wendeln & Becker 1996). The nutrients and contaminants ingested are deposited into the eggs which consequently reflect the contaminant load of the diet in a dose-dependent way (see chapter 3.1, Bäckström 1969, mercury and feathers: Lewis & Furness 1991).

3.1 Bioaccumulation

Birds are good indicators of those environmental chemicals which tend to biomagnify through food chains and which are accumulated in lipid-rich tissues such as organochlorines and methyl-mercury (Fig. 1 and 2) (Becker, 2003).

In particular, ability to integrate pollutant signals over time and space by bioaccumulating contaminants in tissues means that to obtain a given level of accuracy measurements, a smaller number of animal samples is required than of physical samples thus increasing the power of trend analyses (Furness et al., 1995).

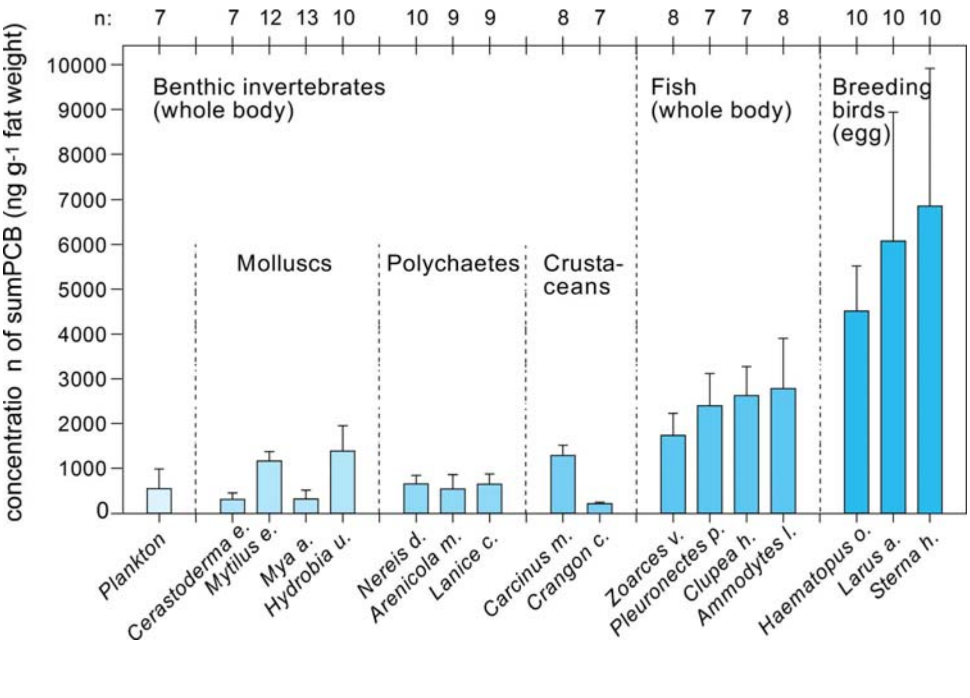


Figure 1: Bioaccumulation of PCBs in the food web of the Wadden Sea. Sum of the concentration of 8 PCB congeners (ng/g fat weight). After Mattig et al., 1996.

3.2 Temporal trends

Both, laboratory experiments and oral dosing of birds in the field with mercury and other chemicals, have shown that concentrations in tissues like liver, kidney, feathers and eggs are dose-dependent (e.g. mercury: Teijning 1967, Lewis & Furness 1991). For this reason, birds indicate the current environmental burden with a chemical, and also react relatively fast to its change (e.g. mercury can be detected in the egg within a few days after dosing; Bäckström 1969). This is clearly shown by the long-term data of Common Terns on the Elbe river (Fig. 2), and of Guillemots *Uria aalge* in the Baltic (Fig. 3, Bignert et al. 1995, 1998), as well as by small-scale spatial patterns in bird contamination.

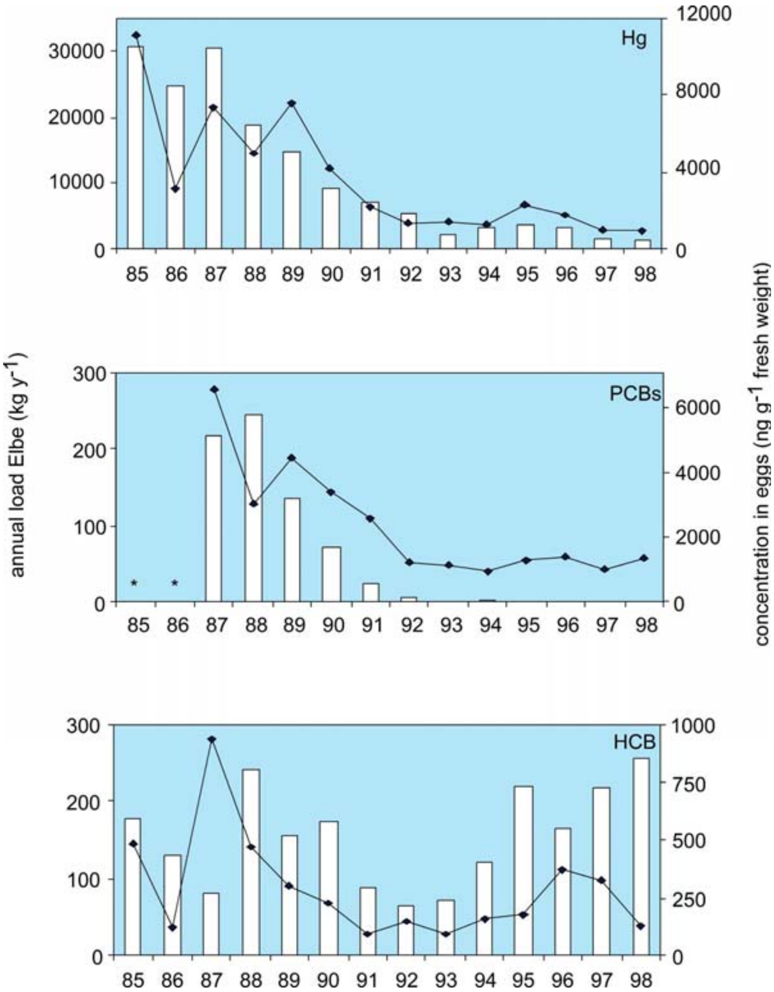


Figure 2: Concentrations of chemicals (Hg, PCBs, HCB) in Common Tern eggs (lines) reflect the annual loads of the river Elbe (columns). Data for the period 1985 – 1998, Becker et al., 2001.

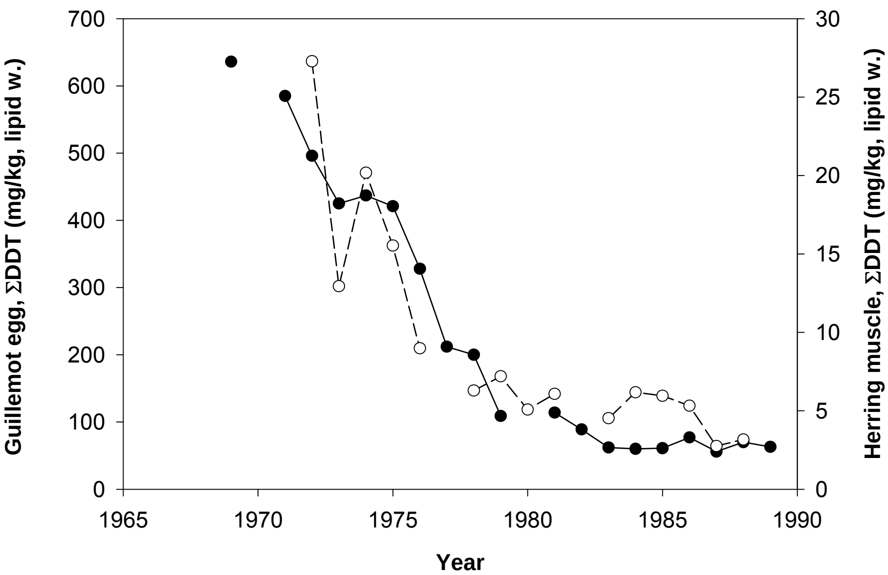


Figure 3: Baltic Guillemots'- egg levels (dots) of DDTs from 1969 - 1989 correspond to the respective levels in Herring (open circles), the main food of Guillemots. Biomagnification factor was about 20. After Bignert et al. (1995).

As part of the Predatory Bird Monitoring Scheme (PBMS), Gannet (*Morus bassanus*) eggs from two Scottish island colonies, Ailsa Craig (Atlantic coast) and Bass Rock (North Sea coast) are monitored for organochlorine insecticides, PCBs (35 congeners) and total mercury on an approximately biennial basis. On Bass Rock, total PCB and mercury concentrations have changed little between 1973 and 2006 (Figure 4).

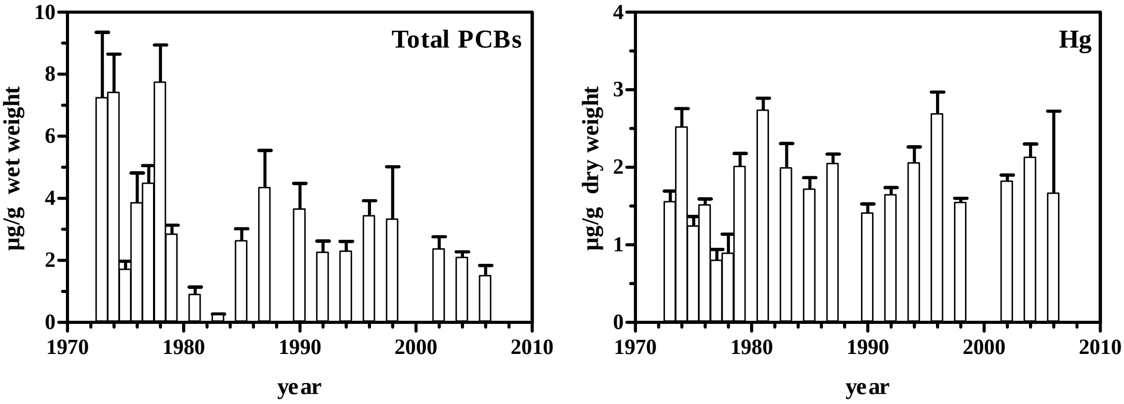
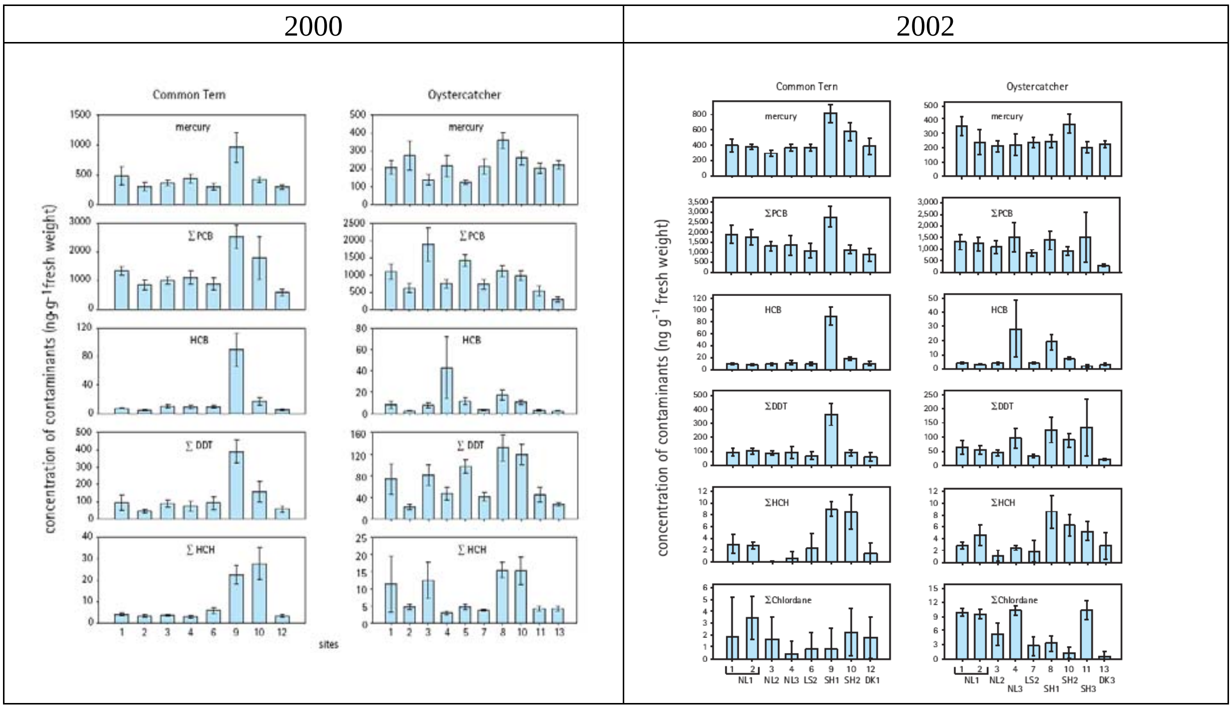


Figure 4: Geometric mean (±SEM) of total PCBs and mercury (Hg) concentrations in Northern Gannet (*Morus bassanus*) eggs collected from the Bass Rock colony (Firth of Forth, Scotland) between 1973 and 2006.

3.3 Spatial Distribution

The North Sea contamination originates mainly in three pathways: riverine inputs, atmospheric deposition, and direct discharges (e.g. Albrecht and Schmolke, 2002; Weigel, 2002). Near the coast, the most important pathways are riverine and direct inputs. Consequently, at the German Wadden Sea, the Elbe estuary and the inner German Bight still were the “hot spots” of chemical contamination (Fig. 5) Also at the western part of the Dutch Wadden Sea, effects of riverine inputs could be recognized, most probably by contaminant loads originating from the river Rhine or IJsselmeer (Jonge, 1990; Jonge and Essink, 1991; Bester and Faller, 1994)

In the Danish Wadden Sea, lowest egg residue levels were recorded. Because of the direction of North Sea currents, the pollutant loads originating from the Elbe are transported into north-eastern and northern directions (e.g. Lee, 1980). Accordingly, bird contamination decreased from the Elbe estuary to the Danish Wadden Sea, obviously in parallel with an increasing dilution of chemicals in water, sediment and food web. Yet despite the lowered inputs of chemicals into the North Sea through rivers and by atmosphere, the contamination of the seabird eggs clearly indicates distinct geographical variation even today, with the Elbe estuary still persisting to date as a hot spot.



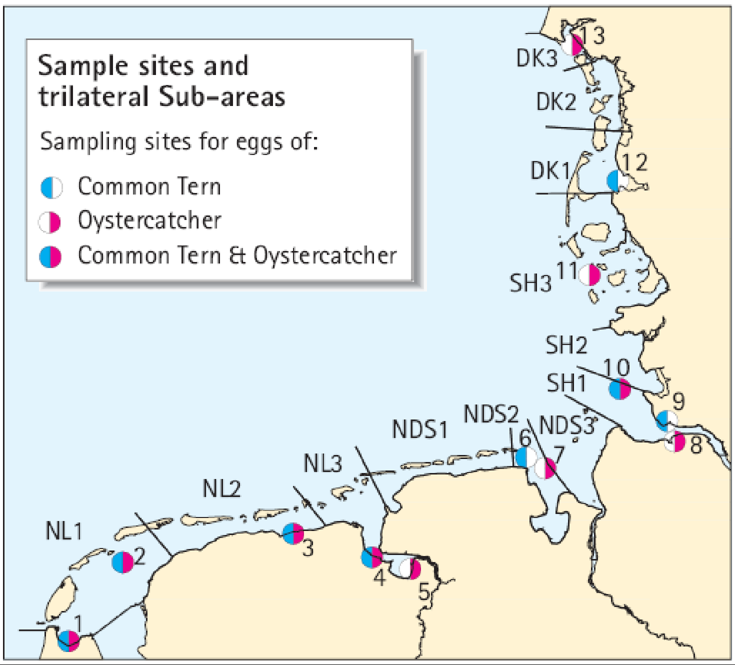


Figure 5: Geographic variation of contaminants in Common Tern and Oystercatcher eggs in the Wadden Sea in 2000 and 2002 and map with 13 sampling sites of the Trilateral Monitoring and Assessment Program (TMAP).

3.4 Combination with population parameters

Besides the value of birds as accumulative indicators of chemicals' levels, the capacity of avian top predators to act as sensitive indicators should be utilized to monitor for possible biological effects of chemicals coastal areas. This approach uses birds (i) as an early warning of new chemicals not covered by the regular monitoring program (ii) to spot dangerous interactions of chemicals, (iii) to derive critical levels for toxic chemicals. In this way in Sweden, for example, the reproductive success of White-tailed Sea Eagles (Helander et al. 1998, 2002, Olsson et al. 1998) is a parameter of the national marine monitoring program. In Canada, monitoring contamination of aquatic birds at the Great Lakes is supplemented by studies on reproductive performance, congenital anomalies, mutagenicity and on biochemical and physiological effects (Mineau et al. 1984, Ryckman et al. 1998, Grasman et al. 1998, CWS 2001) in order to receive an early warning of possible toxic effects of environmental chemicals.

This approach was also recommended (Becker 1991, 1992, Exo et al. 1996), successfully tested and adopted by the TMAP in the Wadden Sea (Thyen et al. 1998, 2000) and includes the species Common Tern and Oystercatcher, but has not yet been applied. The implementation of the parameter "breeding success" into the revised TMAP is currently being discussed (Koffijberg 2007).

Programs monitoring chemicals should be combined with studies of bird demography, in particular of possible effects on reproduction, in order to use birds acting as an early warning system. Such studies should especially cover the hot spots of environmental pollution relevant also in the future: rivers, estuaries, industrial areas, where pollution sources and environmental chemicals become concentrated, and where the first signs of negative effects on nature are apt to become manifest – such as the Elbe estuary. But sites with low pollution levels also have to be covered, in order to compare natality between sites of different degrees of contamination and to be able to derive critical levels and species' sensitivity towards chemicals.

Contaminant studies on bird eggs can easily be supplemented with studies on e.g. egg shell thickness or thickness index (Bignert et al. 1995) or weights of fledglings (Österblom et al. 2001)

For the Wadden Sea, it is proposed to establish an additional monitoring parameter "Breeding Success" as a supplement of the ongoing bird monitoring program (number and distribution of birds, contaminants in bird eggs, beached bird surveys). The parameter "Breeding Success" would be measured preferably at the hot spots of pollution and at some other logistically favorable sites, in connection with monitoring of "Contaminants in Bird Eggs" and using the same indicator species. Within a selected colony, egg contamination can be linked with reproductive success (hatching success, fledging success) on a colony-basis or even on a clutch-basis: chemical data of one sampled egg can be related to the reproductive outcome of the other eggs in the same clutch (e.g. Becker et al. 1993, Muñoz Cifuentes 2004). In this way, coastal birds may act as a real early warning system against deleterious effects of pollution on the ecosystem as well as on man using its resources.

4. Status

4.1 Monitoring

Trilateral Monitoring and Assessment Program (TMAP)

Since 1981, eggs of Common Tern and Oystercatcher have been sampled at selected sites from the western to the northern Wadden Sea in the framework of several research projects. Since 1998, contaminants in bird eggs have been monitored within the framework of the Trilateral Monitoring and Assessment Program (TMAP) and as an integrate part of the joint bird monitoring in the Wadden Sea. Yearly samples are taken from bird colonies at 13 sites in the Wadden Sea (see map in Figure 4).

Monitoring is carried out in accordance with the OSPAR JAMP monitoring guidelines (OSPAR, 1997). Sampling and analysis are carried out in accordance with SOPs. Concentrations of these chemicals have been determined: Mercury (Hg), PCBs (including 62 polychlorinated biphenyl congeners), hexachlorobenzene (HCB), DDTs (including p,p'-DDT, o,p'-DDD, p,p'-DDD, o,p'-DDE, and p,p'-DDE), HCHs (α-, β-, γ-HCH), and, since 1998, Chlordanes (cis- and trans-chlordane, and cis- and trans-nonachlor).

A first trilateral report was published in 2001 (Becker et al. 2001). In a second report, results from a six-year period (1998 – 2003) were analyzed with statistical tools for the entire Wadden Sea in order to assess spatial and temporal variability of contaminants in bird eggs (Becker & Munoz-Cifuentes 2004, Becker & Munoz Cifuentes, 2005).

COMBINE Monitoring of HELCOM

The COMBINE monitoring program of HELCOM quantifies the impacts of nutrients and hazardous substances in the marine environment, also examining trends in the various compartments of the marine environment (water, biota, sediment). Guidelines have been established for monitoring of contaminants in eggs of Common Tern and Guillemot (http://www.helcom.fi/groups/monas/CombineManual/en_GB/main/).

In Sweden and Germany, sampling of bird eggs is carried out in the framework of the national Environment Specimen Banking (see section 3.3).

Environment Specimen Banking Sweden

The Swedish Environmental Specimen Bank - the ESB - is an essential part of the monitoring of contaminants in the Swedish environment and fauna. It is also of importance for studies of, for example, biological diversity (studies of DNA) and the effects of noxious substances on threatened animal species. Homogeneous and continuous series of samples from the late 1960s up to now are stored. The ESB is also a central institution for the collection, shipping, preparation and storing of samples from the whole of Sweden. The ESB is located at the Swedish Museum of Natural History (www.nrm.se) and collaborates with other national specimen banks to set and follow international standards.

Guillemot eggs are sampled annually at one station at the Swedish east coast (station M7) (Bignert et al., 1995, 2007) (Figure 6) and analyzed for Hg, Pb, Cd, Ni, Cr, Cu and Zn and organochlorines. Time series have been analyzed for PCC (Wideqvist et al. 1993), dioxins/dibenzofurans and polybrominated compounds (Sellström, 1996, Sellström et al. 2003), bis(4-chlorophenyl) sulfone, methylsulfonyl-DDE and -PCBs (Jörundsdóttir H. et al. 2006) and PFOS/PFOA (Holmström et al., 2004).

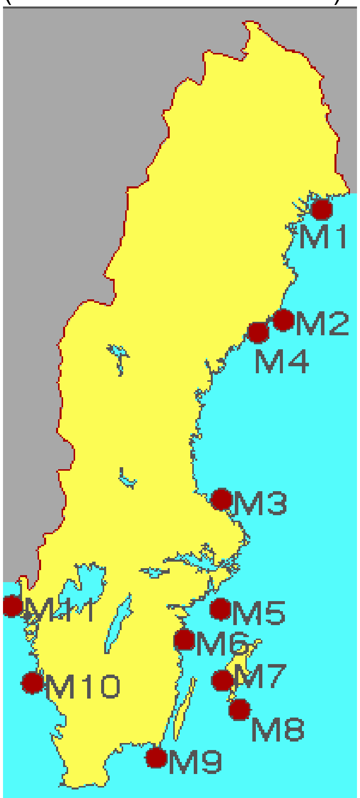


Figure 6: Sampling stations of the National Swedish Contaminant Monitoring Programme in Marine Biota. Station M7: Sampling station of Guillemot eggs.

The Predatory Bird Monitoring Scheme in the UK

The Predatory Bird Monitoring Scheme (PBMS; http://pbms.ceh.ac.uk/) is a long term, UK-wide, exposure monitoring scheme that determines the concentration of selected pesticides and pollutants in the livers and eggs of predatory birds. The PBMS routinely monitors the concentrations of contaminants in a range of terrestrial and marine predatory birds and, in addition, maintains an archive (-20ºC) of tissues and egg samples that date from the early 1970s.

The contribution that the PBMS currently makes to North Sea monitoring is the measurement of contaminants in gannet eggs Bass Rock, in the Firth of Forth, Scotland. Homogenised egg contents are analysed for mercury (Hg), hexachlorobenzene (HCB), DDT, DDE, TDE, α-HCH, γ-HCH, HEOD and PCBs (including 35 congeners).

Environment Specimen Banking Germany

The German Environment Specimen Bank (Umweltprobenbank, UPB) was established in 1985 under the general responsibility of the Federal Ministry of Environment Nature Conservation and Nuclear Safety and the administrative coordination of the Federal Environmental Agency.

For the German ESB, ecologically representative environmental and human specimens are collected, analyzed for environmentally relevant substances, and stored. Long-term storage is performed under conditions minimizing any change in composition or chemical properties over a period of several decades. This archive retains specimens for retrospective analytical characterization concerning unpredictable questions which may arise in future (www.umweltprobenbank.de).

Herring Gull eggs are sampled annually (April/May) at two stations in the Wadden Sea (Trischen, Jade Bay) and at one station in the Baltic Sea (Bodden National Park). All material is pooled, milled, fractionated (~10g) and stored above liquid nitrogen. Continuously analyzed parameters are Hg, As, Se, Tl, Cu, Pb, 7 PCBs, DDTs, HCHs, HCB, OCS, Dieldrin, PeCBZ.

Other monitoring programs

Other examples of chemical monitoring with seabirds are from the high Arctic (e.g. Braune 2007, Braune et al. 2007, Ólafsdóttir et al. 2005).

Summary Monitoring

Table 1 gives on overview of the monitoring of seabird eggs which Contracting Parties have already in place. The monitoring of Common Tern and Oystercatcher eggs in the Wadden Sea is the most comprehensive program, covering 13 stations and a broad range of parameters analyzed regularly (Figure 7).

Other comprehensive programs are the Environment Specimen Banking in Sweden and Germany both sampling different bird species (Guillemot and Herring Gull) covering the inner Germany Bight and the Baltic Sea and the UK Predatory Bird Monitoring Scheme.

Table 1 Overview of the monitoring of seabird eggs Contracting Parties already have in place (see map in Figure 7).

Country/ area	Program type	No. of stations	Frequency	Since (year)	Species	Analysed Parameters*
	Monitoring					
DK	Monitoring TMAP	2	annual	1998	Common Tern, Oystercatcher	Hg, 62 PCB, HCB, DDTs , HCHs, Chlordanes
DE	Monitoring TMAP	7	annual	1981/86	Common Tern, Oystercatcher	Hg, 62 PCB, HCB, DDTs , HCHs, Chlordanes
DE	Specimen Banking	3	annual	1988	Herring Gull	Hg, As, Se, Tl, Cu, Pb, 7 PCBs, DDTs, HCHs, HCB, OCS, Dieldrin, PeCBZ
NL	Monitoring TMAP	4	annual	1993/97	Common Tern, Oystercatcher	Hg, 62 PCB, HCB, DDTs , HCHs, Chlordanes
SE	Specimen Banking	1	annual	1969	Guillemot	Hg, Pb, Cd, Ni, Cr, Cu and Zn; 7 PCBs, HCB, HCHs, DDTs,
UK	Predatory Bird Monitoring Scheme	1	biennial	1973	Gannet	Hg, 35 PCBs, HEOD, DDTs, HCHs, HCB
	Research					
NL	Research project RIKZ	1	-		Common Tern	PCBs, PBDEs, HBCD, PFOS dioxins, furans, PAHs, PFOA, others

*In case of specimen banking, only parameters are listed which are analysed continuously (see text).

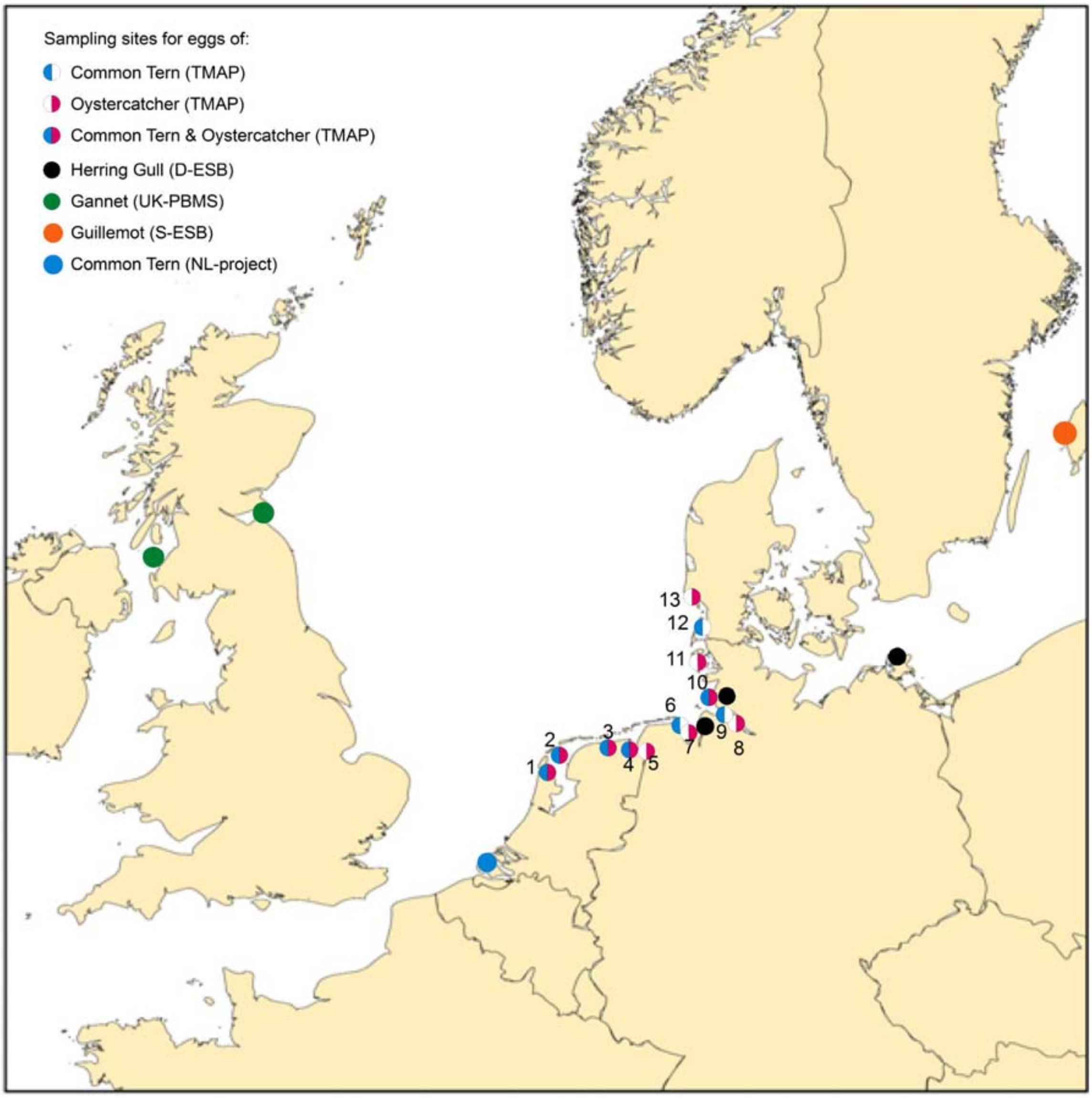


Figure 7: Map with stations of monitoring of seabird eggs Contracting Parties already have in place (see Table 3)

4.2. Status assessment criteria

Assessment criteria have been developed by OSPAR in OSPAR Agreement 2005/06 for background concentrations (BCs) and background assessment concentrations (BACs). [BCs and BACs have not yet been established for metals in biota, so that the Background Reference Concentrations (BRCs) from OSPAR Agreement 1997/14 are used]. Values for Environmental Assessment Criteria (EACs) have also been developed by OSPAR. So far, no assessment criteria have been developed for substances in bird eggs.

No EcoQOs for mercury and organochlorines in seabird eggs have been agreed. ICES (2003) suggested practical EcoQOs for Common Tern and Oystercatcher: 20 ng g^{-1} of PCBs; 10 ng g^{-1} of DDT and metabolites; and 2 ng g^{-1} of HCB and of HCH. For mercury, concentration from less polluted non-industrial sites such as south-west Norway and Moray Firth were recommended as EcoQO (BDC 06/2/6).

4.3 Research projects

The EU Project MODELKEY (Models for assessing and forecasting the impact of key environmental pollutants on marine and freshwater ecosystems and biodiversity) is conducting s comprehensive study on the transfer of contaminants in the food chain of the Common Tern from the Western Scheldt estuary in cooperation with a Dutch baseline study on dioxins by RIKZ.

Various contaminants, including WFD priority chemicals (PAHs, PBDEs), were determined in abiotic (sediment, suspended particulate matter) and biotic compartments (benthic algae, invertebrates, fish, common tern eggs) to study the accumulation of contaminants in the marine food web, but also to provide data for effect and exposure food chain models developed in MODELKEY.

5. Synergies between EcoQOs and other monitoring and reporting requirements.

There area several requirements for monitoring of hazardous substances in various matrices of biota including seabirds eggs. There are many connections between the OSPAR EcoQO work, the relevant EU Directives (WFD, Birds and Habitats, Marine Strategy) and the Trilateral Wadden Sea Cooperation and many areas to seek harmonization and coherence. Presently, definition of specific objectives and reference values, as well as monitoring programs are under development. Therefore, there are opportunities to tune these activities across the countries in order to address both the requirements under the various EU Directives and the objectives of OSPAR and the Trilateral Wadden Sea Cooperation.

EU Water Framework Directive (WFD)

The EU Water Framework Directive (WFD) (Directive 2000/61/EC), which came into force in December 2000, establishes a new integrated framework for the protection, improvement and sustainable use of all waters, including transitional and coastal waters up to 1 nautical mile from territorial sea baselines. The key objective (Article 1) of the Directive that is most relevant to marine ecosystems is: “to prevent further deterioration and protect and enhance the status of aquatic ecosystems and associated wetlands.” A key aim (Article 4) is that Member States will be required to achieve "good surface water status" and also to prevent deterioration in the quality of waters that are already "good" by 2015.

A guidance on monitoring is currently being developed with regard to the selection of matrix (water, sediment and biota (WFD monitoring guidance for surface waters, November 2006). It underlines that analysis of sediment and biota (especially with regard to hydrophobic and lipophilic substances) is resource effective for trend monitoring. The use of sediment and biota is also advised to assess compliance wit the no deterioration objective, to assess long-term changes resulting from anthropogenic activity and to monitor the progressive reduction in the contamination of priority substances (PS) and phasing out of priority hazardous substances (PHS). For marine areas, reference is made to the OSPAR guidelines for sampling and analysis of contaminants and metals in fish, shellfish and seabird eggs (OSPAR 1997).

The EcoQOs for bird eggs can be integrated into the WFD objectives in order to define the “good status” and to monitor the “non-deterioration” target.

EU Birds and Habitats Directive

EU Habitat Directive (Directive 92/43/EEC) aims to maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of Community interest (Article 2).

The EU Birds Directive (Directive 79/409/EEC) aims at the conservation of all species of naturally occurring birds in the wild state in the European territory of the Member States. It covers the protection, management and control of these species and elaborate rules for their exploitation (Article 1).

In order to assess favorable conservation status, bird monitoring will be carried out with regard to abundance, distribution, population trend, breeding success, habitat and food requirement of birds. Monitoring of contaminants and application of EcoQOs supports this assessment in combination with other biological parameters.

European Marine Strategy

The current proposal of the European Commission for a Marine Strategy Directive (2005/0211 (COD)) aims at achieving “good environmental status” [by the year 2021 at the latest] and to ensure the continued protection and preservation of that environment and the prevention of deterioration. With regard to ecological status there is a geographical overlap with the WFD between the baseline and 1 nautical mile seawards.

The proposed EU Marine Strategy Directive (EMS) requires an analysis of main anthropogenic impacts on marine waters by the member states (Article 7). An initial assessment of the current environmental status and the environmental impact of human activities thereon has to be prepared within four years (status report).

The concept of EcoQOs can be also be integrated into the definition of “good environmental status”.

Trilateral Wadden Sea Cooperation

The objective of the trilateral management is to guarantee the natural functioning of the ecosystem through proper regulation of human activities. The best guarantee for a natural ecosystem is to achieve the full scale of habitat types which belong to a natural and dynamic Wadden Sea. Each of these habitats needs a certain quality, which can be reached by proper management of the area. This quality can be described by certain characteristic structures, the presence of certain organisms, the absence of disturbance and toxic effects and by the chemical condition of the habitat.

The trilateral policy and management regarding pollution issues is closely related to the developments in the framework of the North Sea Conferences, OSPAR, IMO and the European Union. The aim of the Trilateral Monitoring and Assessment Program (TMAP) is to provide a scientific assessment of the status of the Wadden Sea ecosystem and to assess the implementation of the Targets of the Wadden Sea Plan (Stade Declaration 1997). One of these Targets is to achieve concentrations of contaminants in the marine environment and in indicator species near background values for naturally occurring substances such as heavy metal (e.g. mercury) and close to zero for man-made synthetic substances (xenobiotic compounds) (http://www.waddensea-secretariat.org/TMAP/Monitoring.html).

The EcoQOs for seabird eggs can already be integrated into the TMAP in order to assess the implementation of the Targets of the Trilateral Wadden Sea and to decide on further management measures. The assessment will be carried out in the forthcoming Wadden Sea Quality Status Report 2009 in preparation of the Trilateral Governmental Conference in 2010.

6. Discussion

6.1 Advantage of bird eggs compared to other matrices

ICES reviewed the EcoQOs in 2003 and 2004 (ACE Report, 2003; ICES Advice 2004) following a standardized template and evaluated the EcoQOs against seven criteria (see section 5). The results of this technical evaluation are attached in **Annex 1**.

The bird egg has been proven to be a favorable matrix and has been used as sample unit in numerous studies and monitoring projects (see section 3 and 4). Advantages and disadvantages of eggs as a matrix are discussed, e.g., by Gilbertson et al. (1987), Becker (1989), Furness (1993), Walker (1994), Becker et al. (1991, 1998), and ICES (1999):

Advantages of the matrix egg:

- high lipid content and accumulation of lipophilic persistent compounds;
- consistent composition;
- originate from a defined area and year;
- reflection of the contamination of breeding females (healthy and reproductive part of the population);
- being restricted to the breeding season, reduced seasonal variability in chemicals’ levels due to limitations of the breeding period;
- ease and speed of sampling; ease of handling and storing samples;
- sensitive reaction of birds during egg development and early chick stage to toxic chemicals and relevance of egg residues to embryotoxic effects;
- feasibility of studies bearing on the relationships between contaminants, eggshell quality and hatching success.

Disadvantages:

- relevance to only a part of the population (reproductive females) and of the year (breeding season);

- variation of pollutant levels with the laying sequence;
- failure of some heavy metals to accumulate in the egg (e.g. cadmium and lead).

The advantages of the matrix egg were clearly confirmed by its use in various long-term monitoring programs in Sweden, UK and the Wadden Sea countries. In the TMAP, a high temporal and spatial resolution of bird egg monitoring and assessment provides a quick and “in time” analyses of the present bird contamination in the Wadden Sea, as well as reliable, representative and repeatable monitoring results (Becker & Munoz Cifuentes, 2005). In addition, a “one-lab-approach” was chosen in order to reduce costs and to enhance the comparability of the results obtained from sites across countries.

Furthermore, together with the biomagnification effect, the lower within-sample variance in the egg as matrix means that spatial or temporal differences in contamination are more conspicuous than in other matrices such as sediment, invertebrates and fish (Becker et al. 2001).

Due to high and stable fat content and high bioconcentration factors for many organic contaminant the random/unexplained between year variation is lower compared to other matrices. This results in superior statistical power at temporal trend analysis. If the required power is set to a fixed value, the sensitivity (lowest detectable trend) or number of years required to detect a certain trend may be estimated and used to compare various matrices (Bignert et al. 2004). Table 2 shows that for mercury, CB-153, DDE, HCB, HBCD and TCDD-equivalents, the sensitivity is much better for guillemot eggs than for e.g. herring caught in the Baltic e.g. an annual trend in mercury change of about 5.6% may be detected in 10 years with a power of 80% whereas the trend has to be around 14% in herring to be detected with the same probability. This implies also that temporal trends can be detected considerably earlier in guillemot eggs.

Table 2. Showing the lowest annual trend (%) expected to be detected with a statistical power of 80%, within a monitoring period of 10 years for guillemot and herring sampled in the Central Baltic Proper. Data extracted from Bignert et al. 2007

Contaminant	n	Guillemot eggs %	Herring muscle %
Hg (w.w.)	22	5.6	14
CB-153 (lw)	17	6.3	11
DDE (lw)	24	6.0	12
α-HCH (lw)	15	8.3	3.0
β-HCH	15	6.6	6.9
γ-HCH	15	23	3.8
HCB (lw)	16	4.1	13
HBCD (lw)	6	2.4	7.8
TCDD-eq	13	5.6	10-15

6.2 Selection of bird species for EcoQO

The proposed EcoQO has the aim to monitor the contamination of coastal birds’ eggs with mercury and ogrganochlorines around the North Sea in its spatial and temporal variability. Together with logistical reasons and sampling strategy this leads to the selection of suitable indicator species:

- They should indicate local contamination and hot spots of anthropogenic pollution of the sea,
- They should represent different levels of the marine food web,
- They should be common, not endangered, have good numbers in high densities and a wide distribution along the North Sea coasts. The coverage should offer small-scale sampling in order to indicate the hot spots of contamination, the numbers should allow monitoring over years in order to investigate temporal trends.

These preconditions are specifically met by two species, Common Tern and Oystercatcher which are in use as bioindicators in the chemical monitoring of the Wadden Sea since the mid 1980s (Becker et al. 2001, Becker & Muñoz 2004, 2005). Both species are common and widely distributed, characterized by different foraging strategies and food chains.

The Common Tern is a long-distance migratory species that arrives in the Wadden Sea in spring and forms large breeding colonies. Oystercatchers, however, are mostly resident birds in the Wadden Sea area. Both species display different habits of foraging and eat different diets: Common Terns feed mainly on fish which are taken by plunge-diving, and are considered a top-predator of the coastal food-chain, while Oystercatchers predominantly feed on macrozoobenthic organisms like mussels and worms (Smit & Wolff 1980, Cramp & Simmons 1985). Both species feed close to their nesting sites (< 10 km).

The good knowledge of the biology and ecology of these species (Becker & Ludwigs 2004, Goss-Custard 1996), their large populations and abundance, the high position they occupy within the marine food-chains, and the capacity to accumulate persistent contaminants in their eggs make them suitable as monitors of the contamination of the environment (Becker et al., 2001).

The use of other species such as Eider, Northern Gannet and Guillemot (ICES 2004) has also to be considered. The last mentioned species, however, are not useful to indicate small scale geographical variation owing to a limited number of breeding sites and large foraging range.

6.3 Assessment criteria – EcoQOs

ICES (2003, 2004) considered the proposed EcoQOs for mercury and organochlorines as consistent with the current scientific information on levels and trends of these substances. It was also recommended to enlarge the number of EcoQ elements and to include further organohalogens in the monitoring program (see Table 2). These substances have been, or are still being used as flame retardants in Europe.

Becker et al. (2004) suggested that the spectrum of chemicals studied should be adapted, and some "new" toxic substances should be assessed whether they should be included into the monitoring of bird eggs (e.g. TBT, polybrominated biphenyls, bromocyclen or musk xylol). However, because there is not enough information available whether bird eggs and which species are suitable for monitoring e.g. on bioaccumulation of these "new" substances in bird eggs.

Table 2: Proposed EcoQO for Common Tern and Oystercatcher (ICES, 2003; 2004) and additional EcoQOs for "new" organohalogens.

Substance	Proposed EcoQO (wet weight) (ICES)
Total PCB	< 20 ng/g
DDT and metabolites	< 10 ng/g
HCB	2 ng/g
HCH	2 ng/g
Mercury	0.1 mg/kg (Oystercatcher 0.2 mg/kg (Common Tern) Concentrations non-industrial sites (feathers)
BDE 47, 99, 100, 183, 209, HBCD, TBBP-A	(to be developed)
Selected PCDDs/PCDFs	(to be developed)
TBTs	(to be developed)
bromocyclen	(to be developed)
musk xylol	(to be developed)

The calculation of EcoQO can be carried out taking into consideration the food chain of the bird species. The developed background concentrations or environmental assessment criteria for, sediment, benthos (mussels) and fish can be used to calculate a specific EcoQO for the different bird species, as different levels of biomagnification occurs (see Figure 1).

Modeling of transfer of contaminants in the food chain as done for the Common Tern in the Wester Scheldt could also be used to find suitable EcoQO values for metals and organohalogenes in bird eggs.

6.4 Analysis spatial coverage

Sampling sites should be selected according to the following criteria:

- Address hot spots of anthropogenic contamination, especially the estuaries (Marine Strategy Directive, see section 5.);
- Include, however, also sites with an expected lower degree of contamination as reference sites;

- Include important Bird Areas such as the German Bight, which are in the focus of the EU Birds and Habitats Directives (see section 5.);
- Consider logistics of sampling (number of breeding pairs available for sampling per site, also in the future prospect; see above);.
- Select an appropriate number of monitoring stations along the North Sea coast to assess EcoQO on a larger scale.;

Currently, only the monitoring program in the Wadden Sea (TMAP) can provide the required information with regard to the ecological quality elements mercury and organohalogen concentrations in eggs of Common Tern and Oystercatcher. There are additional sampling sites for other bird species: in the Wadden Sea for Herring Gull and in the Baltic Sea for Herring Gull and Guillemot.

Becker & Munoz-Cifuentes (2004) suggested to establish an additional sampling site at the Rhine delta with its important industries, in order to record the impact of contaminants originating from this river and being transported to the Wadden Sea. This is also underlined by several studies carried out in the Rhine/Scheldt areas (Stronkhorst et al. 1993).

ICES (2003, 2004) suggested to define the geographical specificity of monitoring (and EcoQOs) by focusing on areas of high riverine inputs and other hot spots. The sites in Table 3 (and Figure 8) were proposed to be selected in order to

- to obtain a North Sea wide overview of the spatial distribution of selected contaminants,
- to assess temporal changes in concentration of contaminants in different parts of the North Sea,
- to assess the status in implementation of the EcoQos by using a consistent and comparable approach.

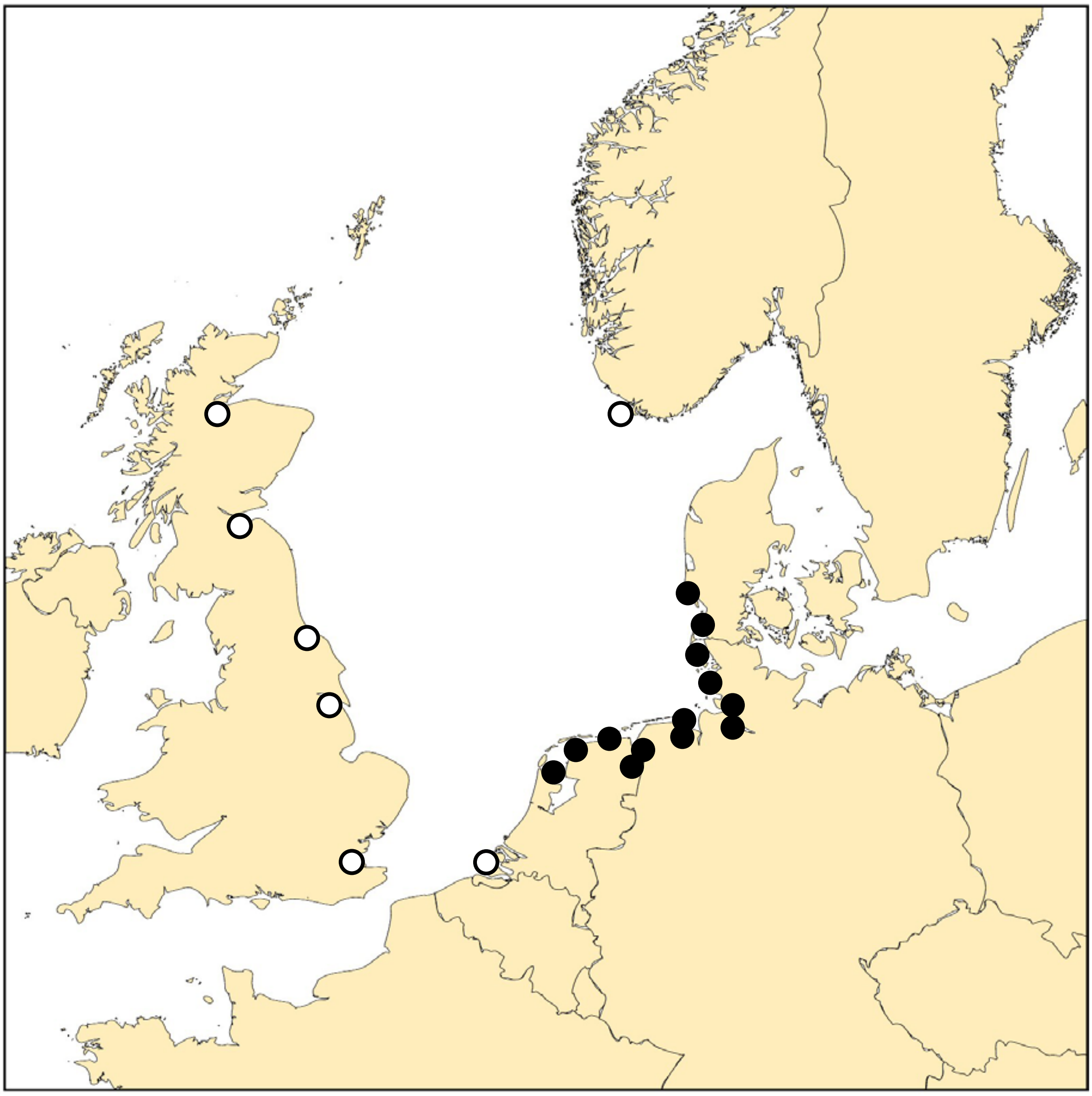


Figure 8: Location of proposed (open circles) and existing (filled circles) monitoring sites for Common Tern and Oystercatcher (see Table 3) (Note: At some of the 13 sites in the Wadden Sea only one species is monitored).

Table 3: Proposed sampling sites of Common Tern and Oystercatcher eggs at the North Sea coast.

Country	Sites	Status	Remark
NL	Rhine/Scheldt	Proposed	Estuary
	Wadden Sea, Ems	Monitoring (TMAP) 4 sites	Estuary and costal area
D	Wadden Sea, Ems, Weser, Elbe	Monitoring (TMAP) 7 sites	Estuaries and coastal area
DK	Wadden Sea	Monitoring (TMAP) 2 sites	Coastal area
UK	Thames	Proposed	Estuary
	Humber	Proposed	Estuary
	Tees	Proposed	Estuary
	Forth	Proposed	Estuary
	Moray Firth	Proposed	Reference area
N	South-west coast	Proposed	Reference area

6.5 Conclusion

Bird eggs have been proven as a favorable matrix for spatial and temporal monitoring of environmental chemicals and to assess the level of contamination in the marine food web.

Common Tern and Oystercatcher are suitable species and fulfill the preconditions for application as EcoQO in the North Sea.

Information about the spatial distribution of contaminants and concentration levels in bird eggs of Common Tern and Oystercatcher along the North Sea coasts is limited. Comprehensive data sets for these species are only available for the Wadden Sea coast.

The proposed EcoQO values for Common Tern and Oystercatcher have been developed based on Wadden Sea data. They have not yet been underpinned with data from other coastal areas. Furthermore, EcoQOs for new emerging substances have not yet been elaborated

7. Recommendations

7.1 Seabirds eggs as EcoQOs

There are good experiences with the use of seabird eggs as matrix for assessing the status of contamination of birds, identification of “hot spots” and short term effects, and robust trend detection in comparison to physical matrix (sediment, water) and other biota (mussel, fish). Monitoring of Common Tern and Oystercatcher eggs should therefore be extended to other parts of the North Sea.

7.2 Spatial Coverage

The current long-term sampling sites in the Wadden Sea area including hot spots (Ems, Weser, Elbe) and areas with lower contamination pressure (Eastern Dutch Wadden Sea, Danish Wadden Sea) should be continued.

As a first step to reach sufficient spatial coverage, an additional sampling site for Common Tern eggs at the Rhine/Scheldt should be established, followed by sites at the Thames and Humber and reference sites in Norway and UK. The selection strongly depends on the availability of suitable bird colonies in these areas.

7.3 Further development of EcoQOs

The proposed EcoQOs for Common Tern and Oystercatcher should be further developed based on data from other suitable stations along the North Sea coast in a pilot project

Calculation of EcoQO for other bird species and for emerging substances by using reference sites, modeling or long-term data series is also required and should be carried out as a separate activity within a pilot phase.

7.4 Pilot project 2008 - 2009

A North Sea wide pilot project should be initiated for the period 2008 - 2009 in order to get the results included in the OSPAR 2010 QSR. The main objective would be to obtain a North Sea wide overview about spatial distribution of selected contaminants in bird eggs and to get sufficient data for the further development of EcoQOs. This pilot project can be coordinated by the CWSS together with the German Institute of Avian Research 'Vogelwarte Helgoland'. The JAMP guidelines can be applied (OSPAR 1997).

The North Sea wide selection of appropriate colonies together with the responsible authorities and bird experts can already start in spring 2008. Sampling of eggs and chemical analysis can be carried in 2008, and the results would then be available in the beginning of 2009.

The analysis should preferably be carried out as a "one lab approach" (sampling, chemical analysis, data reporting by one laboratory), this would keep the costs to a minimum. Within the TMAP, the current costs for the chemical analysis are about 3,500 Euro for one bird species at one sampling sites (10 eggs per species). The actual costs of the proposed North Sea wide pilot project depend on the number of sites, selected species per site and number of chemical substances to be analyzed.

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Technical evaluation

Table 2.1.7.1.8.1 Technical evaluation of the EcoQ element (g) Mercury concentrations in seabird eggs [and feathers]. Since this is not part of the North Sea pilot project, the EcoQ element was assessed as no EcoQO has yet been agreed. The science underpinning this evaluation is summarized in the supporting text.

		Comments	
1	**Issue**	4. Seabirds	
2	**Element**	(g) Mercury concentrations in seabird eggs [and feathers]	
3	**ICES criteria**		
	Relatively easy to understand by non-scientists and those who will decide on their use	Usually	There is a clear link between the anthropogenic input of mercury into the environment and the concentration of mercury in bird eggs.
	Sensitive to a manageable human activity	Usually	Mercury in the environment is predominantly anthropogenic.
	Relatively tightly linked in time to that activity	Rarely	Mercury in the environment is very persistent, and tends to increase up food chains. Because of this persistence, a time lag would exist between applying management measures and the response in seabird eggs (and feathers).
	Easily and accurately measured, with a low error rate	Usually	Eggs are readily available and the analytical methods are well established.
	Responsive primarily to a human activity, with low responsiveness to other causes of change	Occasionally	Mercury concentrations in birds' feathers reflect dietary intake, but this is complicated by a pattern of storage of mercury in soft tissues between moults and excretion of most of the mercury into growing feathers during the moult.
	Measurable over a large proportion of the area to which the EcoQ metric is to apply	Usually	Some seabirds are common and widely distributed.
	Based on an existing body or time series of data to allow a realistic setting of objectives	Occasionally	Recent research indicates that, for establishing historic levels of trace metals, bird feathers from mounted specimens in museum collections are of limited use (Hogstad *et al*., 2003). For mercury in eggs, no historical reference material exists.
4	**Ecological relevance/basis for the metric**	Mercury is a toxic metal that is predominantly introduced into the environment through human activities. Concentrations increase up food chains.	
5	**Current and historic levels (including geographic areas)**	Levels of mercury in the eggs of several species of seabirds have been monitored for some decades. Current levels vary between areas and species.	
6	**Reference level**	Given recent evidence concerning the limited use of bird feathers from mounted specimens in museum collections for establishing reference levels (Hogstad *et al*., 2003), a reference level in bird feathers is difficult to establish. A reference level for bird eggs is not possible to establish given the lack of reference material.	
7	**Limit point**	Unknown	
8	**Time frames**	*Detection of change*	The persistence of mercury in the environment means that there is a time lag between taking action to reduce inputs and the response in seabird eggs and feathers.
		Use in advice	Reporting annually would be of little use. A two- to five-year reporting cycle would be useful.
9	**Advice on EcoQO options**	The mercury concentrations in seabird eggs in any area of the North Sea should not significantly exceed the level recorded in seabird eggs from non-industrial reference areas in the North Sea.	
10	**Monitoring regimes**	A standardization of monitoring is required; monitoring should be implemented in different selected areas, and reference areas should be chosen. The monitoring rate should be annual.	
11	**Management measures to achieve EcoQO**	Management measures to reduce the input of mercury into the environment are in place. Monitoring mercury for this EcoQO could help in establishing whether the existing measures are successful, or additional measures would be required.	

Technical evaluation

Table 2.1.7.1.9.1 Technical evaluation of the EcoQ element (g) Organochlorine concentrations in the eggs of North Sea seabirds. Since this is not part of the North Sea pilot project, the EcoQ element was assessed as no EcoQO has yet been agreed. The science underpinning this evaluation is summarized in the supporting text.

		Comments	
1	**Issue**	4. Seabirds	
2	**Element**	(h) Organochlorine concentrations in seabird eggs	
3	**ICES criteria**		
	Relatively easy to understand by non-scientists and those who will decide on their use	Usually	Most organohalogens are man-made substances; their level in birds' eggs provides an indication of their level and trends in the ecosystem.
	Sensitive to a manageable human activity	Usually	Most of these substances enter the ecosystem entirely through human activities.
	Relatively tightly linked in time to that activity	Occasionally	Bioaccumulation and persistence in ecosystems mean that some linkage will occur, but not always.
	Easily and accurately measured, with a low error rate	Usually	A standardization of methods and ways to express the data is necessary.
	Responsive primarily to a human activity, with low responsiveness to other causes of change	Usually	Due to the persistence of many of these compounds, it will take many years before they disappear from the environment.
	Measurable over a large proportion of the area to which the EcoQ metric is to apply	Usually	Some seabirds are common and widely distributed.
	Based on an existing body or time series of data to allow a realistic setting of objectives	Usually	For most of these substances, the historic level is zero. For certain substances, time series exist (decades).
4	**Ecological relevance/basis for the metric**	Organochlorines, and organohalogens in general, are for the most part man-made, and in many cases are highly toxic substances with long half-lives. Seabird eggs offer a reliable way of measuring the levels and trends of these substances in the environment.	
5	**Current and historic levels (including geographic areas)**	Time series exist for some decades for some organochlorines for some parts of the North Sea. Monitoring for other substances has only started recently. Current levels are different in different areas of the North Sea.	
6	**Reference level**	Most reference levels would be zero, given the fact that most of these substances are exclusively man-made.	
7	**Limit point**	Unknown in most cases.	
8	**Time frames**	*Detection of change*	Given the persistence of most of these substances, firm conclusions on trends and on reaching the EcoQOs can only be made on a relatively long time frame (years).
		Use in advice	Reporting should be on a two- to five-year period.
9	**Advice on EcoQO options (scenarios)**	*Scenario 1*	The level of most of these contaminants in the environment should be zero, given the fact that they are entirely man-made. Dioxins, however, can arise from combustion, including forest fires, and so have a natural "background" level. Given the long half-lives and the continued, sometimes indirect input into the environment of some of these substances, it is not likely that EcoQOs can be reached in a short or even medium term after cessation of the input.
		Scenario 2	For each site, the average concentrations in fresh mass of the eggs of common tern and Eurasian oystercatcher should not exceed 20 ng g^{-1} of PCBs; 10 ng g^{-1} of DDT and metabolites; and 2 ng g^{-1} of HCB and of HCH. For other substances, EcoQOs (maximum levels) should be established.