



Background Document for
Ocean quahog *arctica islandica*



OSPAR Convention

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

Convention OSPAR

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

Acknowledgement

This report has been prepared by the Coastal and Marine Nature Conservation Unit of the German Federal Agency for Nature Conservation (BfN) with the support of Dr. Eike Rachor

Photo acknowledgement:

Cover page: Ocean Quahog©EcoMare

Contents

OSPAR Background Document for Ocean quahog - <i>Arctica islandica</i>	4
Executive Summary	4
Récapitulatif	4
1. Background Information	5
2. Original Evaluation against the Texel-Faial Selection Criteria	5
OSPAR Regions and Dinter Biogeographic Provinces where the species occurs	5
OSPAR Regions and Dinter Biogeographic Provinces where the species is under threat and/or in decline	6
Original Evaluation against the Texel-Faial Criteria for which the species was included on the OSPAR List	6
3. Current Status of the Species	7
Distribution in the OSPAR Maritime Area	7
Population (current/trends/future prospects)	8
Condition (current/trends/future prospects)	10
Limitations in knowledge	10
4. Evaluation of Threats and Impacts	11
Threat and link to human activities	11
5. Existing Management Measures	11
6. Conclusion on Overall Status	11
7. Action to be taken by OSPAR	12
Action/Measures that OSPAR could take, subject to OSPAR agreement	12
Summary of the proposed Monitoring System	12
Annex 1: Overview of Data and Information provided by Contracting Parties (CPs)	13
Annex 2: Description of the proposed Monitoring and Assessment Strategy	14
Rationale for the proposed Monitoring	14
Use of existing Monitoring Programmes	14
Synergies with Monitoring of other Species or Habitats	14
Assessment Criteria	14
Monitoring Techniques/Approaches	15
Selection of Monitoring Locations	16
Timing and Frequency of Monitoring	16
Data Collection and Reporting	16
Quality Assurance	17
Annex 3: References	18

OSPAR Background Document for Ocean quahog - *Arctica islandica*

Executive Summary

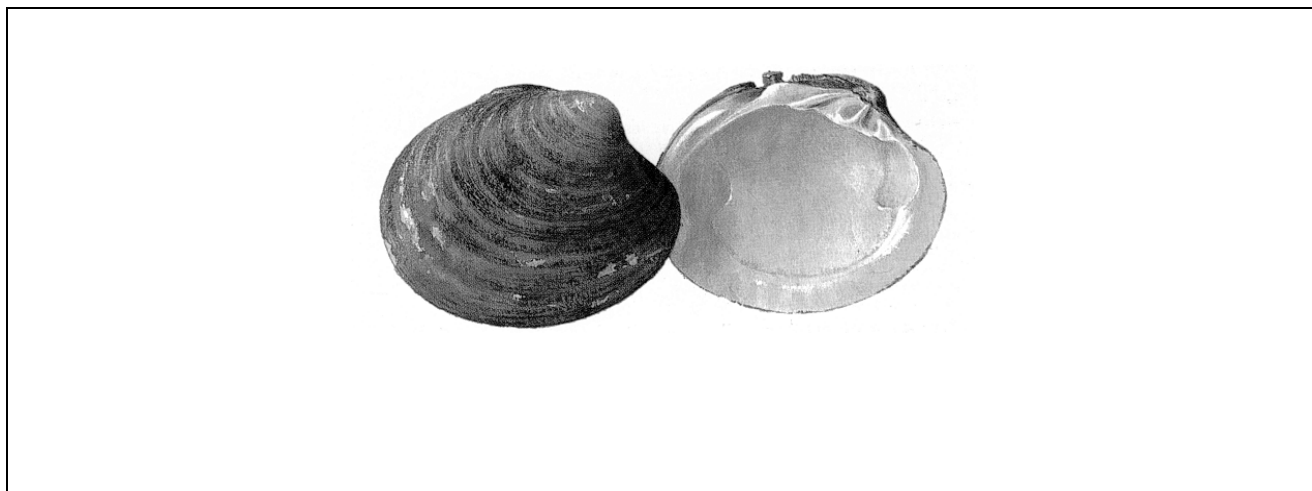
This Background Document for Ocean quahog – *Arctica islandica* -has been developed by OSPAR following the inclusion of this species on the OSPAR List of threatened and/or declining species and habitats (OSPAR Agreement 2008-6). The document provides a compilation of the reviews and assessments that have been prepared concerning this species since the agreement to include it in the OSPAR List in 2003. The original evaluation used to justify the inclusion of *Arctica islandica* in the OSPAR List is followed by an assessment of the most recent information on its status (distribution, population, condition) and key threats prepared during 2009-2010. Chapter 7 provides proposals for the actions and measures that could be taken to improve the conservation status of the species. In agreeing to the publication of this document, Contracting Parties have indicated the need to further review these proposals. Publication of this background document does not, therefore, imply any formal endorsement of these proposals by the OSPAR Commission. On the basis of the further review of these proposals, OSPAR will continue its work to ensure the protection of *Arctica islandica*, where necessary in cooperation with other competent organisations. This background document may be updated to reflect further developments or further information on the status of the species which becomes available.

Récapitulatif

Le présent document de fond sur la *Cyprine d'Islande* a été élaboré par OSPAR à la suite de l'inclusion de cette espèce dans la liste OSPAR des espèces et habitats menacés et/ou en déclin (Accord OSPAR 2008-6). Ce document comporte une compilation des revues et des évaluations concernant cette espèce qui ont été préparées depuis qu'il a été convenu de l'inclure dans la Liste OSPAR en 2003. L'évaluation d'origine permettant de justifier l'inclusion de la *Cyprine d'Islande* dans la Liste OSPAR est suivie d'une évaluation des informations les plus récentes sur son statut (distribution, population, condition) et des menaces clés, préparée en 2009-2010. Le chapitre 7 fournit des propositions d'actions et de mesures qui pourraient être prises afin d'améliorer l'état de conservation de l'espèce. En se mettant d'accord sur la publication de ce document, les Parties contractantes ont indiqué la nécessité de réviser de nouveau ces propositions. La publication de ce document ne signifie pas, par conséquent que la Commission OSPAR entérine ces propositions de manière formelle. A partir de la nouvelle révision de ces propositions, OSPAR poursuivra ses travaux afin de s'assurer de la protection de la *Cyprine d'Islande*, le cas échéant avec la coopération d'autres organisations compétentes. Ce document de fond pourra être actualisé pour tenir compte de nouvelles avancées ou de nouvelles informations qui deviendront disponibles sur l'état de l'espèce.

1. Background Information

Arctica islandica (Linnaeus 1767); Ocean quahog; also known as Icelandic cyprine



Arctica islandica is found buried in sandy and muddy sediments from the low intertidal zone down to 400 m. The species occurs on both sides of the North Atlantic and in the Baltic Sea. Within the OSPAR Maritime Area its distribution extends from Iceland and the Faroes to the Bay of Biscay and includes the Irish Sea and North Sea, but not the wider Atlantic area (OSPAR Region V) (Merill & Ropes, 1969). This comprises approximately 60% of its distribution area (AquaSense, 2001).

A. islandica can grow to a length of about 100 mm and a height of about 85 mm. Adults show a high tolerance to oxygen depletion and hydrogen sulphide and are adapted to cold temperate waters. The optimum temperature range for their development seems to be 13 - 15° C (AquaSense, 2001). Spawning takes place from June to October. It is not evident that spawning takes place in the North Sea, but settlement of larvae is very likely for several areas in the North Sea, particularly for the Fladen Ground (Witbaard *et al.*, 2003).

Its southern distribution (North Sea) is limited by about the 30 m depth contour. In the North Sea salinity seems not to be a limiting factor for the distribution of the species (in the Baltic Sea 16 psu). Based on the above information, the Netherlands produced a potential distribution map of *A. islandica* for the Dutch part of the North Sea (AquaSense 2001).

A. islandica is a long-lived species with a very slow growth rate. Populations of 40 - 80 year old specimens with a substantial proportion over 100 years old have been observed. *A. islandica* is among the longest-lived and slowest growing marine bivalves.

2. Original Evaluation against the Texel-Faial Selection Criteria

OSPAR Regions and Dinter Biogeographic Provinces where the species occurs

OSPAR Region: I, II, III, IV

Dinter Biogeographic Province: Lusitanian (Cold/Warm), Lusitanian-boreal, Cold-temperate pelagic waters, Boreal-lusitanian, Boreal, Norwegian Coast (Westnorwegian), Norwegian Coast (Skagerrak), South Iceland - Faroe Shelf

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

OSPAR Region: II

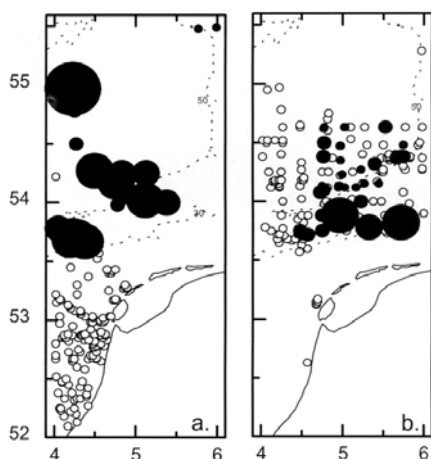
Dinter Biogeographic Provinces: Boreal

Original Evaluation against the Texel-Faial Criteria for which the species was included on the OSPAR List

A. islandica was nominated for inclusion on the OSPAR List with particular reference to decline and sensitivity, with information also provided on threat, and as priority for OSPAR Region II.

Decline: Information on the distribution and density of *A. islandica* in the North Sea reveals significant changes during the last century. A comparison of historic epifauna data from 1902 - 1912 collected during ICES routine cruises in the North Sea, with epifauna data from the ICES-Benthos Survey of 1986, shows that *A. islandica* was present at 45% of the stations sampled in the early part of the century compared to between 20 - 30% of all stations in 1986 (Rumohr *et al.*, 1998). Most of the difference was due to its absence at the shallower sampling stations between 30 - 50 m. There is also information on the density of *A. islandica* in different parts of the North Sea including a detailed study of the south-eastern North Sea suggesting a significant decrease in relative abundance between 1972 - 80 and 1990 - 94 (Figure 1).

Figure 1 A Comparison of Relative Densities of *A. islandica* in the south-eastern North Sea (Fig. 2.2 from Witbaard, 1997).



The size of the circles corresponds to the relative abundance. Hollow circles indicate the absence despite sampling (a) abundance as estimated by Noort *et al.*, (1979 - 1986) between 1972 and 1980, and (b) densities determined from cruises with *RV Aurelia* and *RV Pelagia* between 1990 and 1994.

A study that examined the ecological requirements of *A. islandica* and used these to plot its potential distribution in the Dutch sector of the North Sea, suggested that the species could potentially be more widespread. In particular, it was mainly absent from areas of apparently suitable habitat but where fishing intensity was high (AquaSense, 2001).

Sensitivity: *A. islandica* is a long-lived species with a very slow growth rate. The population structure is often skewed with some locations dominated by juveniles and others by adults (AquaSense, 2001). These factors, plus evidence of irregular recruitment or low juvenile survival, mean that recovery may be very slow in areas where the population numbers become depleted.

Mechanical damage and incidental catch of *A. islandica* from bottom fishing gear is known to damage shells and lead to direct mortality (Piet *et al.*, 1998; Fonds, 1991; Klein & Witbaard, 1995). This may have a

particularly significant effect on sub-adult individuals as shell strength is correlated with size. *A. islandica* can survive with some shell damage, but repeated disturbance may lead to death. After its planktonic larval stage *A. islandica* settles on the seabed and is relatively stationary. It is therefore exposed to damage from rapidly approaching beam trawls.

In principle, *A. islandica* can be washed ashore by winter storms (Rees *et al.*, 1977), but as most populations in the North Sea inhabit areas deep enough to escape wave impacts, this does not present a threat.

Threat: The main threat to *A. islandica* in OSPAR Region II stems from disturbances to the seabed. This is particularly linked to beam trawling which is known to cause shell damage and direct mortality (for example, Witbaard & Klein, 1994; Piet *et al.*, 1998). Mortality of *A. islandica* caught in a beam trawl has been estimated to be in the range of 74 - 90% (Fonds, 1991). Klein & Witbaard (1995) have reported corresponding trends in the scar frequencies of *A. islandica* shells and temporal fluctuations in the total engine capacity of the Dutch beam trawl fleet.

Other threats include sand and gravel extraction, where these coincide with the occurrence of *A. islandica*, and direct as well as indirect effects of oil and gas extraction including suggested decrease in growth rates around exploration facilities (Witbaard, 1997).

A. islandica is recorded at significantly different densities across its range with the highest reported from the northern parts of its range. In subarctic waters up to 100/m² have been observed compared to 16/m² in the northern North Sea and as low as 0.18/m² in the south-eastern North Sea (Zatsepin & Filatova, 1961; Thórarinsdóttir & Einarsson, 1994; Witbaard, 1997).

It has been suggested that it is unlikely for *A. islandica* to become extinct in the North Sea because of its relatively long pelagic larval stage (which is not affected by fishing activity), together with low catch-efficiency of the beam trawl for this species, and its wide-spread distribution in the North Sea (Witbaard, 1995). Nevertheless, in the German North Sea EEZ, *A. islandica* is regarded as threatened.

3. Current Status of the Species

Distribution in the OSPAR Maritime Area

Arctica islandica is an arctic-boreal species of the North Atlantic and adjacent waters. Its global distribution and extent is shown in Fig. 2, whereas Fig. 3 provides presence/absence data for the North Sea. The species range extends into the Baltic Sea, where the Kiel and Mecklenburg Bights are densely colonized and clearly are also recruitment areas. In the Mecklenburg Bight individuals were found at an age range from 1 to 70 years with a shell length from 1.5 to 64 mm (Zettler *et al.*, 2001). *A. islandica* populations from the North Sea tend to reach older ages; in the inner German Bight individuals with an age up to 163 years have been found (Epple *et al.*, 2006).

Figure 2: Distribution of *Arctica islandica* [Source: Dahlgren *et al.* 2000]



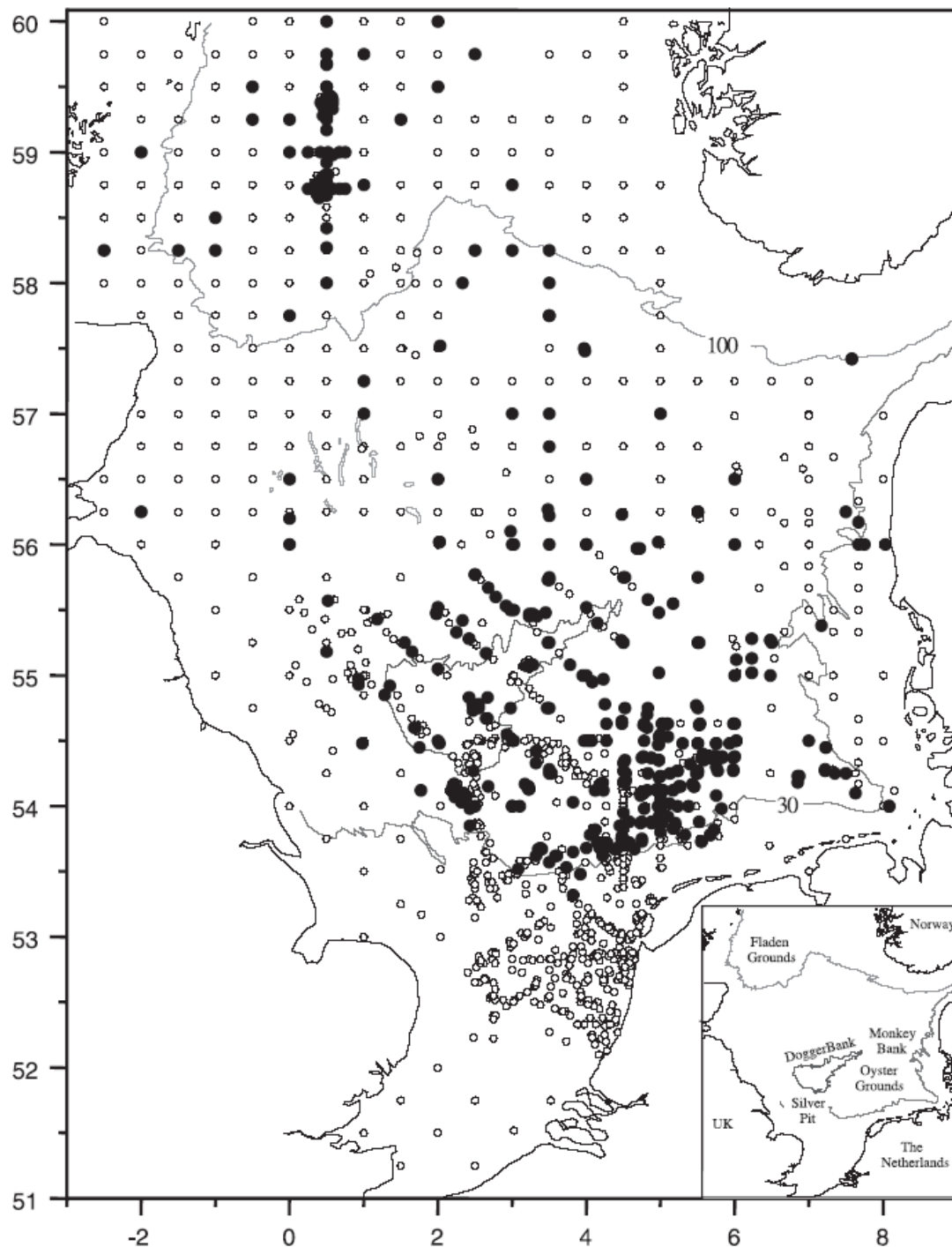
Population (current/trends/future prospects)

The 1986 ICES benthos survey in the North Sea found *A. islandica* only in about 20 - 30% of all sampling stations. This represents a severe decline, because according to Lindeboom & de Groot (1998: cited in AquaSense, 2001) it had been 45% in earlier years. Maximum densities occurred in the northern part of the distribution area (up to 100 individuals/m²), whereas in the North Sea maximum densities range from 0.18 individuals/m² in the south-eastern part (AquaSense 2001) to 12 individuals/m² on the Fladen Ground, where almost every boxcore sample yields one or more living specimens.

In surveys before 1995, due to different sampling devices, in some areas only adults were found while in others only juveniles. In July 2000, quantitative sampling with the Triple-D dredge which retains all specimens larger than 10 mm, gave an entirely new picture with estimated local densities up to 286 individuals/m² (Witbaard & Bergman, 2003). However, even with these new numbers, it remains evident that the occurrence of *A. islandica* in the North Sea has decreased between the beginning of the 20th century and the 1990s (AquaSense 2001, Witbaard & Bergman, 2003, and ICES CR 288, 2007).

Until regular surveys are conducted, future trends cannot be predicted. However, the apparent large declines in abundance in recent decades serve as grounds for precautionary measures (see also OSPAR Commission 2000, p. 89).

Figure 3: Presence-Absence Data of *Arctica islandica* (> 10 mm) within the North Sea
 [Source: Witbaard & Bergman 2003]



Filled dots represent stations where one or more specimens were found in a grab, trawl or Triple-D dredge sample. Open circles represent stations where, despite sampling, no living *Arctica* were found. The map is based on 1520 records from NIOZ sampling operations between 1972 and 2000 as well as on records from the literature (see also North Sea Task Force, 1993, p. 93). [Source: Witbaard & Bergman 2003]

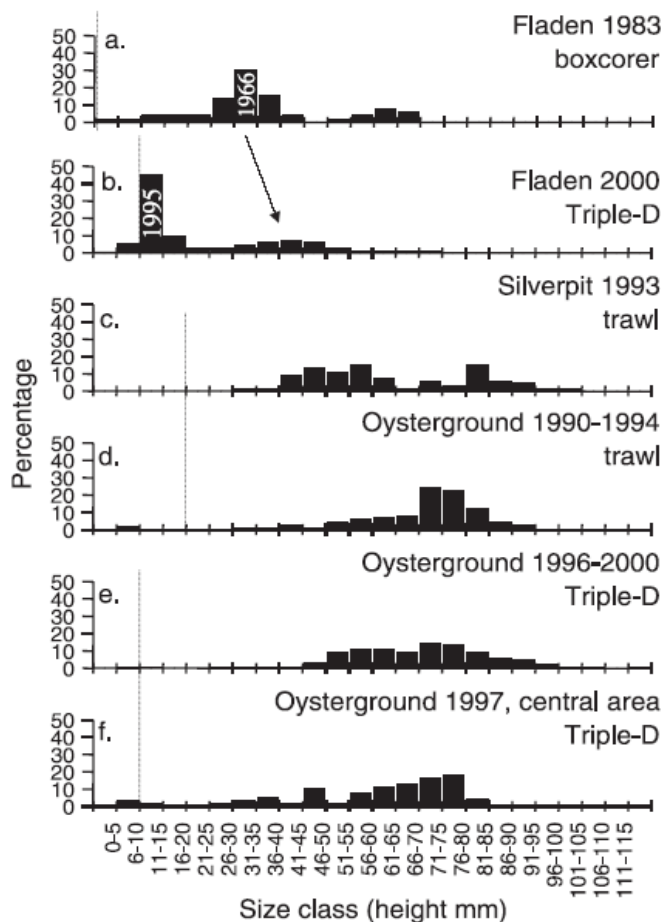
Condition (current/trends/future prospects)

The ICES review of this nomination (ICES, 2002) agreed that the species is impacted by bottom trawling fisheries and acknowledged the decline reported by Witbaard & Klein (1994). The group considered that there is no indication that the entire population is threatened (for example, there is no decline in the Baltic and the species is common along the Norwegian coast). It should be noted however that some declines have been reported from outside the OSPAR Maritime Area (for example, east coast of Denmark and Kiel Bight, Germany, in the Baltic (Pearson *et al.*, 1985; Weigelt, 1991). This species is now only nominated for OSPAR Region II (the North Sea), which should address this concern. ICES also noted that the failure of recruitment for many years in the North Sea is a possible point of concern and may be a signal, but there are no clues to the cause at the present time. The group suggests that further work is needed on the recruitment biology of this species to find possible explanations (ICES, 2002).

Limitations in knowledge

There is insufficient data on distribution and abundance of *A. islandica* in the OSPAR Region II and insufficient data on the health aspects and quality of habitats and on temperature effects on distribution limits.

Figure 4: Size Frequency Distributions of *Arctica islandica* Populations in the North Sea
[Source: Witbaard & Bergman, 2003]



(a) Fladen Ground sampled by boxcorer in 1983 (50 individuals); (b) Fladen Ground sampled by the Triple-D dredge in July 2000 (5859 individuals); (c) North edge of the Silverpit sampled by 5-m beam trawl with fine-meshed net in 1993 (65 individuals); (d) Oyster Ground sampled by 5-m-wide fine-meshed beam trawl between 1990 and 1994 (975 individuals); (e) Oyster Ground sampled by the Triple-D dredge between 1996

and 2000 (430 individuals); (f), central Oyster Ground, sampled in 1997 by the Triple-D benthos dredge (61 individuals).

In each panel a vertical dotted line indicates the minimum shell size under which the sampling gear used is expected to have underestimated the size classes due to mesh size selection. In (a) and (b) the year in which the largest cohorts settled is indicated. [Source: Witbaard & Bergman, 2003]

4. Evaluation of Threats and Impacts

Threat and link to human activities

Relevant human activity: Fishing, harvesting. Sand and gravel extraction.

Category of effect of human activity: Biological – removal of non-target species; shell damage and direct mortality of *A.islandica* has been linked to fishing (specifically beam trawling). Physical - habitat loss or degradation through physical damage (for example, sand and gravel extraction).

The main threat to *A.islandica* in OSPAR Region II stems from disturbances to the seabed. This is particularly linked to beam trawling which is known to cause shell damage and direct mortality (e.g. Witbaard & Klein, 1994; Piet *et al.*, 1998). *A.islandica* becomes immediately exposed at the sediment surface when a beam trawl is towed over the sea bottom. This happens also to spat of *A.islandica* (Witbaard & Bergman, 2003). Specimens that have been injured by beam trawls would have only a limited ability to rebury.

Mortality of *A.islandica* caught in a beam trawl has been estimated to be in a range of 74 - 90% (Fonds, 1991). Klein and Witbaard (1995) have reported corresponding trends in the scar frequencies in the *A.islandica* shells and temporal fluctuations in the engine capacity of the Dutch beam trawl fleet. The observed decline in *A.islandica* abundance between the 1970s and 1990s in the Dutch sector of the North Sea (Figure 1) coincides with the intensification of beam trawl fisheries in this area (AquaSense, 2001).

Other threats include sand and gravel extraction, where these coincide with the occurrence of *A.islandica* and direct as well as indirect effects of oil and gas extraction, including suggested decrease in growth rates around exploration facilities (Witbaard, 1997).

5. Existing Management Measures

There are no known existing management measures specifically addressing *A.islandica*.

OSPAR has communicated its concerns over the status of *A.islandica* in Region II to the EC, particularly highlighting the negative impact of bottom fishing on the species and its habitats. The response from the EC – DG MARE recognised that existing measures are insufficient to halt the decline and recovery of endangered species and that there are no targeted measures concerning the species but that effort restrictions operated in the North Sea, which will affect trawlers and beam trawlers should be expected to have some protective effect on these species.

The following MPAs included in the OSPAR network of MPAs include *A.islandica*: Borkum Riffgrund/Oestlich Deutsche Bucht (Germany) and Gullman fjord (Sweden).

6. Conclusion on Overall Status

There are severe gaps in knowledge of the distribution of *A.islandica* and only six of the 12 relevant OSPAR Contracting Parties have provided basic information on the distribution of *A.islandica*.

Trend data from monitoring programmes are only available for the Netherlands (annual BIOM programme). Trend data compiled from restricted research are available for Germany. In the report (paragraph 4b) it is also noted that some trend information also exists for Iceland.

Due to this lack of comprehensive data, for most Contracting Parties there is insufficient knowledge on the distribution and population trends of *A.islandica*. Under these circumstances it remains difficult to draw conclusions on the overall status of *A.islandica* in the OSPAR Maritime Area or its Regions.

7. Action to be taken by OSPAR

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

As set out in Article 4 of Annex V of the Convention, OSPAR has agreed that no programme or measure concerning a question relating to the management of fisheries shall be adopted under this Annex. However where the Commission considers that action is desirable in relation to such a question, it shall draw that question to the attention of the authority or international body competent for that question. Where action within the competence of the Commission is desirable to complement or support action by those authorities or bodies, the Commission shall endeavour to cooperate with them.

OSPAR actions/measures

Communication: Management of fisheries in the OSPAR Region II falls under the remit of the European Common Fisheries Policy and the fisheries management authorities in Norway. OSPAR will therefore need to advocate management measures through these bodies (e.g. restriction of bottom trawl fisheries in marine protected areas like Natura 2000 areas), as well as considering any additional actions that it can take to support appropriate measures introduced by such bodies.

Contracting Party actions

MPAs: Provided beam trawling is regulated or even prohibited in these areas, the designation of areas with suitable habitat and/or high densities of *Arctica islandica* as protected areas (e.g. Natura 2000, OSPAR Network of Marine Protected Areas (MPAs)) could present one tool for the conservation and restoration of these species.

Mapping: CPs should work towards mapping of existing *A.islandica* distribution, and should in parallel also strive towards the preparation of maps / models indicating the possible former distribution of this species.

Summary of the proposed Monitoring System

In order to have a more comprehensive overview of the trends in the distribution and abundance of *A. islandica*, OSPAR should encourage the relevant Contracting Parties to collaborate on the recommended monitoring strategy.

- Historical data should be compiled;
- Gaps in current knowledge of distribution should be filled using targeted initial surveys;
- Known *A.islandica* habitats should be sampled regularly (annually or bi-annually), including areas facing known or suspected threats (e.g. trawling) and unimpacted control sites;
- “Triple-D” dredges, and in addition box cores should be used as sampling methods;
- Animals should be examined on board and returned into their habitat, except for specific, necessary additional research goals;
- Distribution maps should be drawn up and be kept updated.

Annex 1: Overview of Data and Information provided by Contracting Parties (CPs)

Contracting Party	Feature occurs in CP's Maritime Area	Contribution made to the assessment (e.g. data/information provided)	National Reports References or Web Links
Belgium	Yes		
Denmark	Yes		
France	Yes		
Germany	Yes		See ICES CR 288 (2007) Rachor & Nehmer (AWI) 2003. Erfassung und Bewertung ökologisch wertvoller Lebensräume in der Nordsee http://www.habitatmarenatura2000.de/de/downloads/berichte/Benthos_oekolog_Untersuchungen_Nordsee_2004.pdf
Iceland	Yes		
Ireland	Yes		http://www.marlin.ac.uk/species/Arctica Islandica.htm
Netherlands	Yes		
Norway	Yes		http://www.seawater.no/fauna/Blotdyr/kuskjell.htm
Portugal			
Spain			
Sweden	Yes		
UK	Yes		http://www.marlin.ac.uk/species/Arctica Islandica.htm

Arctica islandica was nominated for inclusion in the OSPAR List in 2001 by the UK and WWF

Contact Persons:

David Connor, Joint Nature Conservation Committee, Monkstone House, Peterborough, PE1 1UA, UK

Sabine Christiansen, WWF International, International WWF Centre for Marine Conservation, Hongkongstr.7, D-20457 Hamburg, GERMANY

Annex 2: Description of the proposed Monitoring and Assessment Strategy

Rationale for the proposed Monitoring

In order to determine the conservation status of this species and to advocate or introduce appropriate conservation measures, as necessary, it is essential to elaborate a comprehensive synopsis of the distribution and abundance of *A.islandica* in OSPAR Region II, and to monitor respective changes.

Use of existing Monitoring Programmes

Currently, only the Netherlands conducts annual monitoring of *A.islandica* as part of the BIOM programme, while Germany has a restricted research programme for offshore waters, where the AWI and Senckenberg Institute sample single “permanent” locations every year.

Synergies with Monitoring of other Species or Habitats

It is recommended that *A.islandica* sampling be partly combined with other biological sampling of macro-zoobenthos, as long as the recommended sampling methods are being used and in particular in areas where the species is known to be present. Much information concerning the health of the benthos can be learned from the analysis of the results. In any case, even quick visual/sensory indicators such as size, colour, texture, as well as odour of the sediments can provide a preliminary indication of ecological properties such as substrate type and whether it is likely that anoxic events are occurring.

Assessment Criteria

According to a number of criteria, the status of *A.islandica* populations can be evaluated to fall within one of three criteria: favourable, unfavourable-inadequate, or unfavourable-bad; thus requiring different degrees of conservation effort. The criteria and the threshold levels for the various grades of conservation activities are yet to be determined (Table 1), but are expected to be similar to the assessment approach being taken by the EC Habitats Committee.

Table 1: Initial proposal for Indicators on the Conservation Status of *Arctica islandica*

<i>Population status</i>			
Criteria	Favourable	Unfavourable-Inadequate	Unfavourable- Bad
<i>Shell Size</i>	(values to be developed) Max. length	(values to be developed)	(values to be developed)
<i>Abundance</i>	(values to be developed) Ind. per ha	(values to be developed)	(values to be developed)
<i>Degree of Habitat Disturbance</i>	(values to be developed)	(values to be developed)	(values to be developed)
<i>Age Structure</i>	(values to be developed)	(values to be developed)	(values to be developed)
<i>Ratio of damaged/non damaged Shells</i>	(values to be developed)	(values to be developed)	(values to be developed)
<i>Lipofuscin Concentration</i>	(values to be developed)	(values to be developed)	(values to be developed)
Other Parameters	(values to be developed)	(values to be developed)	(values to be developed)

Monitoring Techniques/Approaches

Baseline (should be adjusted to suit the final parameters agreed (see Table 1))

- Relevant current and historical data about *A.islandica* should be collected and regularly updated in a national data base and be made available to OSPAR;
- Surveys should use the Triple-D dredge¹ supplemented with boxcore samples, as these would give the best insight into the population structure (Witbaard & Bergman, 2003);
- *A.islandica* found during regular surveys and during other benthos investigations or monitoring activities at any station shall be measured (length (optional), width (optional), and height (mandatory) – which is a good single indicator for size);

¹ In large parts of the southern North Sea, the abundance of juveniles and adults is too low to be sampled properly by means of a single grab sample. Because of their low catch efficiency and size selectivity, beam-trawls do not allow reliable density estimates either. Such problems are circumvented by the Triple-D benthos dredge which collects in-faunal species quantitatively by sampling a maximum of 20 m² seabed to a depth of 12 to 18 cm. Unlike previous methods, the dredge retains juveniles and adults. Therefore, it was not until the Triple-D benthos dredge became operational in 1995 that reliable abundance estimates could be obtained for areas where *Arctica* is less abundant. Extensive testing of this equipment showed that the dredge combines the quantitative character of a bottom grab with the advantage of sampling over relatively large bottom surface areas (4 – 20 m²) (AquaSense 2001).

- *A. islandica* shells shall be scrutinized for damages (e.g. scars) e.g., possibly caused by beam trawl fisheries or sand and gravel extraction activities.

Enhanced [should be finally adjusted to parameters given in Table 1]

- Age of a representative sub-sample of shells should be used to correlate to physical size measurements (above), and hence to calculate growth rates;
- Primary production measurements;
- Vertical profiles of salinity and temperature using a CTD (conductivity/temperature/depth), samples for bottom water oxygen, etc. should also be recorded;
- Physiological state of the different populations: A preliminary indication of health could be made by measuring lipofuscin concentration in different tissues using a histological technique. Lipofuscin is a cellular waste molecule and accumulates during ageing, and is greater in stressful environments.

Selection of Monitoring Locations

Initial baseline surveys should preferably be carried out synoptically (over large areas in a short period of time) within the waters of each of the OSPAR CPs, with the aim of identifying recruitment areas and areas with high abundance of the species. Once these areas are identified, they should be sampled in the regular monitoring programme.

However, if the above is not possible, then as a minimum, for waters where *A. islandica* oriented surveys have not taken place so far, initial baseline surveys shall be performed. These can provide solid data upon which to base decisions regarding the need to develop a more detailed monitoring programme (or not) for selected areas.

Supported by the results of existing knowledge and by the results of these baseline studies a map of the potential distribution of *A. islandica* in the maritime area of each Contracting Party should be produced and supported with regular updates.

Timing and Frequency of Monitoring

Baseline

For areas under threat (for example, trawling areas, the North Sea), monitoring should be done on an annual basis.

Enhanced

For other areas, bi-annual (every two years) monitoring would be sufficient.

Data Collection and Reporting

Baseline

- Sampling method;
- Sampling date;
- Sampling location;
- Name of scientist/research institute and programme
- Total number of *A. islandica* in sample per area/volume;

- Each specimen:
 - height (mm);
 - length (mm) – optional;
 - width (mm) – optional;

Enhanced

- Representative sub-sample of *A. islandica*, including all size classes:
 - Age;
 - Full size (mm) [length, width, height];
 - Primary production or biomass;
 - CTD: use of a standard sampling form (including relevant tests, e.g. bottom pressure, bottom temperature, bottom salinity, bottom O₂, fluorometer data, chlorophyll profiles, etc.);
 - Lipofuscin concentration.

Quality Assurance

- Contracting Parties agree on principles of a quality assurance policy and the Commission adopts guidelines [to be developed];
- Contracting Parties agree to make sure that suitable resources (laboratories and trained personal) are available nationally;
- Contracting Parties commit themselves to following the guidelines, protocols, etc., adopted by the Commission.

Annex 3: References

AquaSense (2001). Distribution and threats of *Arctica islandica* - *A. islandica* as an example for listing of species and habitats subject to threat or rapid decline. – Sponsor: The Netherlands Directorate – General of Public Works and Water Management (RWS). North Sea Directorate 1738, 39 pp.

Bergman, M.J.N & van Santbrink, J.W. (2000). Fishing mortality of populations of megafauna in sandy sediments. In: Kaiser, K.J. & de Groot, S.J. (Eds) Effects of fishing on non-target species and habitats. Biological, conservation and socio-economic issues. Blackwell Science, London.

Dahlgren T.G., Weinberg J.R. & Halanych K.M. (2000). Phylogeography of the ocean quahog (*Arctica islandica*): influences of paleoclimate on genetic diversity and species range. *Marine Biology* (2000) 137: 487-495.

Epple, V. M., T. Brey, R. Witbaard, H. Kuhnert, & J. Pätzolt. 2006. Sclerochronological records of *Arctica islandica* from the inner German Bight. *The Holocene* 16:763-769.

Fonds, M. (1991). Measurements of the catch composition and survival of benthic animals in beamtrawl fishery for sole in the southern North Sea. BEON Report 13. 85pp.

Hauton C., Atkinson R.J.A. & Moore P.G. (2003). The impact of hydraulic blade dredging on a benthic megafaunal community in the Clyde Sea area, Scotland. *Journal of Sea Research* 50 (2003) 45– 56.

ICES (2002). Report of the Working Group on Ecosystem Effects of Fisheries. Advisory Committee on Ecosystems. ICES CM 2002/ACE:03.

ICES Cooperative Research Report 288 (2007) Structure and Dynamics of the North Sea Benthos. 258 pp. [s. Rees *et al.*]

Klein, R. & Whitbaard, R. (1995). Long-term trends in the effects of beam trawl fishery on the shells of *Arctica islandica* NIOZ Rapport 1995-3.

Merill, A.S. & Ropes, J.W. (1969). The general distribution of the surf clam and ocean quahog. *Proc.Nat.Shellfish.Assn.* 59:40-45.

NOAA (1999). Technical Memorandum NMFS-NE-148. Essential Fish Habitat Source Document: Ocean Quahog, *Arctica islandica*, Life History and Habitat Characteristics U. S. DEPARTMENT OF COMMERCE National Oceanic and Atmospheric Administration National Marine Fisheries Service Northeast Region Northeast Fisheries Science Center Woods Hole, Massachusetts September 1999 <http://www.nefsc.noaa.gov/nefsc/publications/tm/tm148/tm148.pdf>.

North Sea Task Force (1993). North Sea Quality Status Report 1993. Oslo and Paris Commissions, London (1993). 132+vi pp. ISBN 1-872349-06-4 and 87-85215-26-0.

OSPAR Commission (2000). Quality Status Report 2000 – Region II Greater North Sea. OSPAR Commission, London (2000). 136 pp. ISBN 0 946956 48 0.

OSPAR Commission (2005). Case Reports for the Initial List of Threatened and/or Declining Species and Habitats in the OSPAR Maritime Area. Biodiversity Series 15-18.

Pearson, T.H., Josefson, A.B. & Rosenberg, R., (1985). Petersen's benthic stations revisited. I. Is the Kattegat becoming eutrophic? *J.Exp.Mar. Biol.Ecol.* 92:157-206.

Piet, G.J., Rijnsdorp, A.D., Bergman, M.J.N., van Santbrink, J.W., Craeymeersch, J.A. & Buys, (1998). A quantitative evaluation of the impact of beamtrawl fishery on benthic fauna in the southern North Sea. In Bergman *et al* (Eds) The distribution of benthic macrofauna in the Dutch sector of the North

Sea in relation to the micro distribution of beam trawling. Final report. 1998. BEON Rapport No. 98-2:5-15.

Rachor, E. and Nehmer, P. (2003). Erfassung und Bewertung ökologisch wertvoller Lebensräume in der Nordsee. Abschlussbericht für das F & E Vorhaben FKZ 89985310

Rees *et al.* (2007). Structure and dynamics of the North Sea Benthos. ICES Coop. Res. Rep. 258 pp.

Rees, E.I.S., Nicholaïdou, A., & Laskaridou, P. (1977). The effects of storms on the dynamics of shallow water benthic associations. Pp 465-474. In: Keegan *et al* (Eds) The Biology of Benthic Organisms. Pergamonn Press, Oxford.

Rumohr, H., Ehrich, S., Knust, R., Kujawski, T., Philippart, C.J.M., & Schroeder, A. (1998) Long term trends in demersal fish and benthic invertebrates. In: Linderboom, H.J. & de Groot, S.J. (1998). The effects of different types of fisheries on the North Sea and Irish Sea benthic ecosystems. IMPACT-II. NIOZ-RAPPORT 1998-1.

Schöne, B. R., J. Fiebig, M. Pfeiffer, R. Gleß, J. Hickson, A. L. A. Johnson, W. Dreyer, & W. Oschmann. (2005). Climate records from a bivalved Methuselah (*Arctica islandica*, Mollusca; Iceland). *Palaeogeogr Palaeoclimatol Palaeoecol* 228:130-148.

Taylor, A. C. (1976). Burrowing behaviour and anaerobiosis in the bivalve *Arctica islandica* (L.). *J. Mar. Biol. Ass. U. K.* 56, 95-109.

Thórarinsdóttir, G.G. & Einarsson, S.T. (1994). Distribution, abundance, population structure, meat yield, size of sexual maturity and sex ratio of the ocean quahog, *Arctica islandica* in Icelandic waters. ICES statutory meeting, St.Johns Canada. Shellfish Committee C. M.1994/k:39;7pp.

Weigelt, M. (1991). Short and long-term changes in the benthic community of the deeper parts of Kiel Bay (Western Baltic) due to oxygen depletion and eutrophication. *Meeresforschung* 33:197-224.

Wiltshire, K. H. & Manly, B. F. J. (2004). The warming trend at Helgoland Roads, North Sea: phytoplankton response. *Helgoland Mar Res* 58, 269-273.

Witbaard, R. (1997). Tree of the Sea. The use of the internal growth lines in the shell of *Arctica islandica* (Bivalvia, Mollusca) for the retrospective assessment of marine environmental change. Thesis. University of Groningen. 149pp.

Witbaard R. & Bergman M.J.N. (2003). The distribution and population structure of the bivalve *Arctica islandica* L. in the North Sea: what possible factors are involved? *Journal of Sea Research* 50 (2003) 11 – 25.

Witbaard R. & Klein R. (1994). Long-term trends on the effects of the southern North Sea beamtrawl fishery on the bivalve mollusc *Arctica islandica* L. (Mollusca, bivalvia). *ICES J. mar. Sci.* 51: 99-105.

Witbaard R. Jansma E & Sass Klaassens U (2003). Copepods link quahog growth to climate. *Journal of Sea Research* 50 (2003) 77– 83.

Zatsepin, V.I. & Filatova, Z.A. (1961). The bivalve mollusc *Cyprina islandica* (L). Its geographic distribution and role in the communities of benthic fauna. *Trans.Instit. Oceanology*. XLVI:2-24.

Zettler, M.L., Bonsch, R., Gosselck, F., (2001). Distribution, abundance and some population characteristics of the ocean quahog, *Arctica islandica* (Linnaeus, 1767), in the Mecklenburg Bight (Baltic Sea). *J. Shellfish Res.* 20, 161– 169.



New Court
48 Carey Street
London WC2A 2JQ
United Kingdom

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

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

ISBN 978-1906840-47-1
Publication Number: 407/2009

© OSPAR Commission, 2009. Permission may be granted by the publishers for the report to be wholly or partly reproduced in publications provided that the source of the extract is clearly indicated.

© Commission OSPAR, 2009. La reproduction de tout ou partie de ce rapport dans une publication peut être autorisée par l'Editeur, sous réserve que l'origine de l'extrait soit clairement mentionnée.