OSPAR
COMMISSION

Background Document for Littoral chalk communities

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 assessment has been prepared by Ian Tittley, c/o Natural History Museum, London, UK, on behalf of the Joint Nature Conservation Committee (JNCC), Monkstone House, Peterborough, PE1 1UA

Photo acknowledgement:
Cover page: Littoral chalk communities, ©Willie McKnight, Natural England

Contents

Background document for Littoral chalk communities....3
Executive Summary 3
Récapitulatif 3
1. Background information 3
Name of habitat 3
Definition of habitat....3
Correlation with habitat classification schemes....4
Common characteristics of habitat 4
2. Original evaluation against the Texel-Faial selection criteria....4
List of OSPAR Regions where the habitat occurs....4
List of OSPAR Regions and Dinter biogeographic zones where the habitat is under threat and/or in decline 4
Original evaluation against the Texel-Faial criteria for which the habitat was included on the OSPAR List 4
Relevant additional considerations....5
3. Current status of the habitat....6
Distribution in OSPAR maritime area 6
Extent of habitat (current/trends/future prospects) 7
Condition of habitat (current/trends/future prospects) 8
Limitations in knowledge 9
4. Evaluation of threats and impacts 9
Key threats....9
Forecast to 2020....10
5. Existing management measures....10
6. Conclusion on overall status 11
7. What action should be taken at an OSPAR level? 12
Action/measures that OSPAR could take, subject to OSPAR agreement 12
Brief summary of the proposed monitoring system 12
Annex 1: Overview of data and information provided by Contracting Parties 13
Annex 2: Detailed description of the proposed monitoring and assessment strategy 18
Rationale for the proposed monitoring....18
Use of existing monitoring programmes 18
Synergies with monitoring of other species or habitats 18
Assessment criteria....18
Techniques/approaches....19
Selection of monitoring locations 19
Timing and frequency of monitoring....19
Data collection and reporting 19
Quality assurance 19
Annex 3: References 20

Background document for Littoral chalk communities

Executive Summary

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

Récapitulatif

Le présent document de fond sur les communautés des calcaires du littoral a été élaboré par OSPAR à la suite de l'inclusion de cet habitat 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 cet habitat 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 des communautés des calcaires du littoral dans la Liste OSPAR est suivie d'une évaluation des informations les plus récentes sur son statut (distribution, étendue et condition) et des menaces clés, préparée en 2008-2009. Le chapitre 7 recommande des actions et mesures à prendre éventuellement afin d'améliorer l'état de conservation de l'habitat. OSPAR poursuivra ses travaux, en se fondant sur ces recommandations, afin de s'assurer de la protection des communautés des calcaires du littoral, 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 habitat

Littoral chalk communities

Definition of habitat

The erosion of chalk exposures on the coast has resulted in the formation of vertical cliffs and gently-sloping intertidal platforms with a range of micro-habitats of biological importance. Supralittoral and littoral fringe chalk cliffs and sea caves support various algal communities unique to this soft rock type. Orange, brownish or blackish gelatinous bands of algae, composed of an assemblage of Haptophyceae species such as *Apistonema* spp., *Pleurochrysis carterae* and the orange *Chrysotila lamellosa*, but other genera and species of Chrysophyceae, Haptophyceae and Prasinophyceae are likely to be present as well (Tittley, 1986, 1988). The lower littoral fringe may be characterised by a dense mat of the green algae *Ulva* and *Enteromorpha* spp., various small red and brown algae, *Fucus spiralis* and *Ulva lactuca*. Lower down the shore in the eulittoral the generally soft nature of the chalk results in the presence of a characteristic flora and fauna, notably 'rock-boring' invertebrates such as piddocks and *Polydora* sp, overlain by mostly algal-dominated communities (fucoids and red algal turfs) (George *et al*., 1988, 1989; Gubbay, 2002; Tittley *et al*., 1986, 1998, 2002, 2006; Tittley, 2006). Such coastal exposures of chalk are rare in Europe, with those occurring on the southern and eastern coasts of England accounting for the greatest proportion (57%) (ICES, 2003). Elsewhere, this habitat occurs in France, Denmark and Germany.

(Source: 2008 Case Report)

Correlation with habitat classification schemes

EUNIS (2007; http://eunis.eea.europa.eu/habitats.jsp) codes: Various including A1.126, A1.2143, A1.441, B3.114 and B3.115.

National Marine Habitat Classification for Britain and Ireland (2004) codes: Littoral chalk habitats (various including LR.HLR.FR.Osm, LR.MLR.BF.Fser.Pid, LR.FLR.CvOv.ChrHap, LR.FLR.Lic.Bli and LR.FLR.Lic.UloUro).

Common characteristics of habitat

There are three main types of chalk (Upper, Middle, Lower) that differ in hardness and flint content (a siliceous rock deposited along bedding planes or vertical joints in chalk strata). Chalk at Flamborough Head (Yorkshire) is harder due to compression by overlying strata and by glaciation. On the Isle of Wight and in Dorset, chalk is vertically bedded, in contrast to the horizontal bedding found elsewhere in the UK (www.ukbap.org.uk/UKPlans.aspx?ID=31).

Chalk in Northern Ireland is known as Ulster White Limestone, and in contrast to the relatively soft chalks of southern England, it forms extremely hard, low porosity deposits due to secondary calcite cementation within the pore spaces. As a result it is very resistant to erosion. Eventually erosion results in the formation of cliffs and shore platforms, dominated by cobble and boulder spreads with subtidal reefs.

Many of the communities associated with littoral chalk are not particularly rich in species; however some species that make up these communities are scarce in Britain e.g. Chrysophycean algae and piddocks (pholadidae). The species and their restricted presence (e.g. at Thanet, Kent) may be due to the porosity and dampness of chalk (Tittley et al., 1997, 2002, 2006).

2. Original evaluation against the Texel-Faial selection criteria

List of OSPAR Regions where the habitat occurs

OSPAR Regions: II. Chalk communities associated with Ulster white limestone also occur in Region III.

Biogeographic zones: Boreal and Boreal Lusitanean

List of OSPAR Regions and Dinter biogeographic zones where the habitat is under threat and/or in decline

OSPAR Regions: II
Biogeographic zones: 11 - Boreal

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

Littoral chalk communities were nominated by one Contracting Party, citing decline, rarity and sensitivity, with information also provided on threat.

Rarity: Coastal exposures of chalk are rare in Europe with the greatest proportion (57%) and many of the best examples of littoral chalk habitats located on the coast of England. There are around 120 km of chalk coastline on the French coast of Upper Normandy and Picardy and some chalk exposures at the coast in Denmark and Germany.

Sensitivity: The marine communities associated with littoral chalk habitats are generally tolerant of a high degree of turbidity. The most sensitive elements of the marine communities are probably the algae that are found in the splash zone of cliffed coasts.

Decline: A recent survey of chalk cliffs throughout England revealed that 56% of coastal chalk in Kent and 33% in Sussex have been modified by coastal defence and other works. On the Isle of Thanet (Kent) this increases to 74%. There has been less alteration of chalk at lower shore levels except at some large port and harbour developments e.g. Dover and Folkestone (Doody *et al.,* 1991; Fowler & Tittley, 1993). Elsewhere in England, coastal chalk remains in a largely natural state.

Threat: The main threats to littoral chalk communities are from coast protection works, toxic contaminants and physical loss (Anon, 2000; Fletcher, 1974; Fowler & Tittley, 1993; Tittley et al., 1999; Wood & Wood, 1986). Coast protection work has led to the loss of micro-habitats on the upper shore and the removal of splash-zone communities, including the unique algal communities. The deterioration of water quality by pollutants and nutrients has caused respectively the replacement of fucoid-dominated biotopes by mussel-dominated biotopes, and the possible occurrence of nuisance blooms *of* the green alga *Enteromorpha* spp.

A potential factor affecting the chalk biota is human disturbance especially by trampling, stone-turning, small-scale fishery and damage to rocks though removal of piddocks. Chalk exposures in the Straits of Dover are also vulnerable to oil spills due to the proximity of major shipping lanes. Native species along the coast have been displaced, for example by the seaweeds *Sargassum muticum* and *Undaria pinnatifida*. These threats are potentially significant primarily because of the relatively restricted distribution and small total area of this habitat type.

Relevant additional considerations

Sufficiency of data: There is a limited but good basis for assessing the extent and status of littoral chalk habitat in the OSPAR Area. It is also clear that some areas of habitat have been lost to development and coastal protection works, but in many other areas the habitat has undergone a degree of modification.

Changes in relation to natural variability: The natural erosion of chalk coastlines will result in changes in the extent of the habitat and has caused some dramatic cliff falls such as those in France at Ault (Somme) in October 1998, and at Le Tilleul (Seine Maritime) on November 1998. Falls at Beach Head (UK) in January 1999 resulted in an estimated 100,000 m^3 of chalk debris and 150,000 m^3 at Puys (France) in 2000 (Duperret et al., 2001). Sea level rise and post-glacial land adjustment are expected to submerge areas of intertidal chalk platforms.

Expert judgement: There is clear evidence of threats and declines of this habitat in some areas (OSPAR Region II) and therefore a good case for listing without much emphasis on the need for expert judgement to assess the significance of any qualitative or anecdotal information.

ICES evaluation: ICES finds that there is good evidence of declines and threat in some OSPAR regions and the precautionary approach would see this consideration extended to the whole OSPAR area (ICES 2002). This is based on the view that there is a clear and present danger to the existence of this habitat, primarily from physical threats such as development of ports or coastal protection works and from water quality threats, including those arising from maritime accidents, as many of the sites are in regions of high shipping activity.

3. Current status of the habitat

Distribution in OSPAR maritime area

Littoral (intertidal) chalk is of very limited occurrence in Europe and is only found in UK, France, Germany and Denmark. The exposures in Germany (Island of Rügen) and Denmark (chalk cliffs on Sjaelland at Stevns Klint) occur in the Baltic Sea. Within the OSPAR region *Littoral chalk communities* are now only found in France and the UK, as the small exposure of chalk at Dune Island in the German North Sea was lost in the 17th Century. Apart from the rather different chalk of Northern Ireland, coastal outcrops in the OSPAR area are restricted to the eastern English Channel and southern North Sea (Figure. 1).

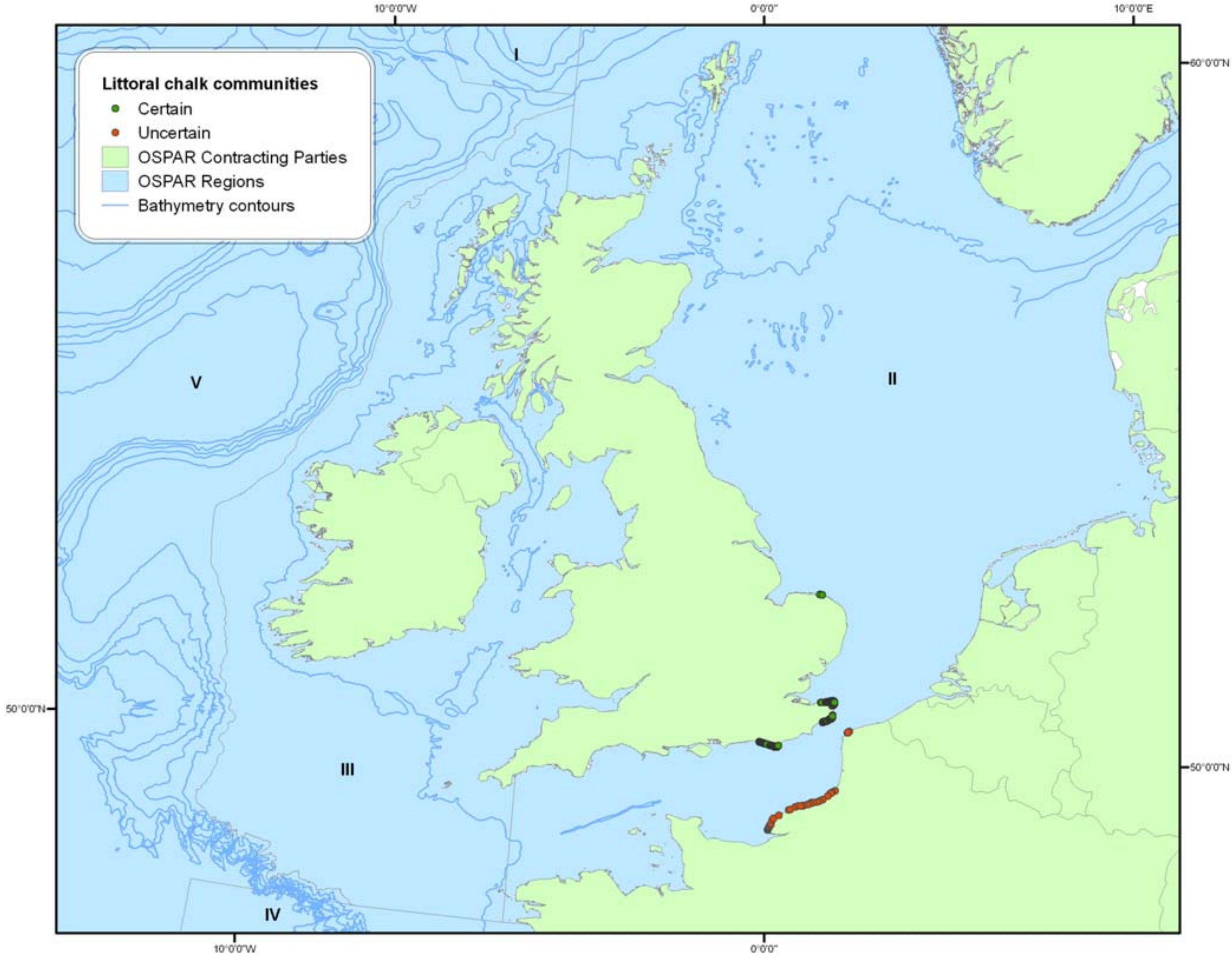

Figure 1. Distribution of Littoral chalk communities in the OSPAR maritime area, based on data supplied by Contracting Parties to December 2008. Records for the UK (Northern Ireland, Dorset, Isle of Wight and north-east England) and Germany (an historical record for Dune Island) have not been reported to the OSPAR database; post-1998 information is available for Kent, Sussex and the Isle of Wight but is not in the OSPAR database.

In France there are approximately 125 km of chalk outcrops in Normandy between Le Havre and Dieppe and east to Ault, (long) as high cliffs, caves and extensive wave-cut platform at intertidal and subtidal levels ('Beaches at Risk' report). There is a small chalk outcrop at Cap Blanc Nez with high cliffs but the wave-cut platform is mostly covered by sand (Tittley & Price, 1978).

In the UK, coastal chalk cliffs and platforms are exposed principally in the south and east of England, from Dorset (in the west) to Flamborough Head (in the north). In Northern Ireland, Ulster White Limestone Formation exposures are present on the County Antrim coast (www.ukbap.org.uk/UKPlans.aspx?ID=31).

The small chalk outcrop in Dune Island by Helgoland (German Bight, North Sea), known as Muschelkalk, is similar to chalk in England and France. The remains of the chalk island show ecological features similar to those in England. The chalk cliff and intertidal area was lost in the 17th century resulting from a combination of natural erosion and quarrying. Today, chalk is exposed only as subtidal reefs at this site, where it is characteristically piddock-bored and supports algal communities.

Globally, coastal chalk is a scarce resource; it occurs in the United States, Australia, the Middle East and Russia (Fowler & Tittley 1993).

Changes in distribution: The overall distribution of the habitat has remained the same in recent geological times, except for the very small outcrop (of white chalk cliffs) on Dune Island, Germany, which was lost in the 17th century as a consequence of natural erosion and quarrying (Vahlendieck, 1992).

Extent of habitat (current/trends/future prospects)

The UK holds 57% of Europe’s coastal chalk, whilst France holds 43%.

> **UK:** In the UK chalk forms less than 0.6% (113 km) of the coastline. Kent holds a higher proportion of the national resource than any other county, with approx 35% of UK coastal chalk (418 ha), along a 27 km stretch of chalk cliffs at Thanet. The extent of coastal chalk in the UK has been reduced by the construction of harbours and ports. Considerable extents of upper littoral and littoral fringe chalk habitat have been lost by coastal protection. Other losses have occurred through land claim in connection with construction of the Channel Tunnel. The chalk coastline of southern England has numerous small groynes, breakwaters, shipwrecks, effluent pipes and other structures which have also resulted in some loss of this habitat.
>
> **France:** In Upper Normandy there is 125 km of chalk coastline with vertical cliffs and sub-horizontal intertidal platforms. Within this sector about 25 km, between the cap d'Antifer and the cap Fagnet (Fécamp) remain very rich in species diversity and algal bands; in particular there is a band of kelp present. To the north and south of this sector (which merits some sustainable development measures) the habitats are much deteriorated: algal bands are impoverished or non existent, which affects the algal grazers and associated benthic fauna in particular.
>
> **Germany:** The total extent of intertidal chalk outcrop on Dune Island was lost in the 17th century (Vahlendieck, 1992); sublittoral reefs still occur around the island.

Future prospects: Future prospects for this habitat in the UK are generally good. The landscape, geological and coastal conservation importance of coastal chalk is now more widely recognised (e.g. 'Thanet Coastal Project', Kent County Council 'Habitat Action Plan', and Environment Agency 'Shoreline Management Plan' e.g. Grain to South Foreland). Sections of the chalk coast on the Grain to South Foreland section have been designated 'Hold the line' and 'No active intervention' i.e. will not be the site of future coastal defence works.

Factors likely to further reduce the extent of littoral chalk communities include piecemeal small developments, e.g. repairs to sea walls and other foreshore structures. In the longer term, the intertidal extent may decrease due to isostatic readjustment (sinking of south-east England), natural horizontal erosion, and sea-level rise due to climate change.

No information was available for France.

Condition of habitat (current/trends/future prospects)

UK: Littoral chalk communities on the English coast can be placed into groups reflecting their current (condition) status, as shown in Table 1.

Table 1. Categorisation of the condition of *Littoral chalk communities* on the English coast

Poor condition	Urban harbour and port areas: Margate, Ramsgate, Dover, Newhaven, Brighton
Moderate condition	Urban area with extensive coastal protection affecting upper littoral: Thanet, Kent (excepting above); St Margaret's Bay, Kent; Brighton to Peacehaven, Sussex Claimed foreshore and coastal protection: Dover to Folkestone
Good condition	Slightly disturbed due to leisure, field trips, foreshore constructions: Cromer to Sheringham, Norfolk Slight disturbance with some foreshore constructions, wrecks: Kingsdown to St Margarets Bay, Kent; South Foreland to Dover, Kent; Peacehaven to Newhaven, Sussex Some non-native species and some leisure activity: Studland to Old Harry, Dorset
Approaching pristine condition	Lengths of undisturbed cliff, intertidal and subtidal: Flamborough Head, Yorkshire; Beachy Head to Seven Sisters, Sussex; Culver Cliff, Freshwater to Needles, Isle of Wight

There is a long time-series of biological information for chalk shores in the UK (cf. Tittley 1999, 2005a, b, c) against which threats impacting associated species can be assessed. The spread of non-native species such as the oyster *Crassostrea gigas* to Thanet on the north Kent coast (from a nearby oyster farm at Seasalter) and the seaweed *Sargassum muticum* to Thanet and other chalk areas has had a negative effect on the communities. Sewage discharge has resulted in fucoid-characterised shores being replaced by mussel-dominated communities and blooms of the green alga *Ulva* sp. in Northern Ireland (Northern Ireland Biodiversity Action Plan, 2005). This has also been observed at sites in Thanet.

France: The chalk coast of northern France has less coastal protection compared with England (despite a more rapid rate of erosion) and appears to be in a more natural state compared to that in England, with fewer man-made structures (groynes, breakwaters, pipes). The harbour areas at Le Havre, Fecamp and Dieppe have harbour walls and jetties.

The sandbanks within the intertidal zone of the Pays de Caux, which have been accentuated by large port and industrial developments (harbour walls for the port of Antifer and the power stations of Paluel and Penly, outer port of Dieppe) have adversely affected the bands of algae and their associated benthic fauna.

BAR (Beaches at Risk) researchers[1] have found that the chalk cliffs of Normandy are retreating more quickly than their Kentish counterparts, at an average rate of approximately 21 cm per year. Erosion is least in the west, near Etretat and Cap D'Antifer (only 8–13 cm per year) and greatest in the east, reaching 28 cm per year near Dieppe.

Other known pressures and impacts include the following:

- Non-native species e.g. *Sargassum muticum* are present at Dieppe, Etretat and Le Havre.
- The coast is popular with tourists thus damage through trampling may be a problem.

[1] www.geogr.sussex.ac.uk/BAR/publish/Interim%20Report.pdf

- Eutrophication of inshore waters has an impact on the ecological communities associated with chalk.

Trends in condition/forecast of likely changes over next ten years

UK: Anthropogenic pressures have caused a rapid decline over the 20th century due to urbanisation, expansion of ports and harbours, improvement of coastal engineering, and the considerable extension of coastal protection. However, over the last 5 years deterioration from anthropogenic causes has probably lessened. Coastal erosion, both horizontal and vertical, can be considerable, but is a natural coastal process and is important for the formation of microhabitats in the chalk cliffs.

France: No information available

Limitations in knowledge

There is a large disparity in the amount of UK and French biodiversity, ecological and environmental data available for this habitat. The majority of information is UK-specific and Information on the French littoral chalk communities is historically limited and recent studies are currently not accessible.

At least one management plan (North-east Kent Marine Sites, prepared by the Thanet Coastal Project) has identified the following issues requiring research: affects of the spread of non-native species, unlicensed shellfish harvesting, leisure activities and disturbance to bird populations.

4. Evaluation of threats and impacts

Key threats

Current human activities impacting or having the potential to impact littoral chalk communities are summarised and categorised in Table 2. There has been a change in the type of threats over time; the main threats were formerly coastal engineering through urban and port expansion, shifting to pollution of inshore waters, public access and disturbance, and now the impact of non-native species.

Table 2. List of human activities and their effects (pressures) which impact littoral chalk communities in the OSPAR area.

Type of pressure	Cause	Locations affected	Scale of threat
Loss of substratum	Quarrying	Dune Island, Germany	High (but in past)
Change in substratum (to artificial)	Sea walls and coastal defence	UK - Kent, Sussex, Antrim	High (particularly in past)
	Port/ harbour construction	UK - Kent, Sussex	High (particularly in past)
Change in substratum (to land)	Land claim	UK - Kent	High (particularly in past)
Visual disturbance (to birds)	Coastal defence, port, harbour and other construction works; dog walking, horse-riding	North Sea, English Channel	Low
Eutrophication/ nutrient loading	Discharge, agricultural run-off	North Sea, English Channel	Low
Sea temperature increase	Climate change	North Sea, English Channel	Potential in future
Removal of species, including over-harvesting	Fishing/potting and shellfish harvesting	North Sea, English Channel	Low

Type of pressure	Cause	Locations affected	Scale of threat
Introduction or spread of non-native species	Oyster farming	North Sea, English Channel	Moderate
Hydrocarbon contamination (oil spills)	Maritime transport/navigation	North Sea, English Channel	Moderate
Damage to chalk habitats/alteration to ecology, e.g. through trampling	Tourism/recreation/research/education/ shellfish harvesting	North Sea, English Channel	Low
Litter	Tourism/recreation	North Sea, English Channel	Low
Noise disturbance (to birds)	Motor cycling	North Sea, English Channel	Low

Forecast to 2020

The current and foreseeable pressures that are expected to affect the condition of this habitat are:

- Continuing spread of non-native species
- Harvesting (locally)
- Eutrophication of inshore waters
- Urban spread and port construction
- Coastal erosion (leading to coastal squeeze and habitat loss)
- Sea-level rise
- Temperature changes (climate change)

5. Existing management measures

UK: There has been less damage to the chalk coasts in the UK since the 1990s due to much improved environmental awareness. A major contribution was the Marine Nature Conservation Review, undertaken between 1987 and 1998, and the UK Biodiversity Action Plan (Anon., 2000) which identified coastal chalk as a habitat of national importance. The UKBAP recognised the relative rarity, geological and biological importance of chalk and its geomorphological expression as arches, caves, stacks, cliffs, foreshore of channels and pools as well as subtidal habitats. This has led to improved understanding of the biodiversity of chalk habitats through recent study.

Most chalk coasts in the UK now have some form of statutory or non-statutory nature conservation or landscape designation (e.g. SAC, SPA, SSSI, SLNCI, IPA, AONB, MEHRA) to reflect their biological, geological and landscape importance. As a result of SAC designation (e.g. Flamborough Head SAC) and the Water Framework Directive, there has been improved awareness and monitoring of inshore water and ecological quality.

There has been recent recognition that natural coastal processes should be allowed to continue and not be unduly inhibited, for example on the north Kent coast.

These management strategies have been largely successful, such that further loss of chalk cliff habitat around Thanet is now considered unlikely, in contrast to 20 years ago when development along the entire coastline could have been possible.

France: Actions and measures to protect this OSPAR habitat are given by the Coastal and Aquatic Environment Commission of the Upper Normandy regional council (hosted by the Agence de l'Eau Seine Normandie (Honfleur)) but no further information has been made available for this document.

6. Conclusion on overall status

The overall prognosis for preventing further deterioration in the current state of the habitat (in the UK) is good. As a result of activities over the past two decades, national, regional and local agencies have greater awareness of the landscape, geological, biological conservation importance of coastal chalk habitats. Coastal development in the future will be strictly reviewed and is expected to have a much-reduced impact compared with the early to mid 20th century. The UK Environment Agency's Shoreline Management Plan, when implemented, is expected to benefit coastal chalk habitat. The designation of sites as SAC (and SPA for birds) is resulting in monitoring of the designated features, including use of improved techniques. Monitoring for the Water Framework Directive is expected to gather additional biological information on the ecological quality of the habitat. Education and information is contributing to improved general public awareness.

No information was available for France.

Table 3. Updated evaluation of littoral chalk communities against the Texel-Faial criteria.

Criterion	Comments	Evaluation
Global importance	Globally, coastal chalk is a scarce resource; it occurs in the United States, Australia, the Middle East and Russia (Fowler & Tittley 1993). The proportion of habitat within the OSPAR area is not known; however the communities supported in the OSPAR area are likely to be quite different to other parts of the world, given the differing biogeographic regions in which they occur.	Probably qualifies (on basis of community characteristics)
Regional importance	Within the OSPAR area, this habitat is concentrated in a small part of Region II (North Sea) and a very small part of Region III (Celtic Seas).	Qualifies
Rarity	Coastal chalk comprises less than 0.1% of the OSPAR region coastline (only 0.6% of the UK coastline and a similar proportion of the French coastline).	Qualifies
Ecological significance	The habitat has only limited ecological significance beyond its own extent. It supports some bird species. It is however important as a natural coastal defence.	Does not qualify
Sensitivity	The marine communities associated with littoral chalk habitats are generally tolerant of a high degree of turbidity. The most sensitive elements of the marine communities are probably the algae that are found in the splash zone of cliffed coasts; these are likely to recover relatively quickly from adverse impacts.	Probably does not qualify
Decline	Substantial lengths of coastal chalk have been lost in the past, through land claim, quarrying and coastal defence works (for example 56% of coastal chalk in Kent and 33% in Sussex have been modified by coastal defences). Additionally the communities are subject to a variety of coastal pressures. There has been less alteration of chalk at lower shore levels, except at some large port and harbour developments e.g. Dover, Ramsgate, Brighton (Doody et al., 1991; Fowler & Tittley, 1993). The main threats to littoral chalk communities at present are from further coast protection works, non-native species (e.g. *Sargassum muticum, Grateloupia turuturu*), eutrophication and physical damage (e.g. through trampling). The habitat faces longer-term threats arising from the impacts of climate change (sea-level rise, temperature change, coastal squeeze).	Qualifies, with continued threat

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

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

Management of both terrestrial and maritime activities will be important in controlling ongoing and future factors which may lead to the further decline of this habitat. This primarily falls under the remit of national planning authorities and should include decisions about the siting of coastal developments and improvements to water quality. Environmental Impact Assessments should be undertaken for all new developments.

Although many remaining areas of the habitat are protected through various nature conservation designation mechanisms, given the scarcity of the habitat and the range of threats, further areas could be designated (e.g. as OSPAR MPAs). It should be noted that littoral chalk habitats can be protected via the EC Habitats Directive, under the Annex I habitat "reefs", and could therefore be included in the Natura 2000 network.

Management plans for existing protected sites need to ensure that activities on the sites are not leading to further deterioration of the habitat.

From an OSPAR perspective, the effectiveness of management activities by the relevant Contracting Parties should be monitored, e.g. through periodic reporting.

Brief summary of the proposed monitoring system

A balanced monitoring programme, based on the Pressure-State-Response model, should be undertaken:

- **Pressures** – in particular, the levels of eutrophication and physical damage from trampling and boulder-turning (e.g. for peeler crabs).
- **State (coarse-scale)** – initially, detailed mapping of the extent of the habitat and the extent of coastal protection and other forms of habitat modification, followed by periodic assessment of gross changes in habitat extent and formation (e.g. cliff erosion).
- **State (fine-scale)** – monitoring of community-level characteristics at selected sites, in relation to key pressures (eutrophication, physical disturbance, non-natives), with reference sites in undisturbed areas.
- **Response** – monitoring of the effectiveness of Impact Assessments for all new proposals, in ensuring continued protection of the habitat. Assessment of the effectiveness of management plans for protected areas.

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

UK

Overview: Littoral and sublittoral chalk is a rare feature in the UK and forms only 0.6% of the UK coast. It is largely restricted to the east and south coasts of England. Until recently the main threat to the habitat has been from coastal development and protection that has resulted in the loss of considerable lengths of upper littoral chalk. Port and harbour constructions have caused the loss of habitat at littoral and sublittoral levels. Further considerable loss of littoral and sublittoral chalk in the UK is unlikely as it is now well recognised for its geological, biodiversity and ecological features. The principal threats now arise from extraction of resources (fish/ shell fisheries), spread of non-native species, possible maritime accidents and people-pressure through leisure and educational activities. Deterioration of water quality is now less likely as the WFD requires maintenance or even improvement of ecological and water quality. Most of the chalk coast of the UK has management designations and there is regular monitoring for Habitats Directive, Water Framework Directive and other purposes and the data gathered will contribute to biological and ecological condition status assessment for chalk shores. Threat monitoring can be pursued through planning requirements, social science studies of human activity on the coast, and sea-fisheries monitoring. Overall the prognosis for the maintenance of littoral chalk features is positive with most threats manageable with perhaps the exception of non-native introductions (despite legislation to control this). Modern approaches to shoreline management now allow for natural coastal processes (i.e. erosion of coastal chalk) to occur; this benefits biodiversity and ecological features, as well a creating the geomorphological features that contribute to chalk habitat diversity. Climate change and sea-level rise could potentially have a profound impact on the ecology and biodiversity of littoral chalk as it could suffer coastal squeeze to the point of near elimination.

Distribution and formations: Extensive chalk wave-cut platforms (known as reefs) are found in Kent at Thanet, between Kingsdown and Dover and to a lesser extent between Dover and Folkestone. In addition, Thanet supports the second-most extensive chalk sea cave formations in the UK, with a smaller number of caves between Kingsdown and Dover.

There is coastal chalk in Yorkshire at Flamborough Head (cliffs, caves, intertidal wave-cut platform; cf. George et al., 1988); North Norfolk at Sheringham-Cromer (cf. George et al., 1988): a short outcrop (approx 3 km) with no chalk cliffs but an extensive wave-cut platform at intertidal and shallow subtidal levels; in Kent at Kingsdown (near Deal), Dover towards Folkestone: cliffs of layers of upper middle and lower chalk; wave cut platform; East Wear Bay (near Folkestone): a small outcrop of soft, gault-like, grey chalk-marl-clay (below white chalk); in Sussex from Beachy Head to Brighton: chalk cliffs, extensive wave cut platforms extending offshore subtidally (Tittley, 2006); layered chalk (upper, middle, lower); on the Isle of Wight at two places, Culver Cliff and Freshwater Bay to the Needles (cf. George et al., 1989). Chalk layers are inverted with harder lower chalk outmost. Intertidal wave-cut platform where present narrow but which extends subtidally; high cliffs bored by sea-caves; in Dorset at Studland (cf. George et al., 1989): short outcrop of chalk cliff and wave cut platform; and in Devon at Beer Bay Devon (cf. George et al. 1989): very small outcrop of chalk cliff and foreshore boulders.

Extent: The overall geological extent will largely remain the same; however, the chalk coastline is subject to aerial and marine erosion and will have changed locally over past millennia. Wave-cut platforms and their topography is an indication of the position of former chalk coastlines. Change in chalk coastline, its topography and geomorphology, can be seen from past maps and other illustrative material.

The extent of coastal chalk (cliff, intertidal and subtidal wave-cut platform) has been reduced by the construction of harbours/ports at Margate, Ramsgate, Dover, Newhaven, and Brighton at Black Rock. Considerable extents of upper littoral, littoral fringe chalk habitats on Thanet (see Fowler & Tittley, 1993), sporadically between Kingsdown (Deal) and Folkestone, and between Peacehaven and Brighton have been reduced by coastal protection. A section of chalk intertidal and inshore subtidal chalk coast between Shakespeare Cliff Dover and Abbot's Cliff was lost through land claim in connection with Channel Tunnel construction. The chalk coastline of southern England is littered with many small groynes, breakwaters, shipwrecks, effluent pipes and other structures; a lighthouse has been built on chalk foreshore at Beachy Head. Seaside resorts, e.g. Cromer, Margate, Brighton, have piers/jetties. Less spoilt sections of chalk coast are at Flamborough Head in Yorkshire, South Foreland in Kent, Seven Sisters in Sussex, and on the Isle of Wight.

The rate of coastal protection on Thanet (from Fowler & Tittley, 1993) is given in the Table 4.

Table 4. Increases in the extent of coastal protection in the UK (1900-2008) (Fowler & Tittley, 1993).

Year	Length of coastal protection (km)	Proportion (%) of coastal protection
1900	4.25	19.5
1930	8.25	36.0
1940	10.0	43.5
1960	10.25	44.5
1965	14.25	62.0
1970	14.75	64.0
1982	16.0	70.0
1984	16.5	72.0
1986	17.1	74.0
1990	17.1	74.0
2000	17.1	74.0
2008	17.1	74.0

Assessment of pressures: The following activities have been identified as previously impacting *Littoral chalk communities*; dumping of solid waste and dredged spoils, construction of ports and harbours, coastal defence, traffic infrastructure, land-based activities, aquaculture/ mariculture, shipping and navigation, military activities, pipelines, fishing, hunting and harvesting, tourism and recreational activities and research. An assessment of all main activities is given in Table 5.

Table 5. Evaluation of human activities and their potential effects on *Littoral chalk communities*

Human activity	Assessment of pressures on littoral chalk communities
Extraction of sand, stone and gravel	Not aware of coastal chalk quarries in England (they are mostly inland)
Oil and gas exploration and exploitation and of other mineral resources	Not aware of impact on habitat
Dumping of solid waste and dredged spoils	Reclamation of foreshore areas for Channel Tunnel which used excavated material
Constructions (e.g. artificial islands, artificial reefs, offshore wind-farms)	Ports and wind-farms offshore of Thanet, Kent

Human activity	**Assessment of pressures on littoral chalk communities**
Coastal defence measures	Extensively around Thanet and Brighton areas, sporadically elsewhere
Traffic infrastructure (e.g. dredging of navigational purposes)	Subtidal chalk excavated to make deep-water channels entrance to Ramsgate Harbour extended in the 1980's (JNCC/English Nature undertook some subtidal surveys on this in 1997)
Land-based activities (emissions and inputs from e.g., agriculture, forestry, industry, urban waste water)	Formerly urban waste discharge (Cromer monitoring - see Document 1 - was in relation to removal of inshore to offshore discharge). Inshore waters in southern North Sea are probably eutrophic due to agricultural and urban run-off. Suspicion of 'green-tide' effect on Thanet coast (see Tittley et al., 1998 and Wilkinson (2005).
Placement and operation of pipelines	Formerly many waste-water discharge pipes, but now taken out further to sea by means of directional drilling
Fishing, hunting, harvesting	Inshore netting for fish along Thanet coast; unofficial gathering of shellfish along Thanet coast (currently being investigated); inshore angling from boats and piers/jetties not uncommon. Potting for crustaceans (e.g., Dover area, Isle of Wight west).
Tourism and recreational activities	Major tourist resorts at Sheringham, Cromer, Margate, Broadstairs, Ramsgate (Thanet), St Margaret's Bay (south Foreland), Seaford, Newhaven, Brighton coast. Sea-shore trampling, rock-pooling are common activities, as are jet skiing, windsurfing, horse riding, dog-walking (possible disturbance to Bird population in North East Kent SPA). Codes of practice for coastal activities have been produced by the 'Thanet Coast Project'.
Research & education	Not uncommonly undertaken by Museums, Marine Laboratories, Universities, Government Agencies, Private Consultancies and the voluntary sector (Wildlife Trusts, Natural History Societies). School and university field trips commonly undertaken on most chalk shores
Bio-prospecting	Unaware of any at present
Aquaculture/mariculture	Spread of non-native oyster *Crassostrea gigas* to Thanet coast probably from nearby oyster farm at Seasalter on the north Kent coast Spread of non-native alga *Sargassum muticum* (and other algal species) to Thanet and other chalk shores as a result of importation to Europe of insufficiently quarantined oysters.
Shipping and navigation	Most chalk shores in south-eastern England and northern France lie adjacent to major shipping lanes; possibility of shipping accidents and oil spills (cf. MEHRAs). Ships have been grounded on chalk shores in inclement weather
Military activities	World war II fortifications along chalk coasts.
Placement and operation of submarine cables (including the use of the water body as a conductor for electricity)	Cables from Thanet wind-farm to Richborough may cross sublittoral chalk (needs confirmation).

Management: In Thanet, volunteer Coastal Wardens maintain a watching eye on the coast; NGOs (e.g. Kent Wildlife Trust Shoresearch and Seasearch) undertake regular marine recording and observation.

Other targets for the protection of chalk habitats are set out the 2007 Management Plan produced by the 'Thanet Coast Project'. Additionally, the 'Thanet Coast Project' is considering designating 'no-take' areas, to retain sections of chalk coast in as near-natural state as possible (see also Tittley *et al*., 1999). Thanet SAC, and Thanet Coast Project have also been successful in addressing anthropogenic impacts. A more comprehensive collation of marine data for *Littoral chalk communities* would create a useful contribution to the management of littoral and sublittoral chalk.

The following is a list of chalk sites in the UK and their corresponding protection mechanisms:

Site	**Protection**
Ramsgate to South Foreland	MEHRAs (two)
Kingsdown Cliffs to Dover	SSSI
South Foreland, Dover-Folkestone	HC [Heritage Coast]
Folkestone Warren	SSSI
Beachy Head - Seaford	SSSI, AONB, HC, VMCA [Voluntary Maine Conservation Area]
Newhaven- Brighton	
Telscombe Cliffs	SSSI
Isle of Wight	SAC, SSSI, in part MEHRA, in part HC
Studland	No designation
Beer Bay	SSSI
Rathlin Island	SAC
Thanet	SAC, SPA
Cromer	Chalk reefs are undesignated although the (non-chalk) cliffs are in part a geological SSSI. A Biodiversity Action Plan has been prepared for this short length of littoral and sublittoral chalk (www.norfolkbiodiversity.org/SAPsHAPs/Littoralchalk_final_May2006.pdf).
South Downs	Shoreline Management Plan (1997)

Littoral and sublittoral chalk has been given non-statutory recognition as 'Important Plant Areas' by the plant conservation NGO 'Plantlife' (Brodie et al., 2008).

France

Habitats EUNIS Code: A.1.12 ; A1.111 ; A1.126

The Cellule de Suivi du Littoral Normand (CSLN) has been studying the intertidal chalk communities at the base of the cliffs in Normandy since 1996: (Simon, 1999), (Delamarche, 2003), (Simon *et al.,* 2003), (Simon, Delamarche, 2006), (Simon *et al.*, 2007), (Simon, Friboulet,2007) et (Simon *et al.,* 2008).

Note: Kelp forests which occur on the chalk shores do not have their own EUNIS code. This habitat should be given more importance both at a European and regional seas level, particularly as it plays an important role in sheltering and concentrating the prey of coastal fish.

Extent of habitat: In Upper Normandy there are 125 km of chalk coastline with vertical cliffs and sub-horizontal intertidal platforms. Within this sector about 25 km, between the cap d'Antifer and the cap Fagnet (Fécamp) remain very rich in species diversity and algal bands: in particular there is a band of kelp present. To the north and south of this sector (which merits some sustainable development measures) the habitats are much deteriorated: algal bands are impoverished or non-existent, which affects the algal grazers and associated benthic fauna in particular.

Sensitivity: In Upper Normandy the bands of algae found in the inferior medio-littoral zone and infralittoral zone are sensitive to periodic silting-up events, although some red algae (*Griffithsia flosculosa*, *Polysiphonia nigrescens*, *Gracilaria verrucosa*) are well able to resist this limiting factor.

The sandbanks within the intertidal zone of the Pays de Caux, which have been accentuated by large port and industrial developments (harbour walls for the port of Antifer and the power stations of Paluel and Penly, outer port of Dieppe) have impacted the bands of algae and their associated benthic fauna. The sectors of this habitat that have suffered the most are located between the port of Antifer and the cap la Héve, as well as to the north of the cap Fagnet (Fécamp). The former has the Seine's poor water quality and the latter the run-off from several small rivers which contribute to their deterioration.

Threat: In Upper Normandy the main threats to this habitat consist of various obstacles to coastal currents in the shape of coastal defence works for port enlargements. The disposal of dredged sediments from ports also results in poor water quality at a local level and is the source of fine sediment influxes to rocky coastal habitats. This problem is particularly pronounced to the north of Dieppe.

The other threat to this habitat is eutrophication of coastal waters manifested on chalk platforms by the colonisation of the green alga *Ulva* spp. at all littoral levels.

Fishermen collecting peelers (shore crabs) who do not re[place boulders in their original position are also a threat to habitats at the foot of the chalk cliffs. Certain sectors in the north of Seine-Maritime county have been impacted by the intensive collecting of mussels. The mapping of these mussel beds (Potel & Simon 2001) should be renewed. Recent observations have shown a tendency towards an increased development in amateur fishing using fixed nets along the chalk platforms of the pays de Caux, perhaps as a consequence of the price increase and rarity of wild fish available commercially.

Invasive species are limited for the time being limited. The brown alga *Sargassum muticum* is present on numerous coastal sites in Upper Normandy but does not give rise to massive exclusions of indigenous species. The crab *Hemigrapsus saguineus* is increasingly common amongst rock slides and boulders on the upper beach, probably as a result of dispersal from the port of le Havre.

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

Rationale for the proposed monitoring

(1) The identification of gross change in features, e.g. loss of cliff, cave, intertidal and subtidal reef.

(2) The identification of change or stability at a finer resolution.

(3) Monitoring of key pressures:

- Future developments (major engineering projects)
- People activities (e.g. tourism and recreation)
- Pollution
- Non-native species.

Use of existing monitoring programmes

Monitoring programmes that could be modified for OSPAR purposes include:

- SAC (and possibly SPA) monitoring schemes (e.g. at Flamborough, Thanet and Isle of Wight intertidal SACs) (e.g. Tittley et al., 2002, 2006, 2008).
- Anglian Water plc intertidal monitoring programme at Dover (George et al., 1992, 1993, 1996, 1997; Spurrier et al., 2000).
- The monitoring strategy (based on SAC monitoring) designed for the Beachy Head to Seaford SSSI (not implemented).

Synergies with monitoring of other species or habitats

Existing monitoring schemes that could be utilised in synergy with a monitoring strategy for *Littoral chalk communities* include:

- Biological monitoring for the Water Framework Directive;
- Ornithological monitoring (e.g. by the British Trust for Ornithology in the UK);
- Local sea-fisheries committee information;
- Other marine information gathered by research institutes, museums, universities, agencies, consultancies, NGOs, and local biological records centres (e.g. Tittley 2006).

Assessment criteria

The principal assessment criteria should be:

- loss of littoral and sublittoral chalk habitat through coastal protection, port and harbour and other coastal development (measurable);
- deterioration in inshore water quality (directly measurable, and through WFD ecological quality assessment);
- spread of non-native species (measurable);
- damage through leisure, recreation, education and research activities (difficult to assess);
- resource extraction (potentially measurable);
- maritime accidents.

Techniques/approaches

1) Mapping and GIS. Mapping the length of habitat with coastal protection as a proportion of total extent of habitat (e.g. Fowler & Tittley, 1993). There are long lengths of sea walls at upper littoral levels; ports and marinas cover whole foreshore areas into sublittoral levels. There is also massive clutter of other structures, breakwaters, discharge pipes, tidal swimming pools, slipways etc.

2) Compliance with any measures directed towards the habitat i.e. SAC condition monitoring.

3) Outcomes of planning proposals (i.e. will new developments affect the habitat?).

Selection of monitoring locations

Periodic assessment of condition at selected sites (linked to risk of local damage, e.g. from tourism, water quality issues) by intertidal survey. The Thanet Management Programme considers site selection for monitoring purposes.

Timing and frequency of monitoring

Periodic (e.g. 6 years) assessment of extent (linked to assessing length of coastal protection) using aerial or satellite imagery and put on GIS. Monitoring condition of communities will need more frequent monitoring to help distinguish anthropogenic impacts from the natural variation in the communities.

Data collection and reporting

To be considered.

Quality assurance

To be considered.

Annex 3: References

Table 6: Summary of literature information for the UK

Floristic historical	Price & Tittley (1972); Tittley (2005a, b, c)
Floristic modern	Tittley & Price (1977, 1978); Tittley 2006
Ecology	Tittley & Price (1978)
Chalk cliff/cave communities	Fowler & Tittley (1993);Tittley (1985, 1988); Tittley & Shaw (190)
Chalk shore survey	Price & Tittley (1988); Tittley (1986); Tittley et al., (1986, 1998); Wood & Wood (1986)
Chalk shore monitoring	George et al. (1988, 1989, 1992, 1993, 1996); Spurrier et al. (2000); Tittley (1998, 1999); Tittley et al. (2006; 2008)
Chalk shore conservation - management	Tittley et al. (1999)
Chalk shore conservation - rare species	Tittley (2000)
Chalk shore conservation - Important Plant Areas (algae)	Brodie et al. (2008)

Anon (2000). UK Biodiversity Group Tranche 2 Action Plans. Volume V – maritime species and habitats. English Nature, Northminster House PE1 1UA. ISBN 1 85716 467 9. 242 pp.

Anon. Beach sustainability and Biodiversity on Eastern Channel Coasts. Interim report of the Beaches at Risk (BAR) Project (www.geog.sussex.ac.uk/BAR/publish/Interim%Report.pdf))

Brodie J., Holmes M. J. & Tittley I. 2008 Important plants areas for marine algae. In Brodie J & John D.M (eds). Important Plant Areas for algae. Plantlife, Salisbury. Electronic Publication[pp. 8-46].

Delamarche, F. (2003). Littoral cauchois. Natura 2000 site FR 2300139 – Habitat et état de conservation. Rapport CSLHN / DIREN de Haute-Normandie : 7p. ,11 cartes.

Doody, J.P., Johnston, C., & Smith, B. (1991). Directory of the North Sea Coastal Margin. Coastal Conservation Branch, Joint Nature Conservation Committee, Peterborough. 419 pp.

Duperret, A., Genter, A., Mortimore, R.N., Lawrence, J.A., & Martinez, A. (2001) A classification of chalk cliff failures, based on recent cliff collapses along the Channel coasts of England and France. Abstract. International Conference on coastal rock slope instability – geohazard and risk analysis. Le Havre, 30-31 May, 2001.

Fletcher, R.L. (1974) Ulva problem in Kent. Mar.Poll.Bull. 5:21

Fowler, S.L. & Tittley, I. (1993) The marine nature conservation importance of British coastal chalk cliff habitats. English Nature Research Report No.32. English Nature, Peterborough.

George J.D., Fincham A.A., Tittley I.& Price J.H. 1988 The macrobenthos of chalk shores in North Norfolk and around Flamborough Head (North Humberside). A report for the Nature Conservancy Council. Pp. 111 British Museum (Natural History) London.

George J.D., Tittley I., Chimonides P.J., Evans N.J. & Muir A.I. 1992 Macrobenthos monitoring near a proposed long sewage outfall in North Norfolk, 1991. A report for Anglian Water Services. Pp. 117. The Natural History Museum, London.

George J.D., Tittley I., Evans N.J., Chimonides P.J., Spurrier C.J.H. & Muir A.I. 1996 Macrobenthos monitoring near a long sewage outfall in North Norfolk, 1995. A report for Anglian Water Services. The Natural History Museum, London. Pp.119.

George D., Tittley I., Muir A.I., Chimonides P.A., Evans N.J. & Spurrier C. 1993 Macrobenthos monitoring near a proposed long sewage outfall in North Norfolk. A report for Anglian Water Services. Pp. 119. The Natural History Museum, London.

George J.D., Tittley I. & Price J.H. Macrobenthos of Chalk Shores in the Isle of Wight, Dorset and Devon. 1989 A report to the Nature Conservancy Council pp 111 British Museum(Natural History), London.

George J.D., Tittley I., Spurrier C.J.H., Chimonides P.J., Evans N.J., & Muir A.I. 1997 Macrobenthos monitoring near a long sewage outfall in North Norfolk, 1996. A report for Anglian Water Services. The Natural History Museum, London. Pp.167.

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

Potel B., & Simon S. (2001). Reconnaissance et état des moulières intertidales de Seine-Maritime – rapport CSLHN/AESN – 79 pages et annexes.

Price J.H. & Tittley I. 1972 The marine flora of Kent, southeast England, and its distribution 1597-1970. Proceedings of the International Seaweed Symposium 7: 31-34.

Price J.H. & Tittley I. 1988 Algae In: Benthic communities and the crab fishery of North Norfolk. A report for the Anglian Water Authority. Pp. 70 British Museum (Natural History) London.

Tittley I. 1985 Chalk-cliff algal communities of Kent and Sussex, Southeast England. A report to the Nature Conservancy Council. Pp. 38 British Museum (Natural History) London.

Tittley I. 1986 A preliminary survey of the intertidal benthic marine algal communities between Shakespeare Cliff and Abbot's Cliff, Dover, Kent. A report for the Nature Conservancy Council. Pp 8 British Museum (Natural History) London.

Tittley I. 1988 Chalk cliff algal communities: 2 outside southeastern England. A report for the Nature Conservancy Council British Museum (Natural History) London. Pp. 26

Tittley I. 1999 Medium to long term studies on the shore vegetation of North Norfolk. In: Scott G.W. & Tittley I. (eds) Changes in the Marine Flora of the North Sea. Centre for Environmental Research into Coastal Issues, Scarborough. Pp. 53-63.

Tittley I. 2000 Marine Algae (Seaweed). In: Waite A. (ed) The Kent red data book a provisional guide to the rare and threatened fauna and flora of Kent. Kent County Council, Maidstone. Pp.457-463.

Tittley I. 2005a The marine algal flora of Kent: species records 1597 – 1800. Transactions of the Kent Field Club 17: 55-85.

Tittley I. 2005b The marine algal flora of Thanet. Stability or Change? In, Rogers P. (ed) ‘Making connections: proceedings of the second North East Kent Coastal Conference, 11 November 2004. English Nature Research Reports 630 pp. 80-95

Tittley I. 2005c The Thanet coast: A site with an exceptional history of marine study. In, Tittley I. & Peckham S. (eds). Proceedings of the North East Kent Coastal Research Workshop 22 October 2002. English Nature Research Reports 570 pp. 13-25.

Tittley I. 2006 An introduction to the marine algal flora of Sussex. Adastra2005 An annual review of wildlife recording in Sussex 2006: 4-9.

Tittley I., Chimonides P.J., Spurrier, C.J.H., & Chapman B. Thanet Coast SAC monitoring 2005 and 2006. 2008 In, Child T & Tittley I. (eds) 'Current Marine and Coastal Issues for North East Kent' Proceedings of the third North East Kent Coastal Conference, 9 November 2006 East Kent': Natural England Research Reports 00 pp. 00-00.

Tittley I., Gilliland P. & Pound D. 1999 The marine flora of the Thanet coast marine SAC: A conservation management perspective. In: Scott G.W. & Tittley I. (eds) Changes in the Marine Flora of the North Sea. Centre for Environmental Research into Coastal Issues, Scarborough. Pp. 65-74.

Tittley I. & Peckham S. (eds). 2004 Proceedings of the North East Kent Coastal Research Workshop 22 October 2002. English Nature Research Reports 570 pp. 76.

Tittley I. & Price J.H. 1977 An atlas of the seaweeds of Kent Transactions of the Kent Field Club 7: 1-80.

Tittley I. & Price J.H. 1978. The benthic marine algae of the eastern English Channel: A preliminary floristic and ecological account. Botanica Marina 21: 499-512

Tittley I., Price J.H., Fincham A.A. & George J.D. 1986 The macrobenthos of Chalk and Greensand Shores in southeastern England. A report for the Nature Conservancy Council. Pp. 117 British Museum (Natural History) London .

Tittley I. & Shaw K.M. 1980 Chapter 8. Numerical and field methods in the study of the marine flora of chalk cliffs. In: Price J.H., Irvine D.E.G. & Farnham W.F. The shore environment, Vol. 1. Methods. pp 213-240 Systematics Association Special Volume 17a.

Tittley I., Spurrier C. J. H. & Chimonides P.J. 2002 Thanet intertidal survey: Assessment of favourable condition of reef and sea-cave features in the Thanet Coast cSAC. A report for English Nature, The Natural History Museum. Pp.89.

Tittley I., Spurrier C.J.H., Chimonides P.J. & Chapman B. 2006 Thanet Coast Special Area of Conservation: 2005 intertidal monitoring. A report for English Nature. Natural History Museum, London.

Tittley I., Spurrier C.J.H., Chimonides P.J., George J.D., Moore J.A., Evans N.J. & Muir A.I. 1998 Survey of chalk cave, cliff, intertidal and subtidal reef biotopes in the Thanet coast cSAC. A report for English Nature. The Natural History Museum, London. Pp. 90.

Simon, S. (1999). Etude de la faune et de la flore de la zone de balancement des marées du littoral cauchois. Cellule de Suivi du Littoral Haut - Normand CSLHN/DIREN de Haute-Normandie. 102 pages et annexes.

Simon, S., Berno, A. & Castel, L. (2007). Suivi de la faune et de la flore de la zone intertidale de trois sites du littoral cauchois. Cellule de Suivi du Littoral Normand / AESN DEPEE -Délégation Littoral et Mer .24 pages et annexes.

Simon, S., Berno, A., Friboulet R. & Lefrançois T. (2008). Inventaire et suivi de la faune et de la flore de la zone intertidale du littoral cauchois. Campagnes 2007- Rapport final. Cellule de Suivi du Littoral Normand / AESN -DEPEE -Délégation Littoral et Mer. 33 pages et annexes.

Simon, S., & Delamarche, F. (2006). Suivi de la faune et de la flore de la zone intertidale de trois sites du littoral cauchois. Cellule de Suivi du Littoral Haut - Normand CSLHN/AESN- DEPEE- Délégation Littoral et Mer. 22 pages et annexes.

Simon, S. & Friboulet R. (2007). Suivi de la flore algale de la zone intertidale à proximité du CPN Paluel. Rapport 2007- Campagne d’août et d’octobre 2007. Cellule de Suivi du Littoral Normand / EDF R&D CHATOU .14 pages et annexe.

Simon, S., B. Potel, J. Jourde & F. Delamarche (2003). Inventaire et suivi de la faune et de la flore de la zone du littoral cauchois. Cellule de Suivi du Littoral Haut - Normand CSLHN/DIREN de Haute-Normandie. 52 pages et annexes

Spurrier C.J.H., Tittley I. & Chimonides P.J. 2000 Macrobenthos monitoring near a new long sewage outfall in North Norfolk, 1998. A report to Anglian Water Services Limited. The Natural History Museum. Pp. 165.

Vahlendieck A.W. 1992. Das Witte Kliff von Helgoland Zur Geschichte seiner Zerstörung durch Steinbruchbetrieb. Verlag Norfriisk Instituut Bräist/ Bredstedt.

Wilkinson (2005) Review of possible factors affecting the abundance of opportunistic macroalgae in the Thanet coast Special Area of Conservation. Report to the Environment Agency.

Wood, E.M. & Wood, C.M. (1986) Channel Tunnel sublittoral survey. Report to the Nature Conservancy Council. Marine Conservation Society, Ross-on-Wye.

http://www.kentbap.org.uk//assets/library/documents/Littoral_&_Sublittoral_Chalk040305.pdf

www.Plantlife.org.uk

http://www.ukbap.org.uk/UKPlans.aspx?ID=31

OSPAR COMMISSION

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 clean, healthy and biologically diverse North-East Atlantic used sustainably

ISBN 978-1-906840-64-8
Publication Number: 424/2009