OSPAR COMMISSION

Background document for *Ostrea edulis* and *Ostrea edulis* beds

Biodiversity Series

2009

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 Jan Haelters and Francis Kerckhof for Belgium as lead country.

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Executive summary

This background document on *Ostrea edulis* and *Ostrea edulis* beds has been developed by OSPAR following their inclusion 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 *Ostrea edulis* and *Ostrea edulis* beds since the agreement to include them in the OSPAR List in 2003. The original evaluation used to justify their inclusion in the OSPAR List is followed by an assessment of the most recent information on status (distribution, population/extent, condition) and key threats prepared during 2008-2009. Chapter 7 provides recommendations for the actions and measures that could be taken to improve their conservation status. On the basis of these recommendations, OSPAR will continue its work to ensure the protection of *Ostrea edulis* and *Ostrea edulis* beds, where necessary in cooperation with other organisations. This document may be updated to reflect further developments.

Récapitulatif

Le présent document de fond sur l'huître plate (*Ostrea edulis*) et les bancs d'*Ostrea edulis* a été élaboré par OSPAR à la suite de leur inclusion 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 l'huître plate et les bancs d'*Ostrea edulis* qui ont été préparées depuis qu'il a été convenu de les inclure dans la Liste OSPAR en 2003. L'évaluation d'origine permettant de justifier leur inclusion dans la Liste OSPAR est suivie d'une évaluation des informations les plus récentes sur leur statut (distribution, population/étendue, condition) et des menaces clés, préparée en 2008-2009. Le chapitre 7 recommande des actions et mesures à prendre éventuellement afin d'améliorer leur état de conservation. OSPAR poursuivra ses travaux, en se fondant sur ces recommandations, afin de s'assurer de la protection de l'huitre plate et des bancs d'*Ostrea edulis*, le cas échéant en coopération avec d'autres organisations. Le présent document pourra être actualisé pour tenir compte de nouvelles avancées.

1. Background information

Name of species and habitat

Ostrea edulis, flat oyster

Ostrea edulis beds

EUNIS Code: A5.435

National Marine Habitat Classification for UK & Ireland code: SS.SMx.IMx.Os

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Definition of habitat

Beds of the oyster *Ostrea edulis* occurring at densities of 5 or more per m^2 on shallow mostly sheltered sediments (typically 0 – 10 m depth, but occasionally down to 30 m). There may be considerable quantities of dead oyster shell making up a substantial portion of the substratum. The clumps of dead shells and oysters can support large numbers of the ascidians *Ascidiella aspersa* and *A.scabra*. Several conspicuously large polychaetes, such as *Chaetopterus variopedatus* and terebellids, may be present as well as additional suspension-feeding polychaetes such as *Myxicola infundibulum*, *Sabella pavonina* and *Lanice conchilega*. A turf of seaweeds such as *Plocamium cartilagineum*, *Nitophyllum punctatum* and *Spyridia filamentosa* may also be present (Connor *et al*, 2004).

2. Original Evaluation against the Texel-Faial Selection Criteria

OSPAR Regions and Dinter biogeographic zones where the feature occurs

Ostrea edulis: OSPAR Regions: I, II, III, IV
Biogeographic zones: Lusitanean (Cold/Warm), Lusitanean-boreal, Boreal-lusitanean, Boreal, Norwegian Coast (Finnmark), Norwegian Coast (Westnorwegian)

Ostrea edulis beds: OSPAR Regions: II, III, IV
Biogeographic zones: Warm-temperate pelagic waters, Lusitanean (Cold/Warm), Lusitanean-boreal, Cold-temperate pelagic waters, Boreal-lusitanean, Boreal

OSPAR Regions and Dinter biogeographic zones where the feature is under threat and/or in decline

Ostrea edulis: OSPAR Region II and Boreal biogeographic zone

Ostrea edulis beds: *Ostrea edulis* beds are under threat and/or decline in all the regions where they occur.

General

Ostrea edulis is a sessile, filter-feeding bivalve mollusc associated with highly productive estuarine and shallow coastal water habitats. It is found naturally from the Norwegian Sea south through the North Sea down to the Iberian Peninsula and the Atlantic coast of Morocco and in the Mediterranean and Black Seas (UKBAP, 1999). It has also been cultivated in these areas as well as in North America, Australasia, Japan and South Africa (FIGIS, 2006).

Natural oyster beds of the species *O.edulis* are found in estuarine areas from 0 - 6 m depth on sheltered but not muddy sediments, where clean and hard substrates are available for settlement. They have also historically occurred in deeper waters and offshore, down to 50 m, for example in the North Sea and the eastern Channel, but these beds are now mostly depleted.

Original Evaluation against the Texel-Faial criteria for which the feature was included on the OSPAR List

O.edulis was nominated for inclusion on the OSPAR List with particular reference to global/regional/importance, rarity, decline, role as a keystone species, sensitivity and threat, and as a priority for OSPAR Region II. Additionally, *O.edulis* beds have been nominated as a habitat.

Global/regional/local importance: *O.edulis* only occurs locally outside the OSPAR area in the Mediterranean and the northern shores of the Black Sea. The population in the OSPAR Maritime Area is therefore considered to be of global importance.

Decline: Natural stocks of *O.edulis,* and naturally occurring beds of *O.edulis* are known to have been more abundant and widespread in OSPAR Region II in the 18th and 19th centuries when there were large offshore oyster grounds in the southern North Sea and the English Channel. During the 20th century their abundance declined significantly in European waters (*e.g.* Korringa, 1952; Yonge, 1960). Around 700 million oysters were consumed in London alone in 1864, for example, and the UK landings fell from 40 million in 1920 to 3 million in the 1960s, and have never returned to former levels (Edwards, 1997).

The northern 'coldwater' population, which used to thrive in areas such as the Firth of Forth, Schleswig Holstein and the Dutch Wadden Sea, is extirpated and the southern warmer water population has declined (Korringa, 1976). *O.edulis* has also virtually disappeared from Belgian waters (Houziaux *et al.,* 2008). It was believed to be extinct in the Dutch Wadden Sea from 1940 although a small number were found in 1992 (Dankers *et al.,* 1999). In recent years natural beds have become re-established in the Danish Limfjord and now support a fishery.

Ireland:

Naturally occurring populations of *O.edulis* occur in a number of locations on the north-west, west and south-west coasts of Ireland. Seven areas support or have recently supported commercial fisheries with an annual production of approximately 350 tonnes. These areas are Tralee Bay (by far the largest producer approximately 200 tonnes/annum), Clew Bay, Blacksod Bay, Achill, Lough Swilly, Inner Galway Bay and Kilkieran Bay. Until recently Cork harbour produced between 30 and 60 tonnes annually within an oyster growing area. It has been closed for harvest due to virus problems. The Lough Foyle fishery is also closed. The production, and presumably the biomass, of oyster in these areas is lower than the historic maximum production and stocks in some areas have not been fished in recent years. The cause of the decline is a combination of the impact of the intracellular parasite *Bonamia*[1], poor scientific assessment of stocks leading to unsustainable harvest rates and poor or irregular recruitment. The cultivation of *Crassostrea gigas* also occurs in these areas and management in some cases favoured the production of *C. gigas* over *O.edulis*. However, this has not necessarily resulted in negative consequences for *O.edulis. C. gigas* shells are often used as cultch[2] in the maintenance of *O.edulis* beds and in areas which are actively managed for oyster culture and fishing there tends to be a better knowledge of population density. There are a number of Oyster Orders in the main producing areas in Ireland. These are usually held by co-operatives which actively manage and protect the resource. Management measures include harrowing, allocation of broodstock areas, fishery open and close periods and minimum landing (ring) size. Over the past 10 years oyster beds in Ireland that have been well managed have maintained and even increased production although production is still below historic levels. Nevertheless it demonstrates that in some sites at least scientifically based stock management can result in increased recruitment and biomass.

Keystone species: The role of *O.edulis* and *O edulis* beds in the ecology of marine communities has led to it being considered a keystone species (*e.g.* Coen *et al.,* 1998). These functions include providing a solid surface for settlement by other species, providing a cryptic habitat that serves as a nursery ground for, and protects, small fish and other species, stabilising sediments which may in turn provide some protection from shoreline erosion, and filtration of large quantities of water.

Rarity: Natural beds of *O.edulis* have become increasingly rare in the North Sea and the species is extremely rare in parts of its former range such as the Wadden Sea where its status is considered to be ‘critical’ (under immediate threat of extinction) and therefore on the Red List of macrofaunal benthic invertebrates of the Wadden Sea (Petersen *et al.,* 1996). The populations in deeper waters in the southern North Sea, such as on the Oyster Grounds, disappeared during the 19th and 20th centuries (*e.g.* Benthem Jutting, 1943).

The number of viable *O.edulis* beds on the Irish coast seems to be stable although oyster density within many of these beds is low. Production has remained stable or even increased in managed areas.

Sensitivity: An assessment of the sensitivity of *O.edulis* based on a literature review by the Marine Life Information Network for Britain & Ireland (MarLIN) (Jackson, 2001), lists this species as being highly sensitive to substrate loss, smothering (*e.g.* Yonge, 1960), synthetic compound contamination in particular tributyl tin (TBT) (*e.g.* Rees *et al.,* 2001), introduction of microbial pathogens/parasites (Edwards 1997), introduction of non-native species and direct extraction.

Recovery is dependent on larval recruitment since the adults are permanently attached and incapable of migrating. Recruitment is sporadic and dependent on the local environmental conditions, hydrographic regime and the presence of suitable substratum, especially adult shells or shell debris (Kennedy & Roberts, 1999). Recoverability is considered to be very low from substrate loss, smothering, extraction and introduction of microbial pathogens/parasites, in one case taking around 20 years (Spärck 1951, in Jackson 2001). Oyster spat usually settles on the shells of adult oysters so substantial removal of an existing bed reduces suitable settlement areas for subsequent generations.

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[1] *Bonamia* spp., including *B. ostreae* are protists (intrahaemocytic protozoa) of the phylum Haplosporidia that cause lethal infections of certain oysters, including *O.edulis*. Infection in oysters rarely results in clinical signs of disease and the only visual cue is increased mortality.

[2] Cultch is the term given to a bed of natural material, usually shell but also gravel, to which the settling oyster spat may adhere.

Relevant additional considerations

Sufficiency of data

Data on the status of naturally occurring stocks of *O.edulis* are available from a number of sources including landing records, benthic sampling and detailed studies at particular locations. This information is considered to be a sufficient basis on which to determine that the species has declined in OSPAR Region II and is under threat from a variety of human activities. However, systematic surveys of density, age structure and recruitment in established *O.edulis* beds are not necessarily sufficient to monitor the frequency of recruitment events and the possible causes of change in status of populations.

Changes in the distribution and abundance of *O.edulis* and *O.edulis* beds have been recorded in many parts of its former range in the North Sea. This includes information from studies of specific areas such as the Wadden Sea (Reise & Schubert, 1987: Reise *et al.,*1989) and national records, as in the case of Belgium (*e.g.* Houziaux *et al.,* 2008).

Changes in relation to natural variability

Natural causes such as disease and severe winters may have contributed to the decline of *O.edulis* in the North Sea. There were high mortalities following severe winters such as those experienced in 1947 and 1963 for example, and in the UK the east coast stock has not recovered to the pre-1963 levels (UKBAP, 1999). Many other factors also affect oyster stock abundance as the species has a very variable recruitment from year to year. These include temperature, food supply, and hydrodynamic containment in a favourable environment. It may also be the case that spawning stock density or biomass may be too low in many areas to ensure synchronous spawning or sufficient larval production for successful settlement (Jackson, 2001). Habitat conditions in areas which previously supported oysters may also have changed and become unsuitable settlement areas.

Expert judgement

The data provide a reasonable basis on the status and decline of this species, including the naturally occurring *O.edulis* beds, and their decline in OSPAR Region II.

ICES evaluation

The ICES review of this nomination states that there is good evidence of widespread decline of natural stocks of *O.edulis* and that overexploitation, the introduction of other (warm water) races and other oyster species, disease, and severe winters have all contributed to the decline of *O.edulis* (ICES, 2002). ICES also report that there are some signs of recovery, *e.g.* in the outer Skagerrak area and along the Normandy coast, where specimens are occasionally found.

3. Current status of the species

Ostrea edulis is of commercial importance, although landings have severely declined over time.

Ostrea edulis beds are ecologically important for their rich associated epifauna. The disappearance of *ostrea edulis* beds not only means the disappearance of the oysters, but also the loss of the related fauna. Therefore it is important to maintain some healthy populations that can act as nuclei for the survival of the species and associated fauna.

For the assessment, data are needed on the historic and current distribution, the quality of existing *ostrea edulis* beds (diseases, density of large oysters) as well as on the associated fauna.

Distribution of the feature in the OSPAR region

O.edulis is native to the North East Atlantic. The species occurs in the OSPAR area in intertidal to subtidal shallow waters from the Atlantic coasts of Norway to Spain and in the North Sea.

Population of the species and extent of the habitat (current/trends/future prospects)

Large offshore *O.edulis* beds existed in north western European waters until the 19th century. These beds occurred all along the European coasts, although they probably did not form a continuous zone. They declined or have been largely lost since.

The understanding of the natural distribution *O.edulis* and *O.edulis* beds is hampered by the widespread practice of relaying oysters, fished on wild beds, to fatten in more nearshore and estuarine areas.

The distribution of *O.edulis* beds is shown in Figure 1. This figure originates from the NBN Gateway. At present it only includes historical and/or recent data supplied by the UK, France and Belgium, but from literature sources, there are indications that *O.edulis* beds also occur or occurred in Norway, Denmark, Germany, the Netherlands, and Spain. An additional 9 areas in Ireland, not indicated in Figure 1, are known to support populations of *O.edulis*. These are naturally occurring beds.

More information on the historic decline of oyster beds in European waters can be found in the background document on Case Reports for the OSPAR List of Threatened and/or Declining Species and Habitats in the OSPAR Maritime Area (OSPAR publication 2008/358).

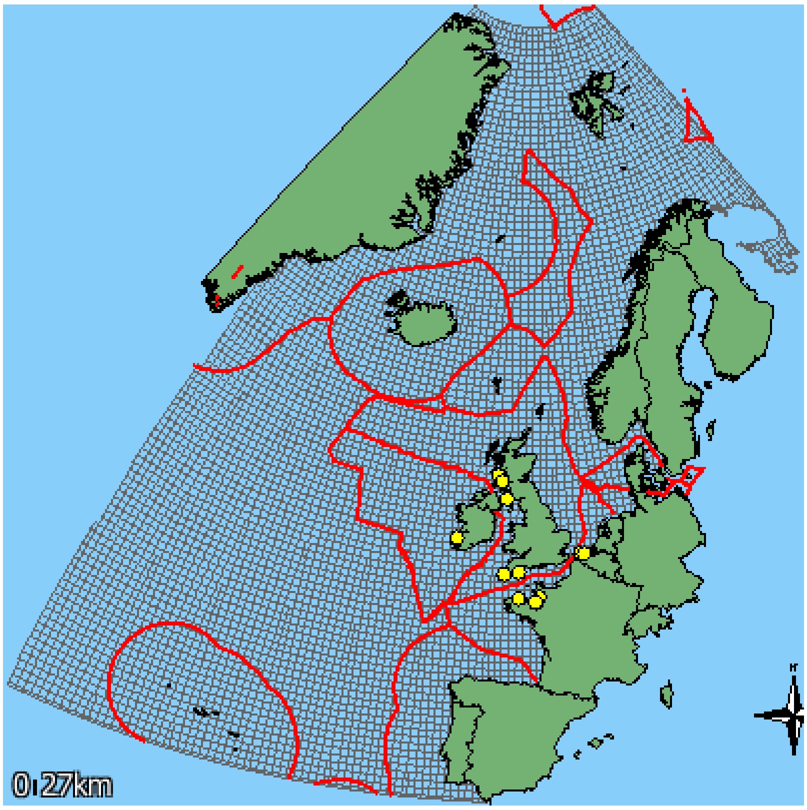

Figure 1: Preliminary map showing the distribution of *O. edulis* beds in the OSPAR maritime area (based on data supplied by Contracting Parties up to 1 October 2008. (shown on the 50 km grid – Map from the OSPAR habitat mapping programme hosted by the UK).

Condition (current/trends/future prospects)

Information on the presence of diseases (bonamiosis, marteiliosis) of *O.edulis* in certain regions is available on the ICES website http://www.ices.dk/marineworld/fishdiseases/. Culloty and Mulcahy (2007) provide a recent review of *Bonamia ostreae*.

For the conservation/ maintenance of the species and the redevelopment of native oyster beds, initial brood stock nuclei are needed, consisting of a sufficient number of large oysters in a sufficiently high density. In Ireland the active management of oyster beds has helped maintain and even increase stocks.

Future prospects

Belgium has indicated that an area where natural oyster beds occurred until the early 20th century and where suitable habitat is still present, qualifies as an OSPAR Marine Protected Area (Haelters *et al*. 2007).

Limitations in knowledge

It is difficult to obtain a broad picture of the distribution of *O.edulis* and *O.edulis* beds in the OSPAR region. Much information remains hidden in grey literature and in reports related to various projects initiated by individual Contracting Parties. Moreover there is an uncertainty whether records of *Oedulis* and *O.edulis* beds refer to natural or cultivated beds or even artificial ones.

Ostrea edulis is a long-lived species, however individual large specimens offshore or from deeper waters are rare. Areas where such specimens occur could serve as nuclei for further expansion or re-establishment of *O.edulis* beds in areas where they once thrived, provided that suitable habitat still exists and is not too degraded. Additionally, there is a lack of historical distribution data of *O.edulis* beds.

4. Evaluation of threats and impacts

Threat and link to human activities

Cross-reference to checklist of human activities in OSPAR Guidelines for management of Marine Protected Areas in the OSPAR maritime area (OSPAR other agreement 2003-18)

Relevant human activity: Fishing, harvesting; land based activities; aquaculture/mariculture.

Category of effect of human activity: Biological – removal of target and non-target species, introduction of microbial pathogens or parasites, introduction of non-indigenous species; Chemical – synthetic compound contamination.

Threat: The main threat to *O.edulis* and *O.edulis* beds in OSPAR Region II has been over-exploitation. There is a long history of collection and cultivation of O.edulis in northern Europe. The dramatic declines seen in stock abundance in the middle of the 19th century are attributed mainly to over-exploitation but there has also been damage by beam trawlers targeting other species. By the late 19th century, stocks were showing signs of depletion, and by the 1950s native oyster beds were regarded as scarce (Korringa, 1952; Yonge, 1960; Edwards, 1997). Next to overfishing and habitat destruction, several other reasons for the decline were put forward.

The parasitic protozoan *Bonamia ostreae* is known to have caused massive mortalities of *O.edulis* in France, the Netherlands, Spain and England (Edwards, 1997).

Poor water quality and specifically contamination by tributyl tin antifouling paints is known to have stunted growth of *O.edulis* and may also have affected reproductive capacity (Rees *et al.*, 2001)

Oyster grounds have been degraded in some areas by the slipper limpet *Crepidula fornicata*, an introduced (alien) species. This species is a filter feeder creating 'mussel mud' which degrades the grounds and hinders recruitment to oyster beds, although the dead shells provide a surface on which the oyster spat do settle. The American oyster drill *Urosalpinx cinerea* is another alien species, which preys on *O.edulis*.

The cultivation and spread into the wild of the Pacific oyster *Crassostrea gigas* is another threat as there is a possibility that it may take over the niche of the native oyster and therefore limit the opportunities for recolonisation by *O.edulis*. At the present time it is unclear whether this is likely to happen (*e.g.* Drinkwaard, 1999; Reise, 1998; Nehring, 1998), but it is clear that the threat may be greatest in shallow coastal and estuarine waters.

The main threats to *O.edulis* beds and the reason for their decline can be clearly linked to manageable human activities although natural causes such as disease and severe winters in the 1930s and 1940s have also played a part in their decline in the North Sea. Studies in North America have reached the same conclusion, which is that destructive harvesting and over fishing can reduce the habitat extent of oyster reefs (*e.g.* Coen *et al.,* 1998).

Evaluation of threats and impacts: An assessment of the sensitivity of *O.edulis* based on a literature review can be found on the Marine Life Information Network for Britain & Ireland (MarLIN) (Jackson, 2001). The species is listed as being highly sensitive to substrate loss, smothering, synthetic compound contamination, introduction of microbial pathogens/parasites, introduction of non-native species and direct extraction.

Table 1: Summary of key threats and impacts to *O.edulis*

Type of impact	Cause of threat	Comment	Scale of threat
Habitat degradation through smothering & siltation	Aggregate extraction industry; navigational dredging; dredge spoil dumping	Operations leading to significant siltation or smothering of the seabed might be expected to have a significant effect on both flat oyster beds and their associated communities, particularly in low energy environments where the silt is unlikely to be dispersed easily. Adequate EIA before such developments begin should identify any risks to the habitat.	Medium
Habitat degradation through physical damage	Anchoring	Anchors dragging through *O.edulis* beds can cause significant localised damage, breaking up clumps of oysters and damaging the overall structure of the habitat. Dislodging of oysters may make the beds more susceptible to subsequent damage by wave action or predation. Potential for such damage is highest in sheltered inlets (sea lochs, estuaries, fjords) where anchoring is more likely.	Low
Habitat loss or degradation through physical damage	Bottom trawling	In the past *O.edulis* beds were dredged, directly targeting *O.edulis.* Now the main threat to *O.edulis* beds is bottom fishing, using trawls and dredges, targeting bottom fish and bivalve molluscs. Trawling damages both *O.edulis* and associated epibenthic species and impacts the abiotic environment. Obvious effects include the loss of epifauna and the alteration/degradation of the habitat.	High

Type of impact	**Cause of threat**	**Comment**	**Scale of threat**
Habitat loss or alteration	Infrastructure development (wind farms, oil & gas, cables)	*O.edulis* beds can be damaged by any infrastructure development which disturbs or alters the seabed habitat: offshore industry developments such as wind farms, oil and gas rigs, trenching and pipe/cable-laying. Provided proper EIAs are undertaken before such developments begin, and sensitive areas of this habitat avoided, the risks can be kept to a minimum.	Low
Overfishing	Target fishery	*O.edulis* has been over harvested during the 19th century and the former beds have not recovered in most cases. Long-term harvesting of particular populations could be unsustainable, due to slow growth rates and poor recruitment success.	Medium
Change in tidal current regimes	Tidal power schemes; causeway building	*Ostrea* beds tend to occur in areas of moderate to strong tidal currents, particularly in tidal channels between islands and offshore sandbanks, narrow entrances to lochs and basins. Any constructions which alter the tidal flow rates through such channels could affect the viability of *O.edulis* beds (either in the channels or down stream of them), alter the associated communities and potentially lead to loss of the beds.	Low
Changes in sea temperature affecting reproduction	Climate change	*O.edulis* cannot tolerate low temperatures. Thus, *O.edulis* may profit from future increases in water temperature. This is likely to be most important in areas towards the northern edge of its range. The influence of water temperature on the prevalence of diseases is not clear. On the other hand, higher temperatures combined with eutrophication and algal blooms can lead to lower oxygen levels causing direct mortality.	?
Pollution	Land-based and marine industrial or commercial sources	*O.edulis* is known to accumulate contaminants, such as heavy metals, in spoil disposal areas. The effects on condition, reproduction and mortality rates are unknown (UKBAP, 1999). *O.edulis* is highly sensitive to synthetic compound contamination (*e.g.* Rees *et al.,* 2001) and tributyl tin. Eutrophication may lead to excessive algal blooms, leading to low oxygen levels.	Medium
Diseases	Introduction of microbial pathogens/parasites	The protozoan *Bonamia ostreae* has caused massive mortalities of *O.edulis* in France, the Netherlands, Spain, Iceland and England (Edwards, 1997; Mirella da Silva *et al* 2005; Culloty & Mulcahy, 2007). Another protist, *Marteilia refringens* can cause 75 - 100% mortality in *O.edulis.* There is evidence for interspecies transmission of diseases. The protozoan *Mikrocytos mackini* also affects *O.edulis* and the oyster herpesvirus infects *O.edulis* and results in larval and seed mortality. The bacterium *Nocardia crassostreae* can infect *O.edulis* and make it heat sensitive. (Ruesink *et al*.	High

Type of impact	Cause of threat	Comment	Scale of threat
		2005).	
Changes in genetic integrity	Importation and relaying of (seed) oysters of foreign origin on commercial beds	Mixing of potentially genetically different strains, from a different geographical origin, could result in problems with physiological adaptation; it can affect the genetic diversity of the species, and introduce diseases to non-resistant populations.	Medium

Forecast to 2020

Recovery is dependent on larval recruitment since the adults are permanently attached and incapable of migration. Recruitment is sporadic and dependent on local environmental conditions, hydrographic regime and the presence of a suitable substrate, especially adult shells or shell debris (Kennedy & Roberts, 1999). Recoverability is considered to be very low from substrate loss, smothering and introduction of microbial pathogens/parasites, in one case taking around 20 years (Spärck 1951, in Jackson 2001) (OSPAR, 2006). Recovery from extraction *per se* should not be an issue if the extraction is within sustainable limits.

There are many other factors that affect oyster stock abundance andcontribute to the high variability of recruitment. These are temperature, food supply, hydrodynamic containment in a favourable environment, anthropogenic effects (*e.g.* coastal development, waste disposal). Also spawning stock density or biomass may be too low in many areas to ensure synchronous spawning or sufficient larval production for successful settlement (UKBAP, 1999).

If spawning stock is present in an area the speed of recovery is closely determined by the frequency of successful recruitment events. Recovery of beds with very low spawning stocks is likely to be extremely slow given that the larvae are short lived and do not disperse over great distances, recruitment from other spawning populations is not likely to occur and generally populations are isolated from each other.

With regard to oyster production, an important issue for the industry is the development of a disease-tolerant strain to initiate a production recovery.

5. Existing Management Measures

O.edulis has been subject to exploitation and cultivation in countries surrounding the North Sea for many centuries. Management measures need to take account of the fact that it was and continues to be subject to husbandry and cultivation practices as well as fishing (UKBAP, 1999).

Useful management measures include continued regulation of the fishery, control of the spread of introduced species, reduction of the risk of transmission of disease and maintenance of a suitable habitat to support successful spatfall. In Ireland local management groups (Co-operatives or Societies) may use a range of management measures including seasonal fishing, season and daily quotas and minimum landing sizes based on a pre-season stock survey. Survey estimates may not be very precise however. Other management measures in Ireland have included the collection of spat on cultch for seeding previously known beds and other suitable areas. One area where this was successfully carried was in Tralee Bay. Together with management practices of bed rotation and providing nursery areas this elevated the fishery from a production of 7 tonnes in the 1980s to its current level of over 150 tonnes. Similarly work has been carried out in Clew Bay, Cork Harbour, Lough Swilly and Lough Foyle. For example in 1991 250 bags of spatted *O.edulis* cultch from Tralee Bay were transplanted to Lough Swilly and ongrown on trestles for over a year. There were approximately 1000 native oyster spat per bag of cultch. These oysters were subsequently seeded onto the seabed in 1993 when they were approximately 40 mm. As a consequence of mussel culture in the area, clean mussel cultch was available and in 1995 natural settlement of native oysters on the mussel cultch in the vicinity was reported.

The fact that the Irish beds have maintained stable production over the last 10 years is directly due to bed management and aquaculture techniques.

EU Regulations

Native oyster fisheries in Europe are managed by national legislation and the shellfish health and hygiene regimes under EU regulations (*e.g.* 95/70/EC and 91/492/EEC).

Oyster beds need to be included in the European Natura 2000 network by Member States, given that they qualify as one of the habitats of the Habitats Directive (reefs). In Ireland a number of oyster beds occur within Natura 2000 sites designated as large shallow inlets and bays (Annex I Habitat 1160). Harvesting of these stocks is subject to appropriate assessment as required by the Habitats Directive.

The Shellfish Growing Waters Directive provides for protection of the water quality of areas designated as shellfish production areas in Europe. In Ireland these include production areas for *O.edulis*. The designated shellfish waters are strongly supported by the oyster fishermen in Ireland who are very proactive in the management of potential pollution.

Council Directive 2006/88/EC stipulates minimum measures to be taken in response to suspected or established cases of certain diseases in aquaculture. Specifically to *O.edulis,* infections of *Bonamia* and *Microcytos* are covered by this directive. However, this is a tool for management of aquaculture products thus does not of itself include comprehensive guidance for managing diseases in wild populations.

National management plans

In some countries management or restoration plans exist or are under way for certain regions *e.g*. in Denmark (Dolmer & Hoffmann, 2004) while restoration programmes are under consideration in the UK (Laing *et al*., 2005) and Northern Ireland (Kennedy & Roberts, 2001).

The native oyster is listed as a priority species in the UK Biodiversity Action Plan (UKBAP, 1999). In this action plan, the evidence of a relationship between spawning stock biomass and recruitment is reviewed, and safe biological reference points are defined. Managers of regulated fisheries are provided with guidelines and a code of practice for habitat protection, stock management and species protection. Surveys of all wild stocks and fisheries to establish stock biomass, distribution and spat fall variability, including assessments of any recovery in areas previously contaminated by TBT, are continued and extended. The implications for genetic variability and biodiversity of using hatchery brood stock to produce seed for stock replenishment are assessed. When importing *O.edulis*, it should be transported from countries where no disease has been present for the past 2 years. In the United Kingdom efforts to manage *O.edulis* involve maintaining the abundance of stock at the fisheries while decreasing local densities to limit the spread of disease, especially *Bonamia ostreae* (UKBAP, 1999).

In Ireland there are initiatives in some cases to restore depleted stocks mainly in the provision of cultch where recruitment has been poor and there is evidence that suitable substrate is a limiting factor in recruitment. Other management initiatives have been described above.

6. Conclusion on overall status

No changes in the evaluation against the Texel-Faial selection criteria, see OSPAR (2008/358).

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

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

The protection of *O.edulis* beds within national, European (Habitats Directive) or OSPAR marine protected area mechanisms should be considered. This holds also for areas where the species was known to occur and where the habitat is still present. Restoration through the establishment of an MPA, could be considered in areas of known severe damage or loss, especially in areas were the habitat is still present. For example, a Belgian study demonstrated the value for a marine protected area with a gravely substrate, where oyster beds were known to occur (Haelters *et al*, 2007).

Natural recruitment of oysters may be limited by the availability of suitable substrate. Development programmes would require a large scale accumulation of brood stock and provision of cultch. In particular areas, restoration through seeding or translocation of adult *Ostrea* may be considered necessary to promote recovery of the habitat. However in view of the risk of genetic erosion and the possible introduction of non-native species or diseases, this option should only be considered after a thorough assessment.

In order to better understand the state of *O.edulis* beds across the OSPAR area and to follow any changes over time it is important to establish suitable long-term monitoring of the distribution, extent and quality of beds, their key threats, and the effectiveness of any conservation measures put in place. Therefore, Contracting Parties should be encouraged to complete habitat surveys of their sea areas. Such monitoring would need to focus on sites which are known to be damaged and areas subject to key threats, particularly from bottom trawling/dredging. Means of assessing habitat quality (including structural integrity of the beds) need to be developed, to facilitate monitoring of change over time. Monitoring of the effectiveness of EIA and licensing mechanisms should be considered.

The principal conservation objectives should be to maintain the existing geographical distribution of *O.edulis*, to expand the existing geographical distribution *of O.edulis* in its natural range, to increase the population, to preserve its genetic variability and, where possible, to restore viable and healthy *O.edulis* beds in areas they formerly occupied. In order to improve the species' chances of survival, these beds should be distributed throughout the natural range of the species and include offshore and coastal locations.

There is insufficient information to assess the overall extent of *O.edulis* beds in the whole OSPAR area or the condition of these beds. Consideration should be given to bringing together a specialist working group drawn from experienced scientists from the Contracting Parties where *O.edulis* is most common. The remit would primarily be to provide a more complete assessment of the distribution and status of *O.edulis* bed distribution and to advise on future monitoring including survey and sampling methods.

Brief Summary of the proposed monitoring system (strategy)

In order to assess the status and trends of *O.edulis* and *O.edulis* beds in the OSPAR region both historical data and contemporary information are needed.

It is suggested that existing methods be used where possible to maximise data continuity and extend surveys to all wild stocks. In certain areas the species is now extremely rare, requiring special monitoring techniques.

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

Ostrea edulis* was nominated for inclusion in the OSPAR List in 2001 by Belgium and the Netherlands. Contact persons: *Netherlands*:** *Gerhard Cadée, Netherlands Institute for Sea Research, PO Box 59, 1790 AB Den Burg Texel, Netherlands.* ***Belgium: *Jan Haelters & Francis Kerckhof, Management Unit of the North Sea Mathematical Models, 3[e] en 23[e] Linieregimentsplein, 8400 Oostende, Belgium*

Ostrea edulis* beds were nominated for inclusion in the OSPAR List in 2001 by the Netherlands and the UK. Contact persons: *Netherlands*:** *Norbert Dankers, Alterra, PO Box 167, 1790 AD Den Burg Texel, The Netherlands.* ***UK: *David Connor, Joint Nature Conservation Committee, Monkstone House, Peterborough PE1 1UA, UK.*

The information here is based on data supplied by the Contracting Parties.

Belgium: Until the early 20th century natural oyster beds occurred in certain areas of the Belgian part of the North Sea, *O.edulis* is considered virtually extinct in the wild and the last official record dates back to 1933.

Germany: Although *O.edulis* was a native species and *O.edulis* beds were once common in the German North Sea, they are considered extinct in German waters since the 1920s. Since then, only a few individuals have been found and recorded; these are believed to stem either from unknown refuges or having been released by oyster enthusiasts

Iceland: *O.edulis* has never been recorded in Iceland.

Netherlands Used to be more common, but has been extinct in the Wadden Sea since 1940. In the southwest of the Netherlands the species has been in decline since the sixties, through cold winters and disease (*Bonamia ostreae*). Since then it only occurs on one location (Grevelingenmeer). The remaining population is under threat of being replaced by the Pacific Oyster, which is also numerous in other locations in the southwest of the Netherlands. Current numbers of *O.edulis* are very low, only 3% of that in the 1970s.

Annex 2: Detailed description of the proposed monitoring and assessment strategy

Rationale

Monitoring should aim to provide data on the geographical distribution of oysters and of oyster beds, on biological aspects and health aspects of the population. These aspects should be included in the more general monitoring systems which exist for benthic species, or in certain areas be specifically developed for oyster beds where these still occur.

To assess the status and trends of *O.edulis* and *O.edulis* beds in the OSPAR region, historical data and contemporary information are needed.

Therefore, a combination of data mining and mapping, to assess the historical presence, spatial distribution and quality of *O.edulis* and *O.edulis* beds, updated with contemporary information and regular surveys are needed.

Therefore it is suggested to use as much as possible existing programmes and methods and thus to continue and extend surveys of all wild stocks and monitor fisheries to establish stock biomass, distribution and spat fall variability including assessments of any recovery.

As most general benthos survey programmes are not intended to detect rare or patchy occurring species, special techniques or programmes may be needed. In certain areas the species is now extremely rare, thus attention is needed to particular sampling methods such as scuba diving and video recording that can document the presence of the species. Monitoring programmes should be undertaken at a species level, and clearly differentiate *O.edulis* from *C.gigas* or other species.

Geographical distribution

Presence:

- *O.edulis*: record keeping and mapping (*e.g.* MarLIN) programmes
- *O.edulis* beds: monitoring programmes (national and international)

Distribution/extent:

- Historical: data mining (literature, museum collections)
- Recent: Existing benthos monitoring programs
- Habitat mapping projects (MESH, OSPAR habitat mapping project, etc)

Density: detailed monitoring programmes

Biological aspects

Monitoring should aim to include aspects of reproduction success, recruitment, composition and structure of the epifauna community, etc.

Aspects of population health

Important factors that can give an indication of population health, and which should therefore be monitored, are age structure, prevalence of disease, presence and spread of alien species and/or pests, in particular *C.fornicata* and *U.cinerea*, *C.gigas*, etc. Also toxin loads of wild and farmed stocks should be monitored.

Use of existing monitoring programmes

Existing shellfish monitoring and national and international benthic survey programmes (in the framework of the Habitats directive, or other national and international programmes such as ICES) can be used.

Marine Strategy Directive

The Strategy would be implemented through Marine Strategies to be developed for each Marine Region. Each Strategy would establish an integrated framework for achievement of environmental objectives.

In preparing the Marine Strategies, there would be an obligation to:

- Assess the pressures and threats impacting upon the marine environment and the costs (including environmental costs) of these pressures;
- Develop a monitoring and assessment programme to be carried out in each sea according to general indications given in the Directive but taking full account of the monitoring and assessment programmes which are already in place.

Thus member states shall establish and implement co-ordinated monitoring programmes for the ongoing assessment of the environmental status of their European marine waters that would include a description of the biological communities associated with the predominant habitats. This would include information on the typical phytoplankton and zooplankton communities including the typical species, seasonal and geographical variability and estimates of primary and secondary productivity. Information on the invertebrate bottom fauna including species composition, biomass, productivity and annual/seasonal variability should also be provided. Finally, information on the structure of fish populations including the abundance, distribution and age/size structure of the populations should be presented.

Synergies with monitoring of other species or habitats

Monitoring and prospecting for *O.edulis* and *O.edulis* beds can be performed simultaneously with the monitoring of other coastal and shallow water benthic habitats such as *Modiolus modiolus* beds, *Sabellaria* reefs and *Zostera* beds.

Assessment criteria

Assessment criteria will depend on the monitoring system used, its integration in existing programmes and the local situation concerning the presence of oysters and oyster beds.

Techniques/approaches

Techniques and approaches for monitoring will depend on the monitoring system used, its integration in existing programmes and the local situation concerning the presence of oysters and oyster beds.

Selection of monitoring locations

Selection of monitoring locations will depend on the monitoring system used, its integration in existing programmes and the local situation concerning the presence of oysters and oyster beds.

Timing and frequency of monitoring

Timing and frequency of monitoring will depend on the monitoring system used, its integration in existing programmes and the local situation concerning the presence of oysters and oyster beds.

Data collection and reporting

As a minimum, basic information should be reported in the framework of the habitat mapping activities within OSPAR, with both historic and current distribution data. To date, only three Contracting Parties have provided information on the distribution of *O.edulis* in their waters.

A database in which the types of monitoring and the frequencies are stored would be useful. Quality assurance procedure(s) should be applied in the collection and reporting of the data.

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