Marine litter monitoring by Northern Fulmars in the Netherlands 1982-2003

Fulmar litter studies are co-funded by the Netherlands Ministry of Transport, Public Works and Water Management and the EU Interreg IIIB program for the North Sea. Beachwashed Fulmars for this study are collected by volunteers of the Beached Bird Survey (NSO) of the Dutch Seabird Group (NZG).

Marine litter monitoring by Northern Fulmars in the Netherlands 1982-2003.

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ABSTRACT

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Earlier studies on litter contents in stomachs of Fulmars have shown that this seabird species can be used as a suitable monitor of levels of marine litter pollution in the North Sea off the Dutch coast. This report updates the earlier data with monitoring results for the years 2002 and 2003 and discusses trends in the light of shipping regulations and the EU inititiative to reduce littering by ships through improvements in systems for Port Reception Facilities. The Dutch research is closely linked to the European Fulmar study conducted in the 'Save the North Sea (SNS)' project 2002-2004 which is co-funded by the EU Interreg IIIB program. Dutch and SNS Fulmar studies form the basis for the development of an Ecological Quality Objective on marine litter as requested by OSPAR.

Keywords: beached-bird-surveys BBS, chemicals, Ecological-Quality-Objective EcoQO, EU-Directive, Fulmarus glacialis, graadmeter, ICES, ingestion, marine litter, monitoring, North Sea, OSPAR, plastic, Port-Reception-Facility, stomach-contents

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Contents

Summary

Marine litter causes serious economical and ecological damage. Among the various sources of litter in the marine environment, the disposal of operational and cargo related waste by ships is important. Recognizing the role of shipping and the inadequacies in the ship to shore waste delivery procedures, the European Union has formulated the Directive on Port Reception Facilities (Directive 2000/59/EC). Obligatory waste delivery to shore and indirect financing of the costs involved are key-elements of the Directive to stimulate and enforce proper disposal of shipwaste in harbours. Monitoring the effect of the implementation of the EU Directive is required. A monitoring program using litter abundance in stomachs of a seabird, the Northern Fulmar, is already in effect in the Netherlands and is being prepared for international application as an 'Ecological Quality Objective (EcoQO)' by OSPAR. The Dutch Ministry of Transport has requested Alterra to update the Fulmar-Litter monitoring database for the Netherlands with the years 2002 and 2003. These years may be considered as the starting point for implementation of the EU-Directive.

Corpses and stomach contents of 95 Fulmars beachwashed in the Netherlands during the years 2002 and 2003 were investigated for the abundance of marine litter ingested by these birds. The data were added to the existing database on this topic covering the years 1982 to 2001. Litter quantities observed in the separate years showed strong variability. High levels of litter were observed in 2002: among 56 birds examined, 98% had plastics in the stomach, the average per bird being 52 plastic particles weiging 0.50 gram. About 23% of the birds had also ingested suspect chemical-like substances. However, in the year 2003, averages for 39 birds were among the lowest on record: although still 95% of birds had plastic, the average number of plastic items wass only 29, weighing 0.17 gram per bird, and suspected chemicals had been ingested by 21% of birds.

Rather than simple annual averages, statistical treatment of individual data over multi-year periods has to be used to examine trends. Analyses of long-term (1982-2003) and short-term (1996-2003) trends show that industrial plastic particles continue a steady decrease, although the rate may gradually level off. User-plastics showed a substantial increase from 1982 to peak pollution levels in the late 1990's, but recent years -in spite of interannual variability- show a significant decrease. Coastal surveys of beached litter are somewhat inconclusive, but also show indications of a possibly downward recent trent in marine litter.

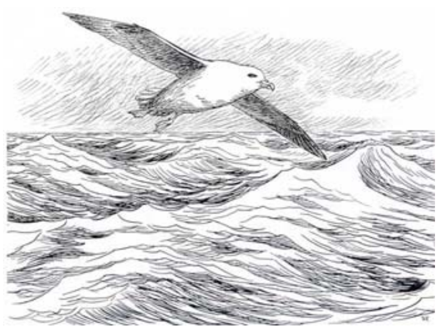
Over the past five years (1999-2003) nearly every beachwashed Fulmar (98%) in the Netherlands contained plastics in an average quantity of 32 items or 0.34 gram per bird. This signals a return to the plastic pollution level in the 1980's but in a modified composition with less industrial, but more user plastics and in smaller fragments. This means that losses of industrial plastic during manufacturing and transport have been reduced, but that the disposal of plastic garbage in the marine environment has increased.

Suspected chemical materials are found in ± 25% of Fulmars beachwashed in the Netherlands, a level considerably higher than during the 1980's.
A tentative EcoQO target for plastic litter pollution has been formulated by OSPAR as "less than 2% of beachwashed Fulmars having more than 10 pieces of plastic in the stomach". Currently, 56% of Dutch Fulmars exceeds the criterion of 10 plastic items.

Important changes in shipping regulations have occurred in the period 1988-1991 when the 'garbage annex' of MARPOL (ANNEX V) entered into force and the North Sea became a Special Area under this annex. Disposal of plastics is totally prohibited under these regulations. Fulmar data are insufficiently detailed around this point in time, but average figures for the 1980's and 1990's show that Annex V did not prevent a sharp increase in garbage user plastic in the marine environment. Reduced abundance of user plastics after the late 1990's is unrelated the EU Directive 2000/59/EC, as its implementation, scheduled for December 2002, has suffered delays. In the Netherlands the Directive was implemented by 15 October 2004. Recent monitoring data may thus be considered as the reference value by which to measure future effects of the Port Reception Directive.

Since late 2002, the Dutch Fulmar research has been expanded to participants in all countries around the North Sea. This international Fulmar study is part of the 'Save the North Sea' awareness campaign concerning marine litter, which is co-funded by the EU-Interreg IIIB program for the North Sea. The combination of the Dutch Fulmar study (time series) and the European one (regional variation) will supply essential background information for the implementation of the 'Fulmar-Litter-EcoQO'. This is one of the Ecological Quality Objectives (EcoQO's) to be developed by OSPAR (OSPAR 2004), as requested by the Ministers of North Sea countries in Bergen (March 2002). The Save the North Sea Fulmar study will present its final report in December 2004, discussing the aspect of regional variation and advising on implementation of the EcoQO in terms of methods, mode of presentation and target levels.

This monitoring study has been made possible by the continuous efforts of the volunteers of the Dutch Beached Bird Survey (NSO) in the Dutch Seabird Group (NZG). During their surveys they collect the beachwashed fulmars on which this study is based.



Samenvatting

Zwerfvuil in het zeemilieu heeft ernstige economische èn ecologische gevolgen. Het door zeeschepen overboord zetten van huishoudelijk of lading-gebonden afval vormt een belangrijke bron van het zwerfvuil. Het Europese Parlement en de Raad hebben de rol van de scheepvaart en de tekortkomingen rond de afgifte van afval in havens onderkend. Daarom is op 27 november 2000 besloten tot de invoering van 'Richtlijn 2000/59/EG betreffende havenontvangstvoorzieningen voor scheepsafval en ladingresiduen' (verkort aangeduid als de HOI-Richtlijn). Verplichte afgifte van afval en indirecte financiering van de kosten vormen de kern van de maatregelen waarmee de Richtlijn correcte afvalafgifte wil stimuleren en afdwingen. Het monitoren van de effecten van de invoering van de HOI-Richtlijn is noodzakelijk. In Nederland worden trends in zwerfafval op zee reeds onderzocht in een monitoring programma dat is gebaseerd op de hoeveelheid afval in magen van dood aangespoelde zeevogels, de Noordse Stormvogel. Deze graadmeter wordt inmiddels ook voorbereid voor brede internationale toepassing als één van de zogenaamde EcoQO's (Ecologische Kwaliteitsdoelstellingen) van OSPAR. Derhalve heeft het Ministerie van Verkeer en Waterstaat Alterra gevraagd om de bestaande Nederlandse monitoring database aan te vullen met gegevens over de jaren 2002 en 2003. Deze jaren kunnen gelden als de aanvangssituatie voor de invoering van de HOI-Richtlijn.

Maaginhouden van 95 in 2002 en 2003 in Nederland aangespoelde stormvogels werden onderzocht op hoeveelheden zwerfvuil in de maag. Gegevens werden toegevoegd aan de al beschikbare database met gegevens vanaf het jaar 1982 tot 2001. De twee onderzochte jaren toonden sterke onderlinge verschillen. In 2002 werden hoge afvalhoeveelheden aangetroffen: van de 56 onderzochte vogels had 98% plastics in de maag, met een gemiddeld aantal van 52 stukjes plastic en een gewicht van 0.50 gram per vogel. Daarnaast had ongeveer 23% van de vogels resten van mogelijk chemische stoffen in de maag. In het daarop volgende jaar 2003 was de hoeveelheid zwerfvuil in 39 onderzocht vogels beduidend lager: weliswaar had 95% van de vogels één of meer stukken plastic in de maag, maar de gemiddeldes waren 'slechts' 29 stukjes en 0.17 gram per vogel. Als 'chemisch' betitelde stoffen werden in 21% van de magen aangetroffen.

Om trends vast te kunnen stellen, moet men niet naar varierende jaargemiddeldes kijken, maar naar statistische analyses over alle individuele gegevens in de loop van series van jaren. Trend-analyses over de langere termijn (1982-2003) en de kortere recente termijn (1996-2003) tonen aan dat industriële plastics vanaf het begin een gestage daling vertonen, hoewel in de recente periode de snelheid van afname lijkt terug te lopen. De gebruiksplastics daarentegen vertoonden eerst een sterke groei vanaf 1982 tot piekniveaus in het eind van de jaren '90. Recente jaren tonen een variable doch significant dalende trend. Hoewel niet eenduidig, suggereren ook tellingen van zwerfvuil op stranden een voorzichtig neerwaardse trend in de hoeveelheid afval op zee.

Gemiddeld over de afgelopen vijf jaar (1999-2003) had 98% van de in Nederland gevonden Noordse Stormvogels plastic in de maag, gemiddeld 32 stukjes en 0.34 gram per vogel. Dit begint te lijken op een terugkeer naar de hoeveelheid plastic die in de jaren '80 werd

aangetroffen, alleen is de samenstelling van het plastic veranderd, met minder industriële plastics, en de gebruiksplastics in kleinere stukjes. Dit betekent dat verliezen van industriële plastic granules tijdens fabricage en transport zijn verminderd, maar dat het lozen van plastic afval in het zeemilieu is toegenomen. Vermoedelijk chemische materialen worden gemiddeld in ca. 25% van de aangespoelde stormvogels gevonden, een duidelijke toename t.o.v. de jaren tachtig.
Als voorlopig 'doelniveau' voor de hoeveelheid zwerfvuil die in een relatief 'schone' Noordzee nog zou mogen worden aangetroffen, is binnen OSPAR geopperd dat "minder dan 2% van aangespoelde stormvogels meer dan 10 stukjes plastic in de maag zou mogen hebben". Op dit moment overschrijdt gemiddeld 56% van de vogels de grenswaarde van 10 stukjes plastic.

Belangrijke wijzigingen in voorschriften voor de zeescheepvaart vonden plaats in de periode 1988-1991, toen eerst de 'vuilnis-annex' van MARPOL (Annex V) van kracht werd en vervolgens het Noordzeegebied tot een 'Speciaal Gebied' onder deze annex werd verklaard. Het lozen van plastics is onder deze maatregelen volledig verboden. De gegevens van stormvogels uit deze periode zijn onvoldoende gedetailleerd maar een vergelijking tussen de 80'er en 90'er jaren laat zien dat de Annex V maatregelen een sterke toename van plastics in het mariene milieu niet konden voorkomen. De afname van plastic zwerfvuil op zee in recente jaren kan niet gerelateerd zijn aan de HOI-Richtlijn, want de geplande inwerkingtreding in december 2002 heeft in de regio vertraging opgelopen en is in Nederland pas op 15 oktober 2004 doorgevoerd. De recente monitoring resultaten moeten dus gezien worden als de uitgangssituatie ('referentiewaarde') waaraan toekomstige effecten van de HOI-Richtlijn kunnen worden afgemeten.

Vanaf najaar 2002 is het Nederlandse stormvogelonderzoek uitgebreid met deelnemers in alle landen rond de Noordzee. Het internationale stormvogelonderzoek is een onderdeel van de 'Save the North Sea' bewustwordings campagne tegen afval in zee. Deze campagne is over de periode 2002-2004 mede betaald vanuit het EU Interreg Programma IIIB voor de Noordzee. De combinatie van het Nederlandse (tijdserie) plus het internationale onderzoek (regionale variatie) levert de basiskennis die nodig is voor de invoering van de Stormvogel-Zwerfvuil-EcoQO door OSPAR in opdracht van de Noordzee Ministers Conferentie 2002. Het Save the North Sea stormvogelonderzoek zal in December 2004 rapportage uitbrengen, waarin het aspect van regionale variatie zal worden besproken en adviezen zullen worden opgenomen voor de invoering van de EcoQO qua methodes, presentatievorm en in de toekomst te bereiken doelniveaus.

Dit monitoring onderzoek is slechts mogelijk dankzij niet aflatende inzet van vrijwilligers van het Nederlands Stookolieslachtoffer Onderzoek (NSO), een werkgroep van de Nederlandse Zeevogelgroep (NZG). Tijdens hun telwerkzaamheden verzamelen zij aangespoelde stormvogels voor het zwerfvuil monitoring project.

1 Introduction

1.1 Background

Marine litter, in particular plastic waste, represents an environmental problem in the North Sea with wide ranging economical and ecological consequences.

Economic consequences of marine litter are for example suffered by coastal municipalities who find themselves confronted with excessive costs for beach clean-ups. Tourist business suffers damage because guests stay away from polluted beaches, especially when various types of litter are a health-risk for tourists. Fisheries are confronted with an increasing bycatch of marine litter which means loss of time and sometimes tainted catch that must be discarded. All sorts of shipping suffer financial damage and more importantly, safety-risks from fouled propellors or blocked water-intakes. Coastal litter blowing inland is even seriously affecting farmers. The economical damage from marine litter is difficult to estimate, but a detailed study in the Shetlands with additional surveys elsewhere indicates that extrapolated costs for the whole North Sea area may exceed one billion Euro's per year (Hall 2000; pers.inf).

The most pronounced ecological consequence of marine litter is suffering by marine wildlife. Entangled seabirds and marine mammals regularly attract public attention. In summer 2004, the first Humpback Whale found on the Dutch coast proved to be snared and killed by a rope around its neck. However, only a small proportion of such mortality becomes visible among beachwashed animals. Even less apparent are the consequences from the ingestion of plastics and other types of litter. Ingestion is extremely common among a wide range of marine organisms including many seabirds, marine mammals and seaturtles. It does cause direct mortality but the major impact may well occur through reduced fitness of many individuals. Sublethal effects on animal populations remain largely invisible. In spite of spectacular examples of mortality from marine litter, the real impact on marine wildlife remains difficult to estimate (Laist 1987, 1997; Derraik 2002). Plastics gradually break down to microscopic particle sizes, but even these may pose serious problems to marine ecosystems (Thompson *et al.* 2004).

Recognizing the negative impacts from marine litter, a variety of international policy measures has attempted to reduce input of litter. Examples of these are the London Dumping Convention 1972; Bathing Water Directive 1976; MARPOL 73/78 Annex V 1988; Special Area status North Sea MARPOL Annex V 1991; and the OSPAR Convention 1992. In the absence of significant improvements, political measures have recently been intensified by for example the EU-Directive on Port Reception Facilities (Directive 2000/59/EC) and the Declaration from the North Sea Ministerial Conference in Bergen, March 2002.

Recent policy initiatives have recognized that policy aims need to be quantifiable and measurable. Therefore, the North Sea Ministers in the 2002 Bergen Declaration have decided to introduce a system of Ecological Quality Objectives for the North Sea (EcoQO's). A number of these EcoQO's will be implemented in an immediate pilot program. For example, the oil pollution situation in the North Sea will be measured by the rate of oil-fouling among Guillemots (*Uria aalge*) found on beaches. The ecological quality target is set at a level in which less than 10% of beachwashed Guillemots has oil on the plumage.
An other set of EcoQO's has to be developed for future implementation. Among this latter group is an EcoQO for marine litter, to be measured by the abundance of plastic in stomachs of seabirds, in casu the Northern Fulmar (*Fulmarus glacialis*). Working Groups in ICES and in OSPAR are involved in the further development and implementation of the EcoQO system including the advise on realistic target levels. For convenience the EcoQO for marine litter is referred to as the 'Fulmar-Litter-EcoQO'.

Within the Netherlands, the Ministry of Transport, Public Works and Water Management (VenW) has a coordinating role in governmental issues related to the North Sea environment. As such, VenW is involved in the development of environmental monitoring systems ("graadmeters") for the Dutch continental shelf area. As a part of this activity, VenW commissioned two earlier projects by Alterra working towards a Fulmar-Litter-EcoQO. The first pilot project considered stomach contents data up to the year 2000 and made a detailed evaluation of their suitability for monitoring purposes (Van Franeker & Meijboom 2002; Alterra Report 401). The second project updated the Dutch time-series to include the year 2001 and described the links to the international Fulmar study in the Save the North Sea (SNS) project (Van Franeker & Meijboom 2003; Alterra-rapport 622). The SNS project is co-funded by the EU Interreg IIIB program and aims to reduce litter in the North Sea area. The Fulmar is used as the symbol in the SNS campaign. Within the SNS project, the study of Fulmars has been expanded to all countries around the North Sea in order to provide sound advise to the development of the Fulmar-Litter-EcoQO as an international policy instrument.

The current report is thus the third in row on litter monitoring by Fulmars in the Netherlands and focuses its discussion on marine shipping and the EU Directive on Port Reception Facilities. A proper interpretation of the information presented, requires a condensed summary of earlier findings.

1.2 The Fulmar as an ecological monitor of marine litter

Van Franeker & Meijboom (2002) discussed the feasibility of using stomach contents of beachwashed Northern Fulmars to measure changes in the litter situation off the Dutch coast in an ecological context. Samples of Fulmars available for the feasibility study originated from the periods 1982 to 1987 and 1996 to 2000, with smaller number of birds from the years in between.

Reasons for selection of the Fulmar out of a list of potential monitoring species are of a practical nature:

- Fulmars are abundant in the North Sea area (and elsewhere) and are regularly found in beached bird surveys, which guarantees supply of adequate samples for research.
- Fulmars are known to consume a wide variety of marine litter items.
- Fulmars avoid nearshore areas and forage excusively at sea (never on land).
- Fulmars do not normally regurgitate indigestible items, but accumulate these in the stomach (digestive processes and mechanical grinding gradually wear down particles to sizes that are passed on to the gut and are excreted).
- Thus, stomach contents of Fulmars are representative for the wider offshore environment, averageing pollution levels over a foraging space and time span that avoids bias from local pollution incidents.
- Historic data are available in the form of a Dutch dataseries since 1982 and literature is available on other locations and related species worldwide (Van Franeker 1985; Van Franeker & Bell 1988).
- Other North Sea species that ingest litter either do not accumulate plastics (regurgitate indigestable remains); are coastal only and/or find part of their food on land (e.g. Larus gulls); ingest litter only incidentally (eg North Sea alcids) or are too infrequent in beached bird surveys for required sample size or spatial coverage (eg other tubenoses or Kittiwake).

Beachwashed birds may have died for a variety of reasons. For some birds, plastic accumulation in the stomach was the direct cause of death, but more often the effects of litter ingestion act at sublethal levels, except maybe in cases of ingestion of chemical substances. For other birds, fouling of the plumage with oil or other pollutants, collisions with ships or other structures, drowning in nets, extremely poor weather or food-shortage may have been direct or indirect causes of mortality.

At dissection of birds, their sex, age, origin, condition, likely cause of death and finding date are determined. Stomach contents are sorted into main categories of plastics (industrial and user-plastics), non-plastic rubbish, pollutants, natural food remains and natural non food-remains. Each of these categories has a number of subcategories of specific items. For each individual bird and litter category data are recorded on presence or absence (“incidence”), the number of items, and the mass of items.

The pilot study undertook extensive analyses to check whether time-related changes in litter abundance were susceptible to error caused by bias from variables such as sex, age, origin, condition, deathcause, or season of death. If any of these would substantially affect quantities of ingested litter, changes in sample composition over the years could hamper or bias the detection of time-related trends.

An important finding of the pilot study was that no statistical difference was found in litter in the stomach between birds that had slowly starved to death and ‘healthy’ birds that had died instantly (e.g. because of collision or drowning). This means that our results, which are largely based on beachwashed starved birds, are representative for the 'average' healthy Fulmar living in the southern North Sea.

Only age was found to have some effect on ingested litter, adults having somewhat less plastics in their stomachs than younger birds. Possibly, adults loose some of the plastics accumulated in their stomach when they feed chicks or spit stomach-oil during defense of nest-sites. Another factor could be that foraging experience may increase with age. However, our understanding of the observed age difference in plastic accumulation is still poor, and further study should be promoted where possible. A first start with such study has been made in the Save the North Sea project. A trial was made analyzing some stomachs of Fulmars from the Faeroer, where Fulmars are hunted for consumption and large numbers of samples are easily obtained: differences between adults and chicks, and seasonal differences within adults suggest that the 'chick-feeding' hypothesis may be true. For a proper analysis a substantial sample of stomachs was collected in each month of the year 2003. Financial resources to process this large number of samples are currently not available, but stomachs have been stored frozen and are ready to be analyzed.

Although age has been shown to affect absolute quantities of litter in stomach contents, changes over time follow the same pattern in adults or non-adults. As long as no directional change in age composition of samples is observed, trends may be analysed for the combined age groups. Presentation of results always includes information on age groups. By using individual sample data rather than annual averages, optimal use of data is made.

Significant long term trends from 1982 to 2000 were detected in incidence, number of items and mass of industrial plastics, user plastics and suspected chemical pollutants (often paraffine-like substances). Over the 1982-2000 period only industrial plastics decreased; others significantly increased. When comparing averages in the 1980's to those in de 1990's, industrial plastics decreased from 6.8 granules per bird (77% incidence; 0.15g per bird) to 3.6 granules (64%; 0.08g). User-plastics increased from 7.8 items per bird (84%; 0.19g) to 27.6 items (97%; 0.52g). Chemical incidence between the decades increased from 10% to 28% (0.18 to 0.53 g per bird).
An analysis for shorter term recent trends over the period of 1996 to 2000 revealed continued significant decrease in industrial plastics and suggested stabilization or slight decreases in other litter categories. A second report (Van Franeker & Meijboom 2003) updating the Dutch time series to 2001, confirmed these findings.

Analysis of variability in data and Power Analysis revealed that reliable figures for litter in stomachs in a particular region are obtained at a sample size of about 40 birds per year and that reliable conclusions on change or stability in ingested litter quantities can be made after periods of 4 to 8 years, depending on the category of litter.

Mass of litter categories, rather than incidence or number of items, should be considered the most useful unit of measurement in the long term, and also is the most representative unit in terms of ecological impact on organisms. Incidence looses its sensitiviy as an indicator when virtually all birds are positive (as is the case in Fulmars). In regional or time-related analyses, mass of plastics is a more consistent measure than number of items, because the latter may vary strongly with changes in plastic characteristics.

The pilot study therefore concluded that stomach content analysis of beachwashed Fulmars offers a reliable monitoring tool for (changes in) the abundance of marine litter off the Dutch coast. By its focus on small sized litter in the offshore environment such monitoring has little overlap with, and high additional value to beach litter surveys of larger waste items. Furthermore, stomach contents of Fulmars reflect the ecological consequences of litter ingestion on a wide range of marine organisms and create public awareness of the fact that environmental problems from marine litter persist even when larger items are broken down to sizes below the range of normal human perception.

Formal indicators recommended in a future Dutch Fulmar-Litter monitoring system were abundances by mass of industrial plastic, user plastic and suspected chemicals. Each of these represents different sources of pollution, and thus speficic policy measures aiming at reduced inputs. Addition of further indicators from other litter (sub-)categories would produce little added value in the current situation. However, data-recording procedures are such that at the raw data-level, these categories continue to be recorded and can be extracted from databases should the need arrive.

The anticipated implementation of the Fulmar-Litter-EcoQO for the whole North Sea necessitated two further lines of activity:

- continuation of the time-series of data on stomach contents of Fulmars from the Netherlands (the only existing long-term series of data allowing immediate analysis of trends)
- research on Fulmar samples from a number of different locations around the North Sea to assess degrees of regional variability in Fulmar stomach contens and their backgrounds.

Such work is essential for a sound advise on a cost-efficient EcoQO monitoring system (in terms of number and spread of sampling locations around the North Sea and in terms of metrics to be used), differentation in EcoQO-target levels, and finally the designation of effective measures to reach targets.

Currently both these lines are implemented. The Dutch long-term time-series has been continued by subsequent national projects. Van Franeker & Meijboom (2003) reported on an update of the Dutch time series to include the year 2001, and described the international linkage in the Save the North Sea project. The current report covers an update of the Dutch monitoring information with the years 2002 and 2003 in relation to the EU Directive on Port Reception Facilities.
The international aspect has been covered by the Save the North Sea project in which groups from all North Sea countries have participated. Results of this study are currently under analysis and will be published in the final report of the project at the end of 2004. This final Save the North Sea report is a decisive step in the further

international implementation of the Fulmar-Litter-EcoQO by OSPAR (OSPAR 2004)

It has yet to be decided whether the final international EcoQO to be implemented by OSPAR will follow the units and mode of presentation used in Dutch monitoring reports.
For example, the way in which political target levels are formulated may require alternative modes of data analysis and/or presentation. As already indicated, this poses no problem because the Dutch as well as international studies collect broad-based raw data that give full flexibility for modified statistical analyses or modes of presentation.

1.3 Shipping, marine litter and policy measures

In historic times any waste products from ships were simply discarded on a convenience base, meaning almost anywhere and any time. The relatively low intensity of shipping and generally decomposable nature of wastes allowed such practice to continue for centuries without significant problems except inside harbour areas. However, exponential population growth and global industrialization has boosted marine transports by fast mechanically powered ships with ever increasing quantities of poorly decomposable and toxic wastes from fuel, cargo and household practises. Old habits are hard to change, particularly if such change involves costs in an extremely competetive international industry such as shipping. For example, the dramatic environmental consequenses of oil discharges from ships were already known in the early 1900's. More than a century later, under continuous public pressure and a continuous sequence of policy measures, the oil pollution problem is to some extent under control, but definitely not solved.

Compared to the problems from dumping of oil or toxic wastes, the issue of disposal of 'garbage' into the marine environment has long been considered of minor importance. It might still be considered that way if not for plastics. Plastics, although known since the early 1900's started their real development only after 1960. Since then, they have found their way into almost any application, replacing old materials in existing products, and creating new use in for example an endless array of 'disposable' packaging products.

Unfortunately, the same factors that made plastics such a popular product have turned them into an environmental problem. Low production costs have promoted careless use and low degradability leads to accumulation in the environment. By 2003 the world production of plastics amounted to about 165 million metric tons, 40 % of which for packaging (www.plastemart.com). Growth rates of this production exceed 5% per year!

At the same time, intensity of shipping has increased. Between 1994 and 2003 the worlds active merchant fleet grew from 437 to 571 million gross tons, a more than 30% growth in 10 years time. The tonnage of new merchant ships (>100 gtons) leaving shipyards doubled from 17.9 million gross tons in 1994 to 35.4 million gross tons in 2003. (Dept. of Transport 2004).

Marine litter originates from a variety of sources, including merchant shipping, fisheries, offshore industry, recreational boating and coastal tourism, influx from rivers or direct dumping of wastes along seashores. The relative importance of various sources differs strongly in different parts of the world, and is almost impossible to quantify. Dutch Coastwatch studies (e.g. Stichting de Noordzee 2003) score litter into categories 'from sea (shipping, fisheries, offshore)'; 'beach-tourism'; 'dumped from land'; and 'unknown'. In the Netherlands, the 'from sea' category consistently represents in the order of 40% of litter items recorded. The 'unknown' category scores a similar percentage. Considerable uncertainties are linked to this categorization. More spefific information may come from the OSPAR initiative for monitoring litter on beaches in a somewhat more systematic approach. In a first German report (Fleet 2003), ten years of Coastwatch like surveys, plus two years of the more detailed OSPAR pilot project were evaluated. From both studies it is concluded that shipping, fisheries and offshore installations are the main sources of litter found on German North Sea beaches. The larger proportion of litter certainly originates from shipping, with a considerable proportion of this originating in the fisheries industry.
Even if sources can not be fully specified, there is little doubt that waste disposal by ships is one of the important sources of marine litter worldwide, a fact also recognized by the International Maritime Organization (IMO) in a specific 'garbage-annex' to the MARPOL Convention.

The International Convention for the Prevention of Marine Pollution from Ships (MARPOL 73/78) entered into force on 2 October 1983 for Annexes I (oily wastes) and II (bulk liquid chemicals), but its Annex V, covering garbage, only achieved sufficient ratifications to enter into force on 31 December 1988. **MARPOL Annex V** contains the following main prohibitions for discharge of solid wastes:

- No discharge of plastics.
- No discharge of buoyant dunning, lining or packaging material within 25 nm.
- No discharge of garbage within 12 nm. Food waste may be discharged if ground to pieces smaller than one inch.
- No discharge of any solid waste, including food waste, within 3 nm.

Unfortunately, control of compliance with Annex V regulations on ships is difficult. During Port State Inspections, garbage related issues will definitely not receive the strongest attention. Nevertheles in the year 2002, 13% of deficiencies recorded related to Annex V garbage regulations (OECD-MTC 2003).

In the European region, and especially the North Sea area, the sheer intensity of merchant shipping and fisheries makes them an undisputed source of marine litter. From that background, North Sea states promoted that the North Sea received the status of MARPOL Special Area for its annexes I (oil) and V(garbage). Amendments to that effect were made in 1989, and the Special Area status for the North Sea entered into force in February 1991. **"Special Areas" under MARPOL Annex V** have a more restrictive set of regulations for the discharge of garbage, with main additions being:

- No discharge not only of plastics, but also of any sort of metal, rags, packing material, paper or glass.
- Discharge of food wastes must occur as far as practicable from land, and never closer than 12 nm.

Within the European Union, progress under worldwide MARPOL regulations was considered insufficient. In the port of Rotterdam approximately 5 to 10% of visiting ships used port reception facilities. Clearly not every ship needs to discharge wastes at every port visit, but the level of waste delivery was clearly too low. High costs of proper disposal in combination with low risk of being fined for violations are a certain background. Poor functioning of available reception facilitilities definitely plays a role as well. Compliance with MARPOL regulations is hard to enforce at sea, especially when many ships fall under jurisdiction of cheap flag-states with little concern for environmental issues. Compliance can only be promoted by measures that can be enforced when ships visit the harbour. From this perspective, the European Commission and parliament have installed the **EU-Directive on Port Reception Facilities for ship generated waste and cargo residues (Directive 2000/59/EC)**. Key elements of the Directive are:

- *Obligatory disposal* of all ship generated waste to reception facilities before leaving port. Ship generated waste includes operational oily residues, sewage, household and cargo-associated waste, but not residues from holds or tanks.
- *Indirect financing*, to a *'significant'* degree, of the delivery of ship generated waste. Finances for such 'free' waste reception should be derived from a fee system on all ships visiting the port. Delivery of cargo residues remains to be paid fully by the ship.
- Ports need to develop and implement a 'harbour plan' that guarantees appropriate reception and handling of wastes

'Significant' was later identified as meaning 'in the order of at least 30%'. Implementation date for the Directive was December 2002. However, implementation has suffered delay in various countries. In the Netherlands the Directive became implemented in October 2004. Initially, the Netherlands had planned to use a 100% level of indirect financing, following examples from Baltic states. However, the current level used is approximately the minimum of 30%.

The Netherlands government wants to monitor whether implementation of the EU Directive for Port Reception Facilities will have the intended effect. As far as litter is concerned, the Fulmar-Litter-EcoQO approach can be used. This tool complements surveys of quantities of litter delivered in ports, or beach surveys for quantities of waste washing onto beaches. These approaches have their specific merits but do not measure residual levels of litter in the marine environment itself. The Fulmar-Litter-EcoQO does look at this marine environment, and at the same time places such information in the context of ecological effects.

2 Material and methods

In 2002 and 2003 Alterra has continued to collect beachwashed Fulmars from Dutch beaches with the assistance of the Dutch Seabird Group (Nederlandse Zeevogelgroep NZG). The collection of birds is part of the activities by the NZG-Working Group on Beached Bird Surveys (Nederlands Stookolieslachtofffer Onderzoek - NSO). Additionally, assistance has been sought from coastal bird rehabilitation centers that occasionally receive Fulmars from the general public.

Bird corpses were stored frozen until analysis. Dissection methods and stomach content analyses were described in full detail in Van Franeker & Meijboom (2002) as were the methods for data analysis and presentation of results. For convenience, some of the methodological information from Van Franeker & Meijboom is repeated here in a condensed form.

At dissections, a full series of data is recorded that is of use to determine sex, age, breeding status, likely deathcause, origin, and other issues. Age, the only variable found to influence litter quantities in stomach contents is largely determined on the basis of development of sexual organs (size and shape) and presence of Bursa of Fabricius (a gland-like organ positioned near the end of the gut which is involved in immunity systems of young birds; it is well developed in chicks, but disappears within in the first year of life or shortly therafter).

After dissection, stomachs of birds are opened for analysis. Stomachs of Fulmars have two 'units': initially food is stored and starts to digest in a large glandular stomach (the proventriculus) after which it passes a small muscular stomach (the gizzard) where harder prey remains can be processed. For the purpose of this study, contents of proventriculus and gizzard are combined.

If oil or chemical types of pollutants are present, these are first subsampled and weighed before rinsing the remainder of stomach contents under cold water. If sticky substances hamper further processing, hot water and detergents are used to rinse the material as clean as needed for further sorting under under binocular microscope, during which items of different categories are separated.

The following categorization is used for objects found in the stomachs:

1 **PLASTICS (PLA)**

1.1 **Industrial plastic pellets (IND).** These are small, often cylindrically shaped granules of ± 4 mm diameter, but also disc and rectangular shapes occur. Various names are used, such as pellets, or beads or granules. They can be considered as "raw" plastic or a half-product in which plastics are usually first produced (mostly from mineral oil). The raw industrial plastics are then usually transported to manufacturers that melt the granules and mix them with a variety of additives (fillers, stabilizers, colourants, anti-oxidants, softeners, biocides, etc.) that depend on the user product to be made. For the time being, included in this category is a relatively small number of very small usually transparent spherical granules, also considered to be a raw industrial product.

1.2 **User plastics (USE)** (all non-industrial remains of plastic objects) differentiated in the following subcategories:

1.2.1 **sheetlike user plastics (she)**, as in plastic bags, foils etc., usually broken up in smaller pieces;

1.2.2 **threadlike user plastics (thr)** as in (remains of) ropes, nets, nylon line, packaging straps etc. Sometimes 'balls' of threads and fibres form in the gizzard;

1.2.3 **foamed user plastics (foa)**, as in foamed polystyrene cups or packaging or foamed polyurethane in matrasses or construction foams;

1.2.4 **fragments (fra)** of more ore less hard plastic items as used in a huge number of applications (bottles, boxes, toys, tools, equipment housing, toothbrush, lighters etc);

1.2.5 **other (oth)**, for example sigarette filters, rubber, elastics etc., so items that are 'plastic like' or do not fit a clear category.

2 **RUBBISH (RUB)** other than plastic:

2.1 **paper (pap)** which besides normal paper includes silver paper, aluminium foil etc, so various types of non-plastic packaging material;

2.2 **kitchenfood (kit)** for human food wastes such as fried meat, chips, vegetables, onions etc, probably mostly originating from ships' galley refuse;

2.3 **various rubbish (rva)** is used for e.g. pieces of timber (manufactured wood); paint chips, pieces of metals etc.;

2.4 **fishhook (hoo)** from either sportfishing or longlining.

3 **POLLUTANTS (POL)** (industrial or chemical waste remains):

3.1 **slags (sla)** that is the remains of burning ovens, eg remains of coal or ore after melting out the metals. Often pumice like material: if doubtful, materials classified as pumice;

3.2 **tar (tar)** is the category for lumps of tarry substances or for more fluid heavy mineral oil;

3.3 **chemical (che)** for lumps of parafine like materials or sticky substances arbitrarily judged to be unnatural and of chemical origin;

3.4 **featherlump (fea)** is used when excessive amounts of preened feathers were found in the stomach, indicating excessive preening by the bird of feathers sticky with oil or chemical pollutants. Presence of a few remains of preened feathers in the stomach is normal and was not recorded under this category. Featherlumps of other species were considered as 'natural food' from scavenging on corpses, unless it was evident that these feathers were heavily polluted.

4 NATURAL FOOD REMAINS (FOO)

Numbers of specific items were recorded in separate subcategories (fish otoliths, eye-lenses, squid-jaws, crustacean remains, jelly-type prey remains, scavenged tissues, insects, other), but details of these subcategories are not used in this litter survey study.

5 NATURAL NON-FOOD REMAINS (NFO)

Numbers of subcategories plant-remains, seaweed, pumice, stone and other were counted separately, but details are not used in analyses. Separately we also made rough estimates of numbers of parasitic worms in the stomach and of 'normal' remains of preened feathers.

After sorting under binocular microscope all above categories, we recorded for each stomach and each (sub)category:

- incidence (Presence or absence) and
- abundance by number (count of Number of items)
- abundance by mass (Weight in grams) using Sartorius electronic weighing scale after a one to two day period of air drying at lab temperatures. For marine litter (categories 1 to 3 above) this was done separately for all subcategories, but the natural-food and natural-non-food categories were each weighed as a whole only. Weights were recorded in grams accurate to the 4th decimal (= tenth of milligram).

Data from dissections and stomach content analysis are recorded in Excel spreadsheets and stored in Oracle relational database. GENSTAT 7 was used for statistical tests.

As concluded in the pilot study (Van Franeker & Meijboom 2002) statistical analysis of data for presence of trends over time was conducted using mass-data. Mass values for litter categories were ln-transformed to allow stastistical tests based on linear regressions fitting mass values for individual birds on the year of collection.
In addition to mass, incidental data on incidence and numbers of items have been provided as well. Until a final decision has been made on methodological aspects for the North Sea Fulmar-Litter-EcoQO, broad based data-collection during dissection and stomach content sorting will be continued to allow for future adaptations in analytical methods and presentation of trends without loss of historical data. Therefore, identical methods have been applied in processing samples collected in the international Save the North Sea Fulmar study.

3 Results

Data presentation in tables and figures follows the format provided in Van Franeker & Meijboom (2002; 2003) to facilitate comparison.

In the years 2002 and 2003 respectively, 56 and 39 Fulmar corpses holding stomachs could be collected from Dutch beaches for the monitoring project. These sample sizes are considered adequate to provide reliable annual figures (Van Franeker & Meijboom 2002). Corpses of beachwashed birds were collected by participants of the Beached Bird Survey of the Dutch Seabird Group (NSO-NZG).

High levels of litter were observed in 2002 (Table 1): among 56 birds examined, 98% had plastics in the stomach, the average per bird being 52 plastic pieces weiging 0.50 gram. About 23% of the birds had also ingested suspect chemical-like substances. However, in the year 2003 (Table 2), averages for 39 birds were among the lowest on record: although still 95% of birds had plastic, the average number of plastic items wass only 29, weighing 0.17 gram per bird, and suspected chemicals had been ingested by 21% of birds. Variability in annual average values has to be expected in this sort of monitoring.

Tables 1 and 2 also provide 'geometric mean values' as derived from logarithmic transformation of data. Statistical procedures for trend analysis or regional variations are based on ln transformed individual data. Data for overall plastic abundance (industrial and user plastics combined) have been added because at the moment, OSPAR has tentatively formulated the EcoQO in terms of **overall** plastic abundance with a provisional target level described as: *"less than 2% of Fulmars having more than 10 pieces of plastic in the stomach"*. Currently 56 % of birds exceeds the 10 piece criterion (1999-2003; 294 Fulmars)

An overview of major annual figures since 1982 is provided in Table 3. The table shows annual data for incidence and abundance by number and by mass for the three formal litter indicators proposed in the pilot study: industial plastics, user plastics (plus their combined totals) and suspected chemicals.

Annual averages however, are of limited value for analysis of trends. Results of statistical analyses for trends are shown in Table 4 and Figures 1 to 4. Graphical presentations for trends follow the format proposed in Van Franeker & Meijboom (2002). Graphs show linear regression trend lines of ln-transformed litter mass against year of collection As in table 2, a graph for 'overall plastics' has been added to conform to current EcoQO definitions. Full details of the regression lines in the graphs are listed in Table 4. Trends have been analysed for all birds, and for separate categories of adult birds and non-adults birds. Adults tend to have less plastics in their stomach, and when proportions in age categories would show directional change, this might affect overall results.

Analyses of long-term (1982-2003) and short-term (1996-2003) trends show that industrial plastic particles continue a steady decrease, although the rate may gradually level off. User-plastics showed a substantial increase from 1982 to peak pollution levels in the late 1990's, but recent years -in spite of interannual variability- show a signigicant decrease. Long-term and recent trends are both shown, because the current standard approach in data-analysis is based on linear trends (in ln transformed data). This does not provide statistical treatment for curves caused by reversal of trends in a single time-series. This is an issue to be considered in the implementation of the EcoQO metrics in a later phase.

To describe the 'recent situation' from monitoring results, this report uses the mean of annual average figures over the past 5 years. This procedure avoids bias from unequal annual sample sizes. Earlier reports used averages from all individual birds since 1996.

Table 1 Summary of sample characteristics and stomach contents of Fulmars collected for Dutch marine litter monitoring in the year 2002.

The top line shows sample composition in terms of age, sex, origin (by colourphase; darker phases are of distant Arctic origin), death cause oil, and the average condition-index (which ranges from emaciated condition=0 to very good condition=9). Although only age is currently relevant in the Dutch dataset, this is not necessarily true in later international comparisons. For each litter-(sub)category the table lists: Incidence, representing the proportion of birds with one or more items of the litter category present; average number of items per bird stomach; average mass per bird stomach; and the maximum mass observed in a single stomach. The final column shows the geometric mean mass, which is calculated from ln-tranformed values as used in trend-analyses. The geometric mean is similar to the median value of the observations.

	YEAR	**nr of birds**	**adult**	**male**	**LL colour**	**death oil**	**avg condition**
	2002	**56**	**54%**	**34%**	**71%**	**14%**	**1.6**

		incidence	average number of items	average mass of plastic (g/bird) ± standard deviation	max. mass recorded	geometric mean mass (g/bird)
1	**ALL PLASTICS**	**98%**	**51.77**	**0.497 ± 1.491**	**11.1**	**0.1542**
1.1	**INDUSTRIAL PLASTIC**	**68%**	**4.61**	**0.086 ± 0.108**	**0.5**	**0.0197**
1.2	**USER PLASTIC**	**96%**	**47.16**	**0.412 ± 1.425**	**10.7**	**0.1027**
1.2.1	sheets	57%	3.00	0.029 ± 0.089	0.6	0.0030
1.2.2	threads	39%	0.91	0.007 ± 0.032	0.2	0.0010
1.2.3	foamed	75%	9.54	0.069 ± 0.367	2.7	0.0061
1.2.4	fragments	95%	26.55	0.288 ± 1.037	7.8	0.0697
1.2.5	other plastic	29%	7.16	0.020 ± 0.064	0.3	0.0014
2	**OTHER RUBBISH**	**16%**	**0.57**	**0.049 ± 0.178**	**0.9**	**0.0012**
2.1	paper	4%	0.04	0.012 ± 0.088	0.7	0.0001
2.2	kitchenwaste (food)	9%	0.39	0.025 ± 0.121	0.8	0.0006
2.3	rubbish various	9%	0.14	0.012 ± 0.064	0.5	0.0004
2.4	fishhook	0%	0.00	0.000 ± 0.000	0.0	0.0000
3	**POLLUTANTS**	**46%**	**3.27**	**0.186 ± 0.509**	**2.7**	**0.0063**
3.1	slags	9%	0.16	0.000 ± 0.001	0.0	0.0001
3.2	tar	0%	0.00	0.000 ± 0.000	0.0	0.0000
3.3	suspected chemical	23%	2.89	0.032 ± 0.127	0.8	0.0013
3.4	feather lumps	20%	0.21	0.153 ± 0.467	2.4	0.0024
4	**FOOD NATURAL**	**77%**	**4.21**	**0.248 ± 0.850**	**5.9**	**0.0155**
5	**NONFOOD NATURAL**	**88%**	**9.20**	**0.191 ± 0.360**	**1.7**	**0.0358**

Table 2 Summary of sample characteristics and stomach contents of Fulmars collected for Dutch marine litter monitoring in the year 2003.
For explanations see caption Table 2.

YEAR		nr of birds	adult	male	LL colour	death oil	avg condition
2003		**39**	**56%**	**41%**	**87%**	**10%**	**1.2**

		incidence	average number of items	average mass of plastic (g/bird) ± standard deviation		max. mass recorded	geometric mean mass (g/bird)
1	**ALL PLASTICS**	**95%**	**28.54**	**0.169**	**± 0.175**	**0.7**	**0.0677**
1.1	**INDUSTRIAL PLASTIC**	**51%**	**2.28**	**0.045**	**± 0.074**	**0.3**	**0.0068**
1.2	**USER PLASTIC**	**92%**	**26.26**	**0.124**	**± 0.156**	**0.7**	**0.0412**
1.2.1	sheets	46%	1.90	0.004	± 0.013	0.1	0.0010
1.2.2	threads	49%	4.72	0.009	± 0.026	0.1	0.0017
1.2.3	foamed	67%	4.79	0.009	± 0.020	0.1	0.0023
1.2.4	fragments	85%	14.18	0.080	± 0.096	0.4	0.0263
1.2.5	other plastic	26%	0.67	0.022	± 0.075	0.3	0.0013
2	**OTHER RUBBISH**	**10%**	**0.10**	**0.090**	**± 0.424**	**2.5**	**0.0006**
2.1	paper	3%	0.03	0.000	± 0.001	0.0	0.0001
2.2	kitchenwaste (food)	5%	0.05	0.027	± 0.171	1.1	0.0002
2.3	rubbish various	0%	0.00	0.000	± 0.000	0.0	0.0000
2.4	fishhook	3%	0.03	0.063	± 0.393	2.5	0.0002
3	**POLLUTANTS**	**28%**	**1.15**	**2.207**	**± 10.963**	**68.2**	**0.0047**
3.1	slags	3%	0.08	0.000	± 0.001	0.0	0.0000
3.2	tar	0%	0.00	0.000	± 0.000	0.0	0.0000
3.3	suspected chemical	21%	0.92	1.944	± 10.425	65.0	0.0026
3.4	feather lumps	15%	0.15	0.264	± 0.799	3.5	0.0019
4	**FOOD NATURAL**	**90%**	**5.46**	**0.287**	**± 0.985**	**6.1**	**0.0438**
5	**NONFOOD NATURAL**	**79%**	**11.97**	**0.190**	**± 0.240**	**0.9**	**0.0474**

Table 3 Major litter categories per year.
Note sample sizes (n) to be very low for particular years implying low reliability of the annual averages for such years, not to be used as separate figures. Also note erratic variability in age proportions of birds in samples. However, trend analyses (table 3 and graphs) are based on values from all individual birds which avoids problems of years of poor sample size or variable age composition. Shown are incidence (%) representing the proportion of birds with one or more items of the litter category present; abundance by number of items per bird (n); and abundance by mass per bird in grams (g).

			INDUSTRIAL PLASTICS			USER PLASTICS			ALL PLASTICS (industrial + user)			SUSPECTED CHEMICALS		
YEAR	*n*	% adult	%	n	g	%	n	g	%	n	g	%	n	g
1982	*3*	0%	100%	5.0	0.11	67%	6.0	0.50	100%	11.0	0.61	0%	0.0	0.00
1983	*19*	39%	84%	8.8	0.19	89%	7.2	0.31	100%	16.0	0.49	0%	0.0	0.00
1984	*20*	40%	70%	9.6	0.19	90%	8.4	0.17	90%	17.9	0.35	25%	0.3	0.56
1985	*3*	33%	100%	5.3	0.14	100%	5.0	0.14	100%	10.3	0.28	0%	0.0	0.00
1986	*4*	25%	50%	0.8	0.02	75%	4.8	0.06	75%	5.5	0.08	0%	0.0	0.00
1987	*15*	67%	80%	3.9	0.11	67%	8.9	0.09	80%	12.7	0.20	13%	0.2	0.07
1988	*1*	0%	0%	0.0	0.00	100%	2.0	0.04	100%	2.0	0.04	0%	0.0	0.00
1989	*4*	50%	75%	5.3	0.14	100%	11.0	0.16	100%	16.3	0.29	0%	0.0	0.00
1991	*1*	0%	0%	0.0	0.00	100%	11.0	0.14	100%	11.0	0.14	0%	0.0	0.00
1995	*2*	50%	100%	1.5	0.02	100%	3.5	0.03	100%	5.0	0.06	0%	0.0	0.00
1996	*8*	63%	75%	2.9	0.07	100%	24.5	0.19	100%	27.4	0.26	50%	1.8	1.97
1997	*31*	16%	74%	5.9	0.13	97%	29.8	0.60	97%	35.8	0.73	6%	0.2	0.00
1998	*74*	47%	69%	3.1	0.07	95%	25.9	0.88	96%	29.0	0.95	30%	1.3	1.23
1999	*107*	69%	58%	3.4	0.06	97%	31.8	0.38	98%	35.3	0.44	33%	3.3	0.28
2000	*38*	58%	61%	3.4	0.08	100%	18.6	0.27	100%	22.0	0.35	26%	2.4	0.06
2001	*54*	38%	63%	2.6	0.06	96%	20.4	0.18	96%	22.9	0.24	15%	0.6	1.73
2002	*56*	54%	68%	4.6	0.09	96%	47.2	0.41	98%	51.8	0.50	23%	2.9	0.03
2003	*39*	56%	51%	2.3	0.05	92%	26.3	0.12	95%	28.5	0.17	21%	0.9	1.94

Table 4 Details of linear regression analyses of the selected litter indicators. Ln-transformed litter mass values for individual birds were fitted on year of collection. The regression line is described by y = Constant + estimate*x. Negative t-values indicate decreasing quantities of the litter category over the years for which the test was performed. Significance (p) of the trend was labelled - or + for significance at level $p<0.05$; -- or ++ for level $p<0.01$ and --- or +++ for level $p<0.001$ for decrease or increase respectively.

LONG TERM TRENDS (1982-2003)
in marine litter indicators, The Netherlands

INDUSTRIAL PLASTIC (lnGIND)	*n*	Constant	estimate	s.e.	t	p	
all ages	*479*	138.1	-0.071	0.018	-3.97	**<.001**	- - -
adults	*242*	92	-0.048	0.028	-1.70	0.090	
non adults	*234*	144	-0.074	0.023	-3.23	0.001	- -
USER PLASTICS (lnGUSE)	***n***	**Constant**	**estimate**	**s.e.**	**t**	**p**	
all ages	*479*	-73.8	0.036	0.015	2.33	**0.020**	+
adults	*242*	-54.4	0.026	0.024	1.08	0.282	
non adults	*234*	-107.8	0.053	0.020	2.67	**0.008**	++
ALL PLASTICS COMBINED (lnGPLA)	***n***	**Constant**	**estimate**	**s.e.**	**t**	**p**	
all ages	*479*	8.9	-0.006	0.015	-0.38	0.704	
adults	*242*	-15.7	0.007	0.023	0.29	0.775	
non adults	*234*	2.1	-0.002	0.018	-0.11	0.914	
SUPECTED CHEMICALS (lnGCHE)	***n***	**Constant**	**estimate**	**s.e.**	**t**	**p**	
all ages	*479*	-60	0.027	0.020	1.39	0.165	
adults	*242*	-72.7	0.034	0.032	1.04	0.301	
non adults	*234*	-38.5	0.016	0.024	0.67	0.501	

RECENT TRENDS (1996-2003)
in marine litter indicators, The Netherlands

INDUSTRIAL PLASTIC (lnGIND)	*n*	Constant	estimate	s.e.	t	p	
all ages	*407*	179	-0.091	0.058	-1.57	0.118	
adults	*212*	10	-0.007	0.086	-0.08	0.933	
non adults	*193*	295	-0.150	0.077	-1.94	0.053	
USER PLASTICS (lnGUSE)	***n***	**Constant**	**estimate**	**s.e.**	**t**	**p**	
all ages	*407*	255.8	-0.129	0.048	-2.71	**0.007**	- -
adults	*212*	270	-0.136	0.073	-1.88	0.062	
non adults	*193*	201	-0.102	0.060	-1.68	0.094	
ALL PLASTICS COMBINED (lnGPLA)	***n***	**Constant**	**estimate**	**s.e.**	**t**	**p**	
all ages	*407*	245.4	-0.124	0.046	-2.71	**0.007**	- -
adults	*212*	196	-0.099	0.071	-1.41	0.160	
non adults	*193*	245	-0.123	0.056	-2.21	**0.028**	-
SUPECTED CHEMICALS (lnGCHE)	***n***	**Constant**	**estimate**	**s.e.**	**t**	**p**	
all ages	*407*	143	-0.075	0.065	-1.14	0.253	
adults	*212*	213	-0.109	0.101	-1.08	0.281	
non adults	*193*	106	-0.056	0.083	-0.68	0.500	

Fig 1.

MONITORING TOOL MARINE LITTER NETHERLANDS
Stomach contents of Northern Fulmar *Fulmarus glacialis*
(beachwashed birds)

INDICATOR 1 INDUSTRIAL PLASTICS

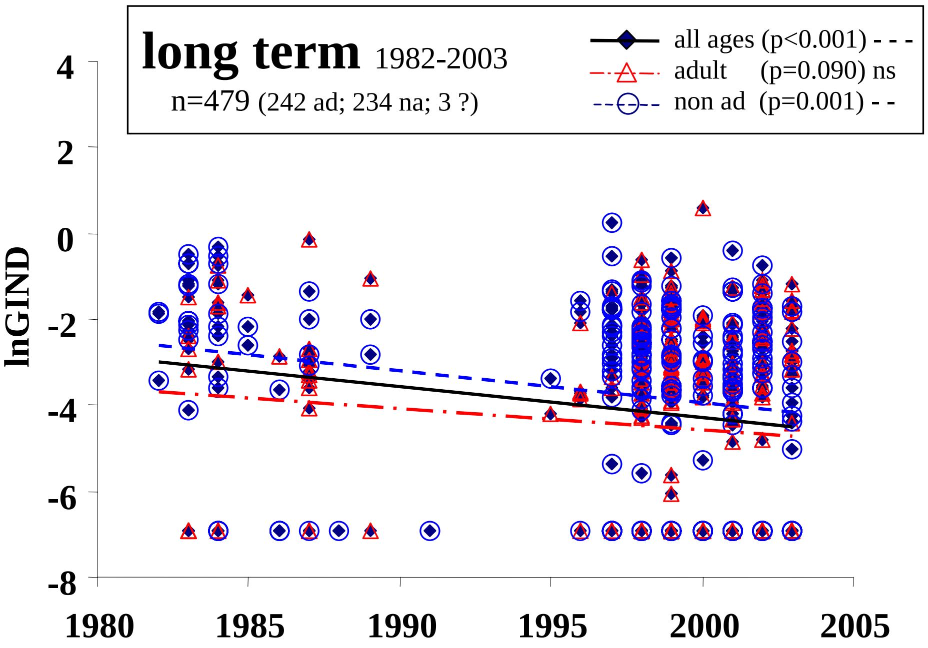
TRENDS 1982-2003, THE NETHERLANDS

indicator:	Industrial plastics present in proventriculus and gizzard
units	mass per bird (total mass of industrial plastics per bird in grams)
trend calculation	linear regression analysis of ln tranformed mass data fitted on year
litter sources	commercial shipping very likely (*poor packaging; deck and hold cleaning*); land-based likely (*loss at factories*)
area:	Southern North Sea, offshore environment
basic data:	1982-2003, mainly early-mid 1980's and 1996-2003
reference:	pre-pollution era: zero industrial plastics
developments	**Long-term decrease** 1982-2003 highly significant ($p<0.001$) **Short-term** decrease 1996-2003 not significant
current situation	mean ± standard deviation over last 5 years (n=5; 294 birds): incidence 60 ± 6%; nr of items 3.3±0.9; mass 0.07±0.02g

Discussion
The long-term and recent decreases reported in the previous assessment have continued. However, the short term decrease has lost significance, indicating that the rate of reduction is slowing down. The gradual disappearance of these hard plastic granules from the marine environment is remarkable. Wear and degradation are likely very low, and expected was a gradual increase through accumulation even in case of reduced input. The trends indicate a combined effect of reduced inputs and of unexpected pathways of disappearance (in which ingestion by birds may play a role).

Fulmar - Litter - EcoQO
The Netherlands

INDUSTRIAL PLASTICS



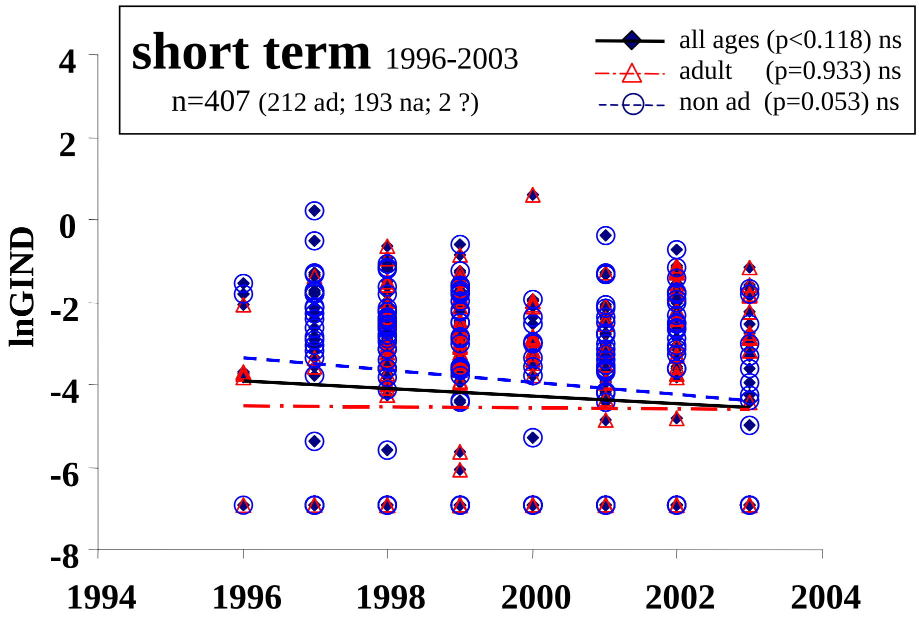


Fig. 2.

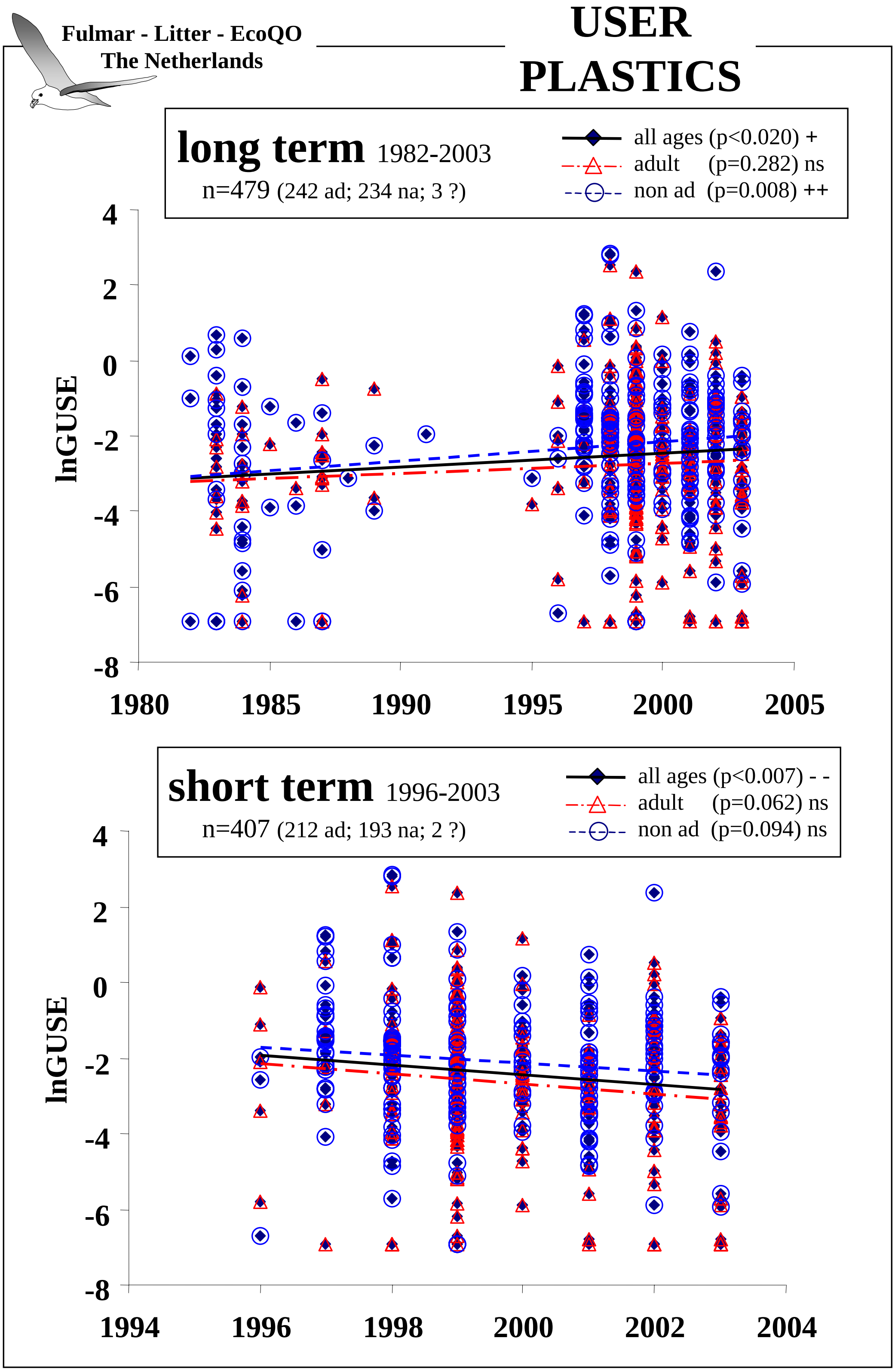
MONITORING TOOL MARINE LITTER NETHERLANDS
Stomach contents of Northern Fulmar *Fulmarus glacialis* (beachwashed birds)

INDICATOR 2 USER PLASTICS

TRENDS 1982-2003, THE NETHERLANDS

indicator:	all non-industrial plastics present in proventriculus and gizzard
units	mass per bird (total mass of user plastics per bird in grams)
trend calculation	linear regression analysis of ln tranformed mass data fitted on year
litter sources	commercial shipping and fisheries very likely; (household and operational cargo and equipment wastes) coastal recreation, land-based and offshore industry possible
area:	Southern North Sea, offshore environment
basic data:	1982-2003, mainly early-mid 1980's and 1996-2003
reference:	pre-pollution era: zero user plastics
developments	**Long-term increase** 1982-2003 significant ($p=0.020$) **Short-term decrease** 1996-2003 significant ($p=0.007$)
current situation	mean ± standard deviation over last 5 years ($n=5$; 294 birds): incidence 96 ± 3%; nr of items 28.8±11.5; mass 0.27±0.12g

Discussion
The more recent decrease of user plastics has been variable but overall continued in 2002 and 2003, resulting in a significant decrease in user plastics over the period 1996-2003. Current levels of user plastics are coming closer to values observed in the 1980's Because of that, the long term trend of increase is loosing some of its earlier significance. The current information suggests that peak pollution with user plastics was reached in the period 1997-99 with subsequent improvement.



Fulmar - Litter - EcoQO
The Netherlands
USER PLASTICS
long term 1982-2003
n=479 (242 ad; 234 na; 3 ?)
all ages (p<0.020) +
adult (p=0.282) ns
non ad (p=0.008) ++
lnGUSE
4
2
0
-2
-4
-6
-8
1980
1985
1990
1995
2000
2005
short term 1996-2003
n=407 (212 ad; 193 na; 2 ?)
all ages (p<0.007) - -
adult (p=0.062) ns
non ad (p=0.094) ns
lnGUSE
4
2
0
-2
-4
-6
-8
1994
1996
1998
2000
2002
2004

Fig. 3

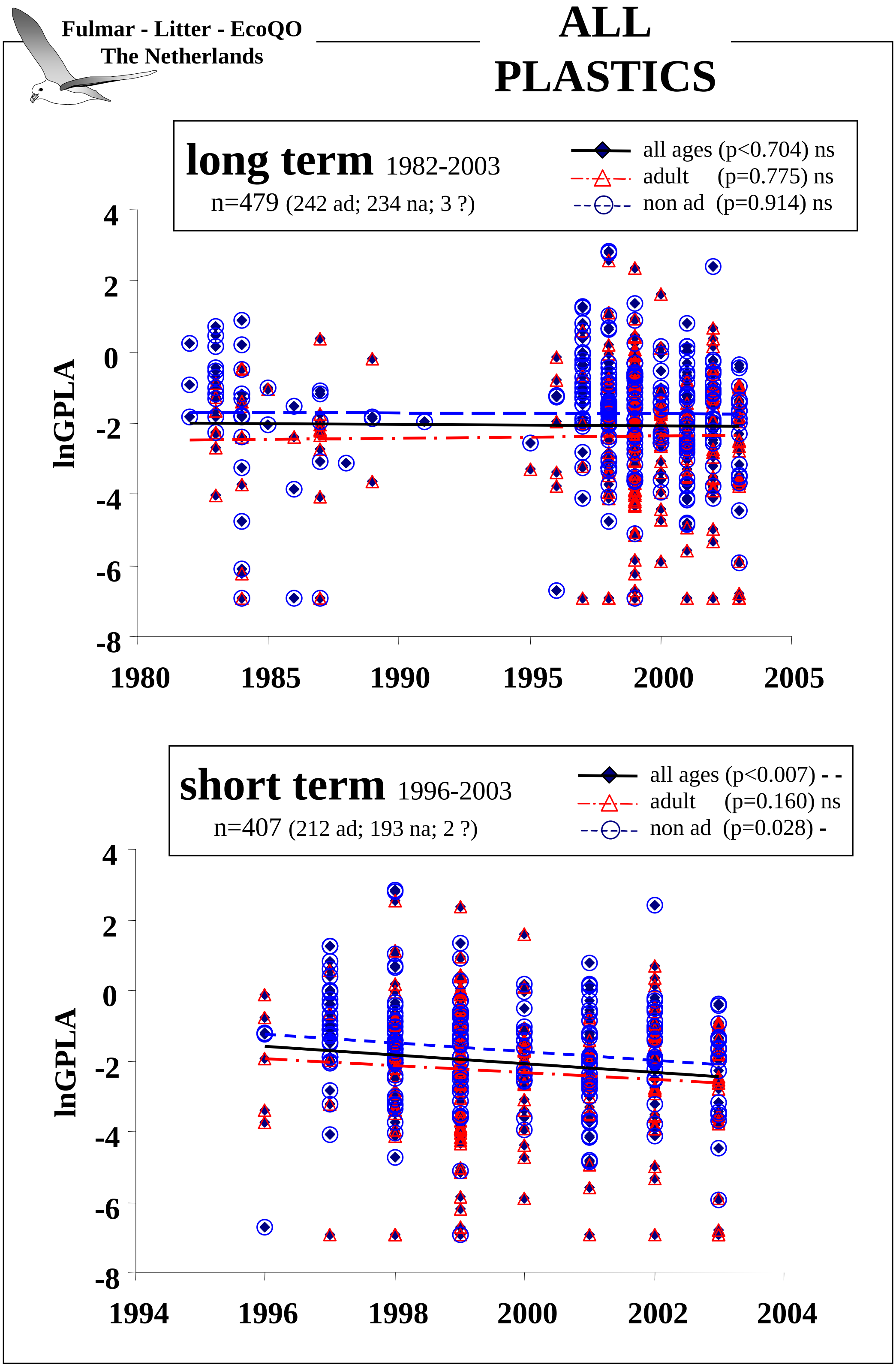
MONITORING TOOL MARINE LITTER NETHERLANDS
Stomach contents of Northern Fulmar *Fulmarus glacialis*
(beachwashed birds)

INDICATOR 1+2 ALL PLASTICS COMBINED

TRENDS 1982-2003, THE NETHERLANDS

indicator:	all plastics present in proventriculus and gizzard
units	mass per bird (total mass of user plastics per bird in grams)
trend calculation	linear regression analysis of ln tranformed mass data fitted on year
litter sources	commercial shipping and fisheries very likely; coastal recreation, land-based and offshore industry possible
area:	Southern North Sea, offshore environment
basic data:	1982-2003, mainly early-mid 1980's and 1996-2003
reference:	pre-pollution era: zero plastics
developments	**Long-term no trend** 1982-2003 no significant linear change **Short-term decrease** 1996-2003 significant ($p<0.007$)
current situation	mean ± standard deviation over last 5 years (n=5; 294 birds): incidence 98 ± 2%; nr of items 32.1±12.2; mass 0.34±0.14g *EcoQO North Sea tentative target: "less than 2% of Fulmars having more than 10 pieces of plastic"*. Currently 56% of birds exceeds the criterion of 10 pieces of plastic.

Discussion
Due to the opposite trends in abundance of industrial and user plastics on the long term, there is no significant trend in the long-term abundance of plastics in the birds stomachs. However, more recently, both types appear to be declining as marine litter, resulting in a significant decline of all plastics combined since 1996. If trends remain similar one could reconsider the original preliminary EcoQO proposed in OSPAR which did not distinguish between litter types. Evidently, this would simplify presentation of information to general public and policy-makers, but at the background the different categories with their different sources would need to be investigated continuously.



Fulmar - Litter - EcoQO
The Netherlands
ALL PLASTICS
long term 1982-2003
n=479 (242 ad; 234 na; 3 ?)
all ages (p<0.704) ns
adult (p=0.775) ns
non ad (p=0.914) ns
lnGPLA
4
2
0
-2
-4
-6
-8
1980
1985
1990
1995
2000
2005
short term 1996-2003
n=407 (212 ad; 193 na; 2 ?)
all ages (p<0.007) - -
adult (p=0.160) ns
non ad (p=0.028) -
lnGPLA
4
2
0
-2
-4
-6
-8
1994
1996
1998
2000
2002
2004

Fig.4.

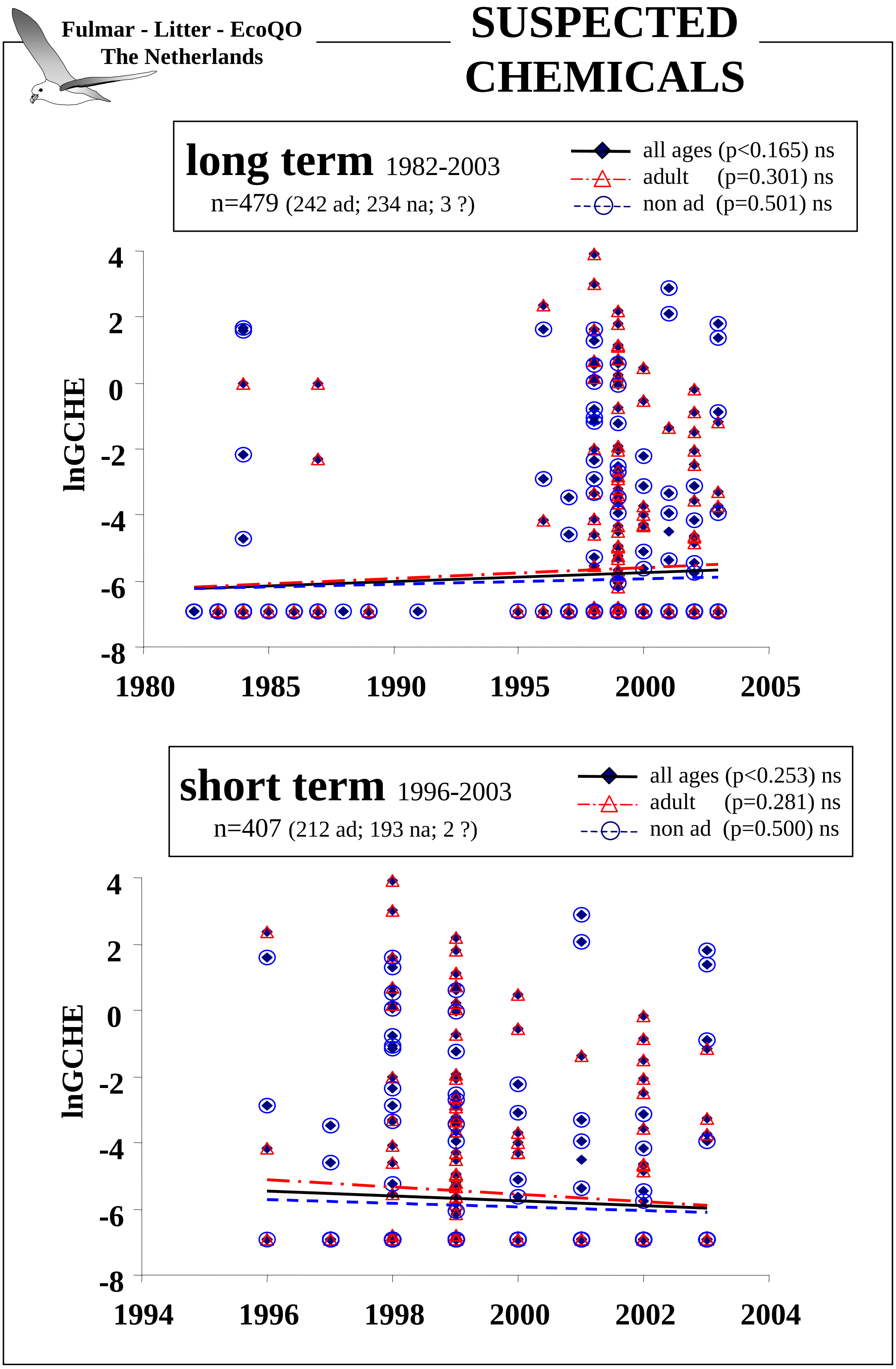
MONITORING TOOL MARINE LITTER NETHERLANDS
Stomach contents of Northern Fulmar *Fulmarus glacialis*
(beachwashed birds)

INDICATOR 3 "CHEMICALS" (suspected chemical substances)

TRENDS 1982-2003, THE NETHERLANDS

indicator:	chemical-like substances present in proventriculus and gizzard
units	mass per bird (total mass of chemical substance per bird in grams)
trend calculation	linear regression analysis of ln tranformed mass data fitted on year
litter source	commercial shipping most likely (tank washing and possibly fuel residues)
area:	Southern North Sea, offshore environment
basic data:	1982-2003, mainly early-mid 1980's and 1996-2003
reference:	pre-pollution era: zero chemicals
developments	**Long term no trend** 1982-2003 increase no longer significant. **Short term no trend** 1996-2003 possibly declining, not significant.
current situation	mean ± standard deviation over last 5 years (n=5; 294 birds): incidence 24 ± 7%; nr of items 2.0±1.2; mass 0.81±0.95g

Discussion
Although the current situation seems slightly improved as compared to the late 1990's, no significant trends are present in either long-term or short-term datasets. Nevertheless it is of concern that approximately 25% of beachwashed Fulmars has suspect substances in the stomach. These substances are mostly fairly soft to fluid and are probably quickly digested. Although it is often suggested that such substances are relatively harmless at ingestion (paraffine, animal or vegetable oil, ….) some incidents on beaches have shown that toxic substances may be involved. Chemical analyses of substances found in bird stomachs is urgently required to assess their characteristics, and could serve as an important indicator of compliance with MARPOL Annex II procedures. Separate funding for such analyses is required.


Fulmar - Litter - EcoQO
The Netherlands
SUSPECTED CHEMICALS
long term 1982-2003
n=479 (242 ad; 234 na; 3 ?)
all ages (p<0.165) ns
adult (p=0.301) ns
non ad (p=0.501) ns
lnGCHE
4
2
0
-2
-4
-6
-8
1980
1985
1990
1995
2000
2005
short term 1996-2003
n=407 (212 ad; 193 na; 2 ?)
all ages (p<0.253) ns
adult (p=0.281) ns
non ad (p=0.500) ns
lnGCHE
4
2
0
-2
-4
-6
-8
1994
1996
1998
2000
2002
2004

Fulmar-Litter indicators 1982 - 2003
Netherlands *summary of results*

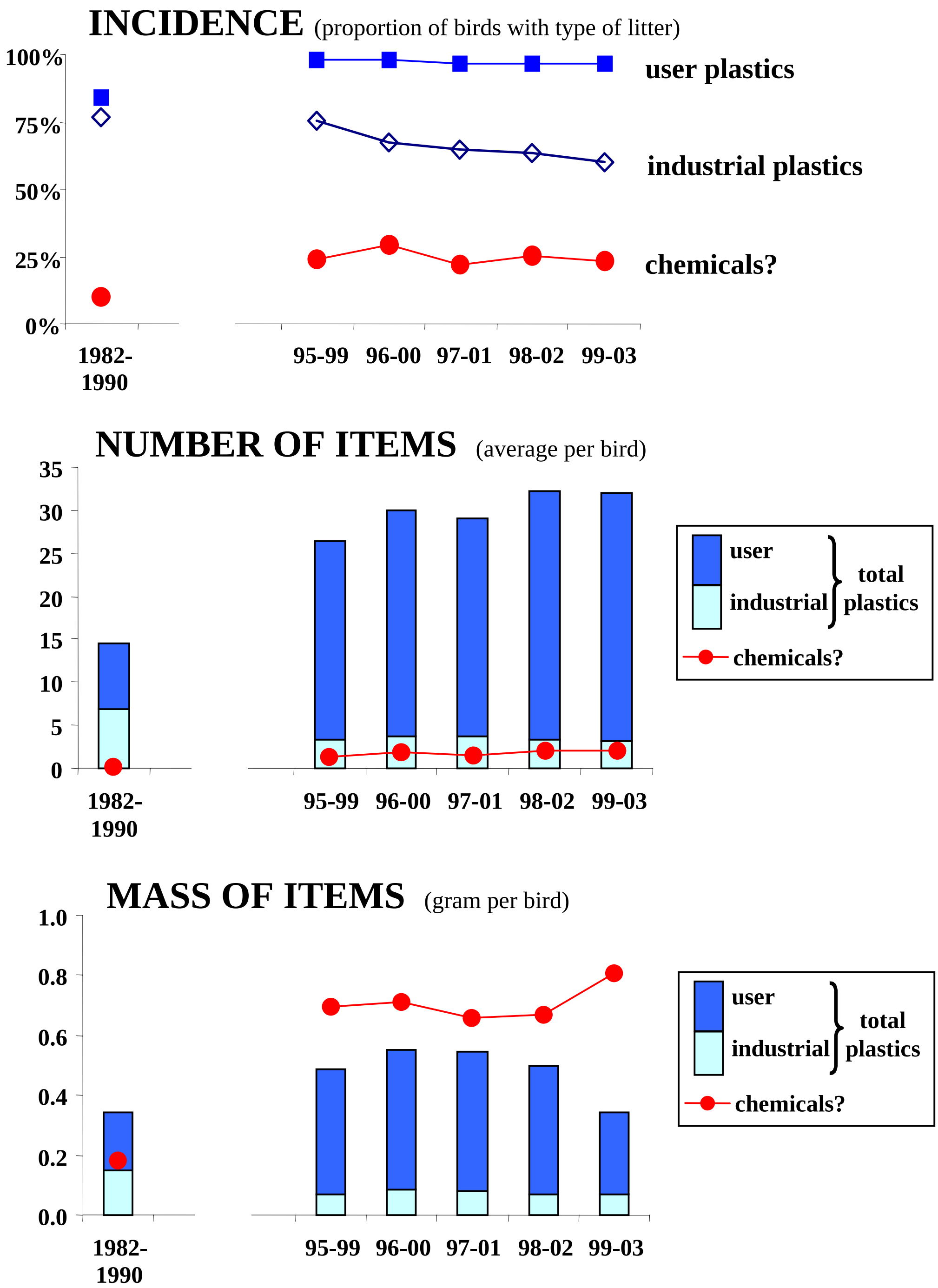


Fig. 5. Visual summary of Fulmar-litter monitoring results in the Netherlands, comparing average data for the 1980's with running 5-year averages for the recent period.

4 Discussion

4.1 Trends in Fulmar-Litter-EcoQO

The level of detail in tables and graphs in the result section is required for proper statistical analysis, but may obscure an overall impression of the monitoring results. Therefore, Fig.5 presents a summarized visualization of all information. Statistical trends in the Fulmar-Litter-EcoQO are based on mass of pollutants in stomachs of individual birds. Fig.5 summarizes all data for incidence, number of items and mass of items, by comparing averages of the 1980's to running 5-year averages for the more recent period in which annually good sample sizes were studied. By using 5 year averages, variations between years are smoothed, which enhances visualization of trends.

Conclusions from analyses of data on mass are confirmed by data on incidence, but not by data on number of items (Fig.5): in comparison to the 1980's the character of user plastics has shifted towards smaller pieces, and this seems to continue in recent years. Possibly this reflects a shift in type and character of commonly used plastics, but usage of waste grinders may also play a role (see below). In the pilot study (Van Franeker & Meijboom 2002) it was decided to use mass data for monitoring as this is the more relevant parameter in terms of input of litter in the marine environment, and also the more relevant one in terms of ecological impact in effects on e.g. Fulmars. In the recent situation (average over 5 last years; 294 birds) 98% of Dutch Fulmars has plastics in the stomach, with an average number of 32 pieces and average mass of 0.34 gram per bird (Fig's. 3 and 5).

The conclusion from (mass)indicators is that in recent years the plastic litter situation in the southern North Sea tends to return to levels similar to those during the early and mid 1980's, after peak litter abundance in the years 1997-99. Within this overall pattern there are different trends for different types of plastic. Industrial plastics have shown a steady decrease throughout, although recent data suggest that the rate of decline is slowing down. User plastics initially showed a sharp increase but after the late 1990's this trend has reversed. Calculations in the pilot study indicated that 4 to 8 years of data are needed for reliable conclusions. Since recent trends can now be analysed from an unbroken time series since 1996, confidence may be given to the reality of the observed decrease in user plastics in recent years. But it should be emphasized that quantities of user plastics are still considerably higher than in the early 1980's. In overall figures this is masked by the reduction in industrial plastic. This shift in relative abundance of different types of plastic is probably not limited to the North Sea but may occur worldwide. Vlietstra & Parga (2002) obtained very similar results in the north Pacific area. Stomach contents of Short-tailed shearwaters (*Puffinus tenuirostris*) showed a change in type of plastic, but not in overall quantity.
Abundance of suspected chemical substances in Fulmar stomachs, after the initial jump between 1980's and late 1990's does not show a clear trend. Roughly 25% of Dutch beachwased Fulmars has such substances in the stomach. Since it is likely that

such substances quickly disappear into the gut, the observed frequency of occurrence suggests high rates of ingestion.

Target levels for a Fulmar-Litter-EcoQO have only been formulated in a very preliminary sense by OSPAR (see Van Franeker and Meijboom 2003; see texts with fig.3). Current levels for Fulmars from the Netherlands are far above such targets: 56% of the Fulmars collected in the last 5 years have more than 10 plastic items in the stomach whereas the preliminary EcoQO target aims this percentage to be below 2% of the birds. The final Save the North Sea report will discuss options for OSPAR target levels.

4.2 Trends in relation to measures for ship generated wastes

The observed changes in Fulmar stomach contents from the southern North Sea do not directly correlate with major policy measures in relation to garbage from ships. The start of MARPOL's garbage Annex V was in 1988 and the North Sea was declared a Special Area under this annex in 1991.

Abundance of industrial granules has consistently decreased from the start of our time series early 1980's. Such decrease is most likely related to ongoing improvements in procedures in factories and waste-water systems and to the increased container-transport replacing loose bags in stowed cargo. To manufacturers and transporters, reduction of losses of industrial plastic granules represents an economic benefit. Measures were likely taken indepedently from changes in shipping regulations.

The gradual reduction of the hard industrial plastic granules from the marine environment is remarkable. Wear and degradation were anticipated to be low, and led to a pessimistic view in which, even in case of reduced inputs, accumulation in the marine environment would continue. The trends indicate combined effects of reduced inputs and of unexpected pathways of disappearance. Possibly large quantities become buried in coastal soils. However, considering the rates in which birds consume these items, wear and degradation in bird digestive tracts may be a realistic explanation for their reduced abundance in the marine environment. Unfortunately this is a largely cosmetic effect, because the plastic does not disappear but is merely reduced to a smaller, less conspicuous size of fragments that can still affect marine organisms (Thompson *et al.* 2004).

The economic benefit of reducing losses does not apply to user plastics or other garbage. Household type or cargo related wastes on ships represent a cost factor in terms of handling effort, stowage space and fees charged for disposal ashore. Disposal at sea was simply the cheaper option, only counteracted by the (low) risk of being caught and fined for violations. This cost factor did not change significantly with the entry into force of MARPOL Annex V (1988) or the designation of the North Sea as a 'Special Area' (1991) under this annex. Our time series of Fulmars has inadequate coverage in this specific time period to observe direct effects. But we do know that these measures did not prevent a sharp and higly significant increase of user plastics in Fulmar stomach from the 1980's to the 1990's. User plastics in Fulmar stomachs averaged at 7.8 items (0.19g) in the 1980's and increased to 27.6 items (0.52g) in the 1990's (Van Franeker & Meijboom 2002: table 4). These figures do not evidence that the MARPOL regulations had no effect at all. Sharp increases in shipping transport and in utilization of plastic materials have occurred over this time period. Maybe MARPOL regulations have contributed to prevent the situation from being even worse. But the ultimate goal of MARPOL Annex V regulations, a reduction in the amount of litter in the marine environment, has not been accomplished.

The recent (1996-2003) decrease in user plastics in stomachs of Fulmars appears to be unrelated to a major change in policies for shipping. The downward trend started before the date of implementation of the EU Directive on Port Reception Facilities in December 2002. Actual implementation was even later, e.g. on 15 October 2004 in the port of Rotterdam. In that sense, the recent data from this report should be considered as the starting point by which to measure effects intended by the EU Directive.

4.3 Trends in coastal litter surveys

Currently, there is only limited information for a comparison with Fulmar litter monitoring results. In the Netherlands the North Sea Foundation co-ordinates annual Coastwatch surveys, with standardized procedures since 1996. Annual averages for number of beachwashed litter items were published in Coastwatch reports (e.g. Stichting De Noordzee 2003). Plastics typically represent ± 60 to 70% of the litter items encountered in beach surveys. For the composition of Fig.6 below, the North Sea Foundation has kindly provided information to update their latest published graph with data for 2003. At first sight, annual averages suggest a pattern of higher values in the late 1990's and variable but somewhat lower figures in the following years, thus not unlike the pattern 1996-2003 for plastics in Fulmar stomachs (cf table 3).

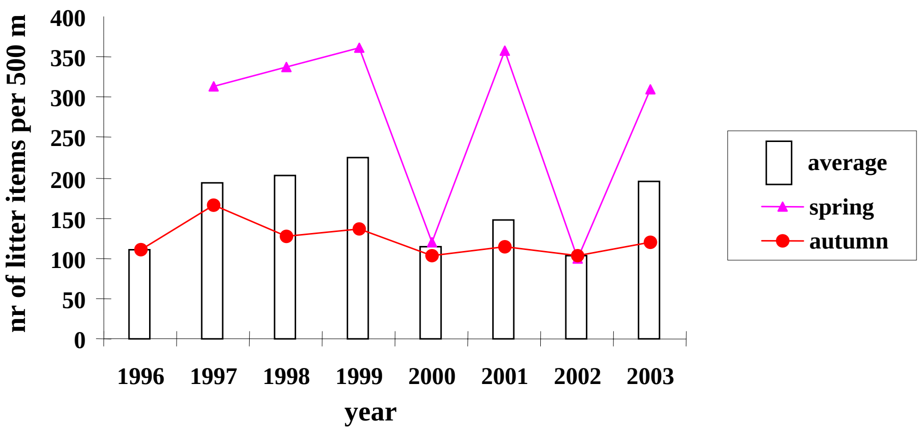


Fig.6. Trends in number of litter items in the Netherlands as found in Coastwatch surveys (Data courtesy North Sea Foundation).

However, Stichting de Noordzee (2003) cautioned against a firm conclusion on decreasing numbers of litter items on the Dutch beaches: the annual averages from Coastwatch were influenced by variable proportions of counts in different areas and different seasons. Even nearby locations may have a very different character in the amount and type of litter found on the beach. Counts in spring usually result in much higher litter densities than those conducted in autumn. To illustrate this, the averages for spring and autumn litter numbers have been added to Fig.6. Under- or overrepresentation of different locations or seasons may strongly affect the annual totals. A linear regression test of the annual averages indicates that there is no significant trend.

Beach litter surveys have also been conducted on several North Sea beaches in Germany, some of them by standard procedures since 1992 (Fleet 2003). However, like in the Netherlands, a integrated interpretation of the combined results is complicated. Similar problems occur of variability in survey-effort (years/seasons/locations) in combination with strongly different amounts and types of litter washing up the beach at different locations. Fleet (2003) therefore made a block diagram of statistical test results for changes over time (max. period 1992-2002) for each location and litter category separately (Fig.7). Although the majority of tests showed no significant trend, a considerable proportion suggested decreases over the past decade for various categories of marine litter. However, no trends were observed in tests for for plastics (one positive, one negative, remainder no trend) and not for fishery items (no trend all locations). The Fulmar-Litter-EcoQ for the Netherlands suggests that also some decrease in plastic litter has occurred, at least in quantities floating around in the marine enviroment.

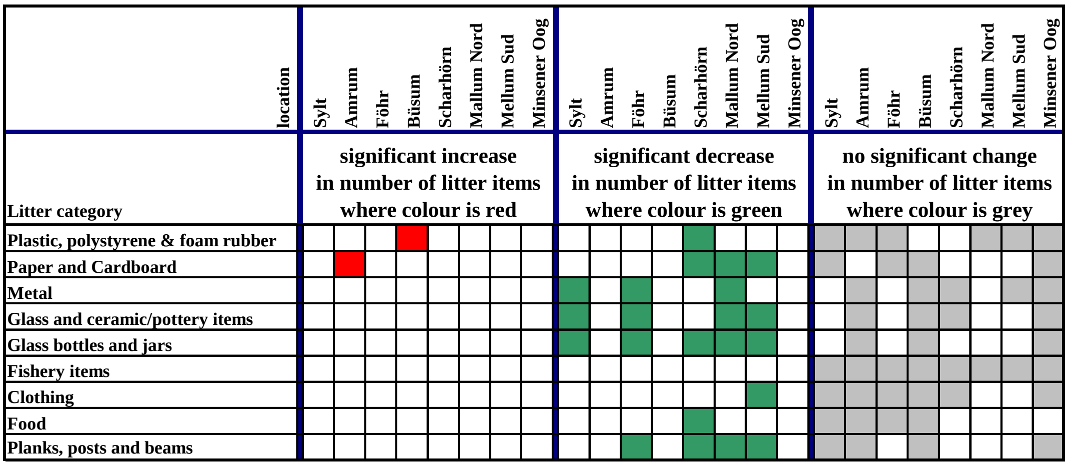


Fig. 7. Marine litter trends on German survey sites (modified from table 15 in Fleet 2003). Summary of the results of Spearman rank correlation tests on time related trends in the number of litter items . A test was conducted for each combination of litter-category and location.

OSPAR has initiated an international Pilot Project on Monitoring Beach Litter (2002-2006). Beachwashed litter is recorded by detailed international standard methods developed in the project. Consistency in survey effort (seasons, frequencies and locations) is an important element of the OSPAR project in order to allow integrated analysis for trends. The different characteristics of even nearby beaches reflect influences from exposure, coastal shape and beach type, wind, currents, irregular clean-ups, nearby coastal activities etc. Such variability will remain difficult, but the approach in the OSPAR pilot project is a major step ahead in making coastal litter surveys suitable for statistical trend analysis. The strength of beach monitoring is that it provides information on trends in different types of litter and their sources. As discussed in the initial chapters, it is the beach surveys that provide evidence for the currently major role of commercial shipping and fisheries in the marine litter problem in the North Sea. Also, beach litter monitoring places the litter problem in an context of economical damage to e.g. coastal communities. The Fulmar-Litter monitoring is less strong on 'sourcing' and focuses on small sized plastic as the main exponent of the marine litter problem.. But the strong point of Fulmar monitoring is that it integrates over time and space and is less disturbed by local coastal variations. This makes it more senstitive to detect trends in litter in the offshore marine environment, and at the same time places these trends in the context of ecological effects of marine litter. With regard to shipping a third potential monitoring tool could be the statistics of the quantities of waste delivered by ships to Port Reception Facilities. Such data can measure relative changes in the level of compliance by the shipping sector, but cannot provide insight in residual quantities disposed of at sea, nor the input from other sources. The different monitoring tools are thus complementary, each having specific merits that may be key-worded as:

- Fulmar-Litter-EcoQO monitoring - sensitive measuring of trends in litter levels in the offshore marine environment in an ecological context
- OSPAR Beach litter monitoring - measuring trends in quantities, types and sources of larger litter (including coastal) in an economical context
- Port Reception monitoring - measuring relative change in compliance with regulations by the shipping sector.

For the current situation, the significant recent decrease in user-plastics evidenced by the Fulmar-Litter EcoQO is partially supported by results from beach litter surveys, although the evidence is not conclusive.

4.4 Fulmars and shipping

As indicated above, for most litter items found in Fulmar stomachs, it is difficult to trace the source of the pollution. Items are usually fragmented without clues to a particular marine or landbased source. Indirectly however, other items found in stomachs do confirm the involvement of shipping (or better marine sources, so including fisheries and offshore).

- In 12% of Fulmar stomachs (mean over last 5 years) rubbish items other than plastic are encountered, such as paper, aluminium foil, foodwastes, manufactured wood etc. In 6% these are human foodwastes such as beans, cabbage, tomato remains, onions etc. Regularly these are of a freshness unlikely to originate from land, but rather indicate consumption of galley wastes shortly after their disposal from ships. The same goes for fragments of paper or tissue that would have a short life-span at sea and are unlikely to originate from shore.
- With increasing frequency we encounter stomach samples that contain a mud of unidentifiable food with up to many hundreds of tiny pieces of user plastic. In our

opinion such samples originate from foodwaste grinders as used in ship galleys. However, in stead of just food, a mix of galley wastes and plastics has been chopped up. The resulting pulp, if discarded, will be attractive to seabirds. Observations of improper use of foodgrinders on cruise-liners was reported on the marine mammal network (Breen 2002).

- About one in four Fulmars from the Dutch coast (24%; mean last 5 years) has substances in the stomach that are listed as 'suspected chemical'. Mostly these are paraffine like lumps but also sticky muds of various colours are encountered. These materials, also encountered on beaches, almost certainly are residues from tankers washing their holds en route at sea. Possibly, but unknown, these are legal discharges under MARPOL Annex II. Because of their semi-solid character such items are treated as 'marine litter' in the Fulmar-litter-EcoQO for which shipping is a certain source. Future trends in this category of marine litter will however not be influenced by the implementation of the EU Directive on Port Reception Facilities because most or all of the discharges involved are regulated under MARPOL Annex II (bulk transport liquid chemicals).

4.5 Major points and conclusions

- Although origins of wastes are hard to identify, there is no doubt that shipping, including fisheries, is among the major contributors of marine litter in the North Sea and on Dutch coasts.

- Marine litter causes economical damage, which in the North Sea may exceed one billion Euro per year (Hall 2000; pers.inf.) .

- Marine litter causes major ecological damage because entanglement and ingestion result in direct and indirect mortality among a wide range of marine organisms.

- MARPOL policies with regards to marine litter in Annex V (garbage; 1988) and the designation of the North Sea as a Special Area under this annex (1991) did not result in noticeable change.

- The European Commission and Parliament therefore decided to take regional measures by the "Directive on Port Reception Facilities for ship generated waste and cargo residues (Directive 2000/59/EC)". Obligatory waste disposal and (partial) indirect financing of reception facilities are key elements to promote and enforce disposal of ship wastes to shore. Implementation of the Directive was scheduled for December 2002, but has suffered delay in the Netherlands until mid 2004.

- In the Netherlands, a monitoring tool has been developed to measure marine litter by the abundance of plastics in stomachs of beachwashed Fulmars. This monitoring instrument was fully evaluated in a pilot study using data over the period 1982-2000 (Van Franeker & Meijboom 2002). Internationally, North Sea

Ministers have asked OSPAR to develop this tool as one of the Ecological Quality Objectives (Fulmar-Litter-EcoQO)

- Related to the implementation of EU Directive 2000/59/EC the Netherlands Ministery of Transport has requested Alterra to update the Dutch Fulmar-Litter-EcoQO to provide a reference value for future change in the marine litter situation.

- The Fulmar Litter database was updated with the years 2002 and 2003. Trends over time were tested on the basis of mass of ingested plastics. Results show that peak plastic pollution levels occurred in the late 1990's but are decreasing since then. The initially upward, and currently downward trend in plastic pollution is caused by changes in quantities of user plastics. Recent levels for all plastics combined are returning to levels like in the 1980's. However, the composition has changed, with a continuously decreasing contribution of industrial plastics being replaced by a higher component of user plastic. Trends from coastal litter surveys are inconclusive but tend to support a moderate downward trend.

- Fulmar monitoring data thus confirm that MARPOL Annex V regulations did not prevent an increasing amount of plastic in the marine environment.

- The current level of plastic pollution, and reference point for future effects of the EU Directive, is that 98% of Fulmars has one or more pieces of plastic in the stomach, the average level being 32 pieces or 0.34 gram per bird (mean over last 5 years; 294 birds). Among these birds, 56% has more than 10 pieces of plastic in the stomach whereas a tentative EcoQO target formulated by OSPAR aims for less than 2%.

- Paraffine-like, and other semi-solid substances listed as 'suspected chemicals' occur in 25% of Fulmar stomachs. Similar substances are frequently found on beaches and almost certainly originate from tanker washing at sea. Although not regulated by MARPOL Annex V or the EU Directive, these substances are considered as marine litter and require closer attention.

5 Acknowledgements

Beachwashed Fulmars for this study were collected by volunteers of the Dutch Beached Bird Survey (NSO) of the Dutch Seabird Group (NZG) and by several seabird rehabilitation centers in the Netherlands. In several stages of this long term project, the dissection work, data analysis and writing of reports has been financially supported by the Netherlands Ministry of Transport, Public Works and Water Management (VenW). Internationally the Fulmar project co-operates in the Save the North Sea project, supported by the EU Interreg IIIB program for the North Sea. Unpublished nformation on coastal litter surveys in the Netherlands was made available by the North Sea Foundation. Information on German litter surveys was provided by the Landesamt fuer den Nationalpark Schleswig-Holsteinisches Wattenmeer. Co-ordinators of the OSPAR Pilot Project on Monitoring Beach Litter kindly commented on relevant parts of this report.

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