

A2.72: Mussel beds in the Atlantic littoral zone

Summary

Dense aggregations of blue mussels (living and dead) form a single or multi-layered framework, held together by byssus threads, that stabilise sediment and provide a habitat for many infaunal and epifaunal species. They are important in sediment dynamics of coastal systems, provide shelter for a large number of species, are important as food source for birds, and form an often rare area of hard substrata in areas of soft sediment. The temporal stability of mussel beds can vary a lot. Some beds are permanent, maintained by recruitment of spat in amongst adults. Other beds are ephemeral and beds can recovery quickly following disturbance. The morphological structures of littoral areas are enhanced by the mussel beds even where absent, as remnants are visible as elevations of clay banks or shell layers. Very old beds may also stabilise creek patterns because clay and shell layers are relatively erosion resistant.

Pressures such as intensive commercial fisheries and harvesting, coastal development, chemical pollution, and other human activities that physically disturb the mussel bed habitat result in widespread losses and may even lead to long-term disappearances of mature mussel beds on sandy and mixed sediments. The main management measures, which would assist the conservation of this habitat, are the regulation of the fisheries which target the mussel beds and protection from physical damage. Specific measures include control of fisheries through quotas, closed areas, specified fishing methods, regulations on the movement of spat including collection of spat for aquaculture, and prohibiting spat collection from intertidal areas.

Synthesis

When determining trends in this habitat it is important to recognise that the temporal stability of mussel beds can vary a lot. Some beds are permanent, maintained by recruitment of spat in amongst adults. Other beds are ephemeral. Many mussel beds are subject to total destruction by storms, ice drifts and tidal surges and on occasion, this may involve hundreds of hectares. Trend analysis also needs to take account of the fact that many intertidal *Mytilus* beds are subject to relaying and commercial exploitation.

There has been a significant decline in the extent and biomass of this habitat, in the Netherlands, Denmark and Germany both historically and in recent decades. The quality of this habitat has also been reduced by fishing as this regularly depletes the mussel beds. Invasive species are also an issue in some locations. In the German Waddensea, for example all eulitoral mussel beds are now inhabited by the invasive species *Crassostrea gigas* and many are dominated by this species to the extent that the biomass of *C.gigas* is sometimes 4 to 5 times higher than biomass of blue mussels.

ICES found sufficient evidence for the decline and threat of this habitat over the whole OSPAR area, and this habitat is on the list of threatened and/or declining species in the OSPAR area.

Where there is good evidence, the decline in extent in recent years has been greater than 50% (and in some cases >80%) however, as this is not the case for all examples of this habitat, the overall decline over the last 50 years is estimated to be >50%. There has been a very substantial reduction in biotic quality of this habitat over the last 50 years in many locations. Expert opinion is that this is at least a severe decline affecting more than 50% of the extent of this habitat. On this basis the habitat is assessed as being Endangered for both the EU 28 and EU 28+.

Overall Category & Criteria			
EU 28		EU 28+	
Red List Category	Red List Criteria	Red List Category	Red List Criteria

Overall Category & Criteria			
Endangered	A1, C/D1	Endangered	A1, C/D1

Sub-habitat types that may require further examination

None.

Habitat Type

Code and name

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Aerial photograph of mussel beds at low water in the Waddensea, Netherlands (© F.Klinge).



Intertidal mussel bed in the Waddensea, Netherlands (© N.Dankers).

Habitat description

Sediment shores characterised by beds of the mussel *Mytilus edulis* occur principally on mid and lower shore mixed substrata (mainly cobbles and pebbles on muddy sediments) but also on sands and muds. In high densities (at least 30% cover) the mussels bind the substratum and provide a habitat for many infaunal and epibiotic species. This habitat is also found in lower shore tide-swept areas, such as in the tidal narrows of sealochs. A fauna of dense juvenile mussels may be found in sheltered firths, attached to algae on shores of pebbles, gravel, sand, mud and shell debris with a strandline of fucoids. Two associated biotopes are *M.edulis* beds on littoral mixed substrata and *M.edulis* beds on littoral sand.

The temporal stability of mussel beds can vary a lot. Some beds are permanent, maintained by recruitment of spat in amongst adults. Other beds are ephemeral, for example in locations where large amounts of spat settle intermittently on a cobble basement. In such situations mussels rapidly build up mud, and are unable to remain attached to the stable cobbles and are then liable to be washed away during gales. A second example of ephemeral mussel dominated biotopes occurs when mussel spat ("mussel crumble") settles on the superficial shell of cockle beds.

'Mussel mud', composed of faeces, pseudofaeces and sediment, accumulates underneath mussel beds. In sheltered habitats, pseudofaeces (undigested, filtered particles) can build up forming a thick layer of anoxic mud. The layer of mud may prevent the attachment of mussels to the underlying substratum, but the silt layer often consolidates and forms a firm clay bank which is very erosion resistant including the mussels embedded into it. 'Mussel mud' (that is not anoxic) supports a diverse range of infauna.

Indicators of quality:

Both biotic and abiotic indicators have been used to describe marine habitat quality. These include: the presence of characteristic species as well as those which are sensitive to the pressures the habitat may face; water quality parameters; levels of exposure to particular pressure, and more integrated indices which describe habitat structure and function, such as trophic index, or successional stages of development in habitats that have a natural cycle of change over time.

There are no commonly agreed indicators of quality for this habitat, although particular parameters may have been set in certain situations e.g. protected features within Natura 2000 sites, where reference values have been determined and applied on a location-specific basis.

The overall quality and continued occurrence of this habitat is largely dependent on the presence of *Mytilus edulis* which creates the biogenic structural complexity on which the characteristic associated communities depend. The density and the maintenance of a viable population of this species is a key indicator of habitat quality, together with the visual evidence of presence or absence of physical damage. Monitoring programmes may include measures of biomass, coverage, length frequency distribution, a condition index for the mussels (a ratio between biomass versus shell length) and descriptions of the structure of a bed including vertical height profile, thickness and type of accumulated sediment, coverage and biomass of macroalgae.

Characteristic species:

Dense aggregations of the mussel *Mytilus edulis*. The wrack *Fucus vesiculosus* (and *Fucus mytili*, currently regarded as a synonym of *F. vesiculosus*) is often found attached to either the mussels or cobbles and it can be abundant. The mussels are often encrusted with the barnacles *Semibalanus balanoides*, *Elminius modestus* or *Balanus crenatus*. Where boulders are present they can support the limpet *Patella vulgata*. The winkles *Littorina littorea* and *L. saxatilis* and small individuals of the crab *Carcinus maenas* are common amongst the mussels, whilst areas of sediment may contain the lugworm *Arenicola marina*, the sand mason *Lanice conchilega*, the cockle *Cerastoderma edule*, and other infaunal species. Although a wide range of species are associated with *Mytilus edulis* beds biotopes these characterizing species occur in a range of other biotopes and are therefore not considered to be obligate associates.

Classification

EUNIS (v1405):

Level 4. A sub-habitat of 'Atlantic littoral biogenic reefs' (A2.7).

Annex 1:

1140 Mudflats & sandflats not covered at low tide

1160 Large shallow inlets and bays

1170 Reefs

MAES:

Marine - Marine inlets and transitional waters

Marine - Coastal

MSFD:

Littoral Sediment

EUSeaMap:

Not mapped

IUCN:

12.3 Shingle and/or Pebble shoreline and/or Beaches

12.4 Mud Shoreline and Intertidal Mud Flats

Does the habitat type present an outstanding example of typical characteristics of one or more biogeographic regions?

Yes

Regions

Atlantic

Justification

Intertidal *Mytilus edulis* beds on mixed and sandy sediments are specific to the North East Atlantic region. The majority are found in the Wadden Sea area (the Netherlands, Germany, Denmark) and in UK waters, although they are also present along the coast of Iceland and Ireland. Historical data report some intertidal *Mytilus edulis* beds on mixed and sandy sediments along the coast of France, but those records have yet to be confirmed.

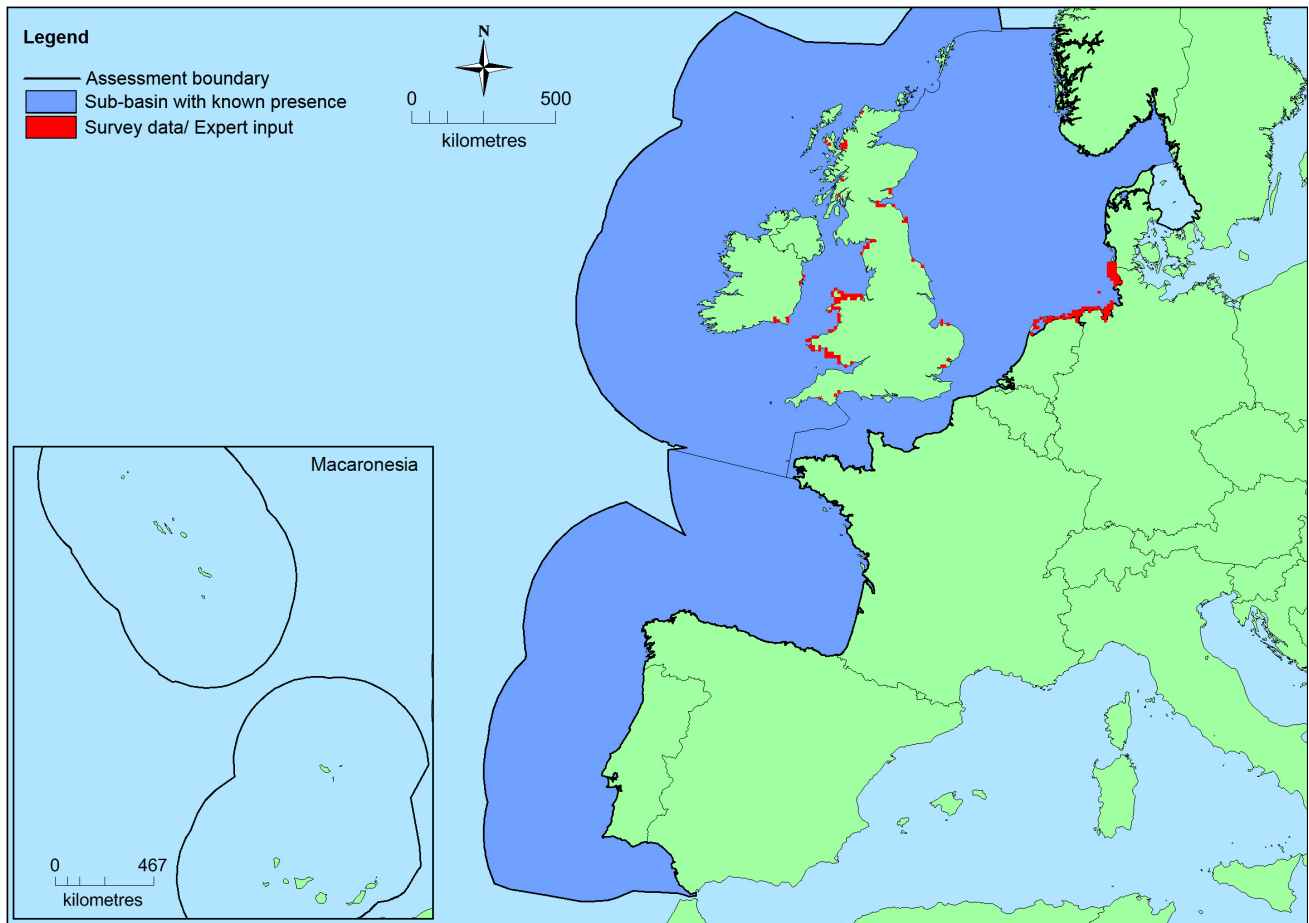
Geographic occurrence and trends

Region	Present or Presence Uncertain	Current area of habitat	Recent trend in quantity (last 50 yrs)	Recent trend in quality (last 50 yrs)
North-East Atlantic	Bay of Biscay and the Iberian Coast: Present Celtic Seas: Present Greater North Sea: Present Kattegat: Uncertain	Unknown Km ²	Decreasing	Decreasing

Extent of Occurrence, Area of Occupancy and habitat area

	Extent of Occurrence (EOO)	Area of Occupancy (AOO)	Current estimated Total Area	Comment
EU 28	584,502 Km ²	184	Unknown Km ²	EOO and AOO have been calculated on the available data. Although this data set is known to be incomplete the figures exceed the thresholds for threatened status.
EU 28+	584,502 Km ²	184	Unknown Km ²	EOO and AOO have been calculated on the available data. Although this data set is known to be incomplete the figures exceed the thresholds for threatened status.

Distribution map



There are insufficient data to provide a comprehensive and accurate map of the distribution of this habitat. This map has been generated using EMODnet data from modelled/surveyed records for the North East Atlantic (and supplemented with expert opinion where applicable) (EMODnet 2010). EOO and AOO have been calculated on the available data presented in this map however these should be treated with caution as expert opinion is that this is not the full distribution of the habitat.

How much of the current distribution of the habitat type lies within the EU 28?

Unknown but likely to be more than 90% as the majority of reported examples of this habitat are in the southern North Sea.

Trends in quantity

There has been a significant decline the extent and biomass of this habitat, in the Netherlands, Denmark and Germany both historically and in recent decades. In Germany, a series of surveys covering the whole littoral of Niedersachsen revealed a decrease in the extent of beds and, more drastically, in biomass from roughly 5,000 ha in extent to the late 1950s (100,000 t fresh weight), 2 700 ha in 1989/1990, 1,300 ha in 1994 to 170 ha (1,000 t) in 1996. Following some good spatfalls an area of 1,280 ha survived the severe winter of 1996/97. In the Dutch Waddensea there was a more or less stable area of 4,500 ha until the middle of the 1980s. Because of the fishery in a period with limited spatfall all beds had disappeared in 1991. Fishing on intertidal beds was then forbidden and the population recovered to about 2500 ha in 2015. About half of these present beds should be considered as mixed beds of mussels and Pacific Oysters. In Schleswig-Holstein a decrease of biomass of approximately 50% was reported between 1989 and 1990.

Comparisons using aerial photography of the German Wadden Sea (Schleswig-Holstein) taken in 1959 reveal severe decline in the extent of this habitat over that time period. Historically (between 60-250 years ago) there has been an estimated reduction in the extent of this habitat in the German Waddensea of

more than 90%. In the Netherlands, Higler *et al.* (1998) observed a serious decline in the populations of mussels between 1988 and 1990, mainly caused by fisheries. The extent of mussel beds decreased from the 1970s to the 1990s. In Denmark, intensive fisheries during 1984 to 1987 almost led to a complete disappearance of the mussel population.

In the UK, large beds exist in the Wash, Morecambe Bay, Conwy Bay and other estuaries of south-west England, north Wales and West Scotland as well as the sea loughs of Northern Ireland many of which have historical data associated with mussel fisheries. In the Wash, for example there appear to have been at least four large fluctuations in abundance since the 1920s. High exploitation and variable recruitment led to a severe decline in the number of productive beds, with 31 beds covering around 1,320 ha in 1940, 14 beds covering 510ha in 1977 and 6 beds covering 155ha in 1992. In the Exe estuary since the farming of mussel beds stopped in the 1950s/60s, the intertidal area occupied by mussels has shrunk considerably. Comparison of known beds covered an area of just over 51ha from the period 1976-1990 compared to just over 36 ha in 2013/14. While there were 31 mussel beds occupying a combined areas of 80ha in 1976, today there are 12 main mussel beds and almost all of the smaller beds have disappeared.

- Average current trend in quantity (extent)

EU 28: Decreasing

EU 28+: Decreasing

- Does the habitat type have a small natural range following regression?

No

Justification

This habitat does not have a small natural range as it occurs in locations as widely separated as the Wadden Sea coast of the Netherlands, Germany and Denmark and in UK waters.

- Does the habitat have a small natural range by reason of its intrinsically restricted area?

No

Justification

This habitat does not have a small natural range as it occurs in locations as widely separated as the Wadden Sea coast of the Netherlands, Germany and Denmark and in UK waters.

Trends in quality

The quality of this habitat has been reduced by fishing as this regularly depletes the mussel beds. Invasive species are also an issue. In the German Waddensea all littoral mussel beds are now inhabited by the invasive species *Crassostrea gigas* and many are dominated by this species to the extent that the biomass of *C.gigas* is sometimes 4 to 5 times higher than biomass of mussels. Decrease in quality is also indicated by decrease in biomass. In Schleswig-Holstein for example, a decrease of biomass of approximately 50% was reported between 1989 and 1990. There may be some beds with good quality (e.g. Exe estuary) which can be used as reference sites on quality.

- Average current trend in quality

EU 28: Decreasing

EU 28+: Decreasing

Pressures and threats

Directed fisheries are the principal anthropogenic threat to this habitat. The extensive, heavily exploited mussel fisheries (especially spat collecting for aquaculture) removed close to the entire stock in the Wadden Sea between 1988 and 1990 as well as having knock on effects such as an increased mortality for seabirds (e.g. eider ducks) and affecting the benthic diversity. The pressure from fisheries activities is exacerbated when settlement of spatfall is low. Another threat is from alien species. The introduced Pacific Oyster (*Crassostrea gigas*) has increased significantly in the Wadden Sea since the beginning of the 21st century and one of the preferred settlement structures for the larvae are existing mussel beds. The result

has been a conversion of a large parts of mussel beds into oyster beds. In the Lower Saxony part of the Wadden Sea, for example, every intertidal mussel bed holds at least some oysters. Bait collection can have a localised effect while phytoplankton blooms, produced by nutrient enrichment (e.g. industrial and residential sewage discharge, agriculture), are another potential threat. Mussel beds could also have intermediate sensitivity to anti-fouling substances and heavy metal contaminants. Climate change effect the reproductive success directly or indirectly eg. via higher abundance of shrimp (*C. crangon*) surviving the winter which are major predators of spat. In the eastern Scheldt oyster drills (aquaculture transfer of spat, with non-indigenous species).

List of pressures and threats

Urbanisation, residential and commercial development

- Discharges

Biological resource use other than agriculture & forestry

- Marine and Freshwater Aquaculture

 - Bottom culture

- Fishing and harvesting aquatic resources

 - Professional active fishing

 - Benthic dredging

 - Leisure fishing

 - Bait digging / Collection

Pollution

- Pollution to surface waters (limnic, terrestrial, marine & brackish)

 - Nutrient enrichment (N, P, organic matter)

Natural System modifications

- Human induced changes in hydraulic conditions

 - Modification of hydrographic functioning, general

Climate change

- Changes in abiotic conditions

 - Temperature changes (e.g. rise of temperature & extremes)

- Changes in biotic conditions

 - Migration of species (natural newcomers)

Conservation and management

The main management measures, which would assist the conservation of this habitat, are the regulation of the fisheries which target the mussel beds and protection from physical damage. Specific measures include control of fisheries through quotas, closed areas, specified fishing methods, regulations on the movement of spat including collection of spat for aquaculture, and prohibiting spat collection from intertidal areas.

List of conservation and management needs

Measures related to wetland, freshwater and coastal habitats

- Restoring/Improving water quality

- Restoring/Improving the hydrological regime

Measures related to marine habitats

Restoring marine habitats

Measures related to spatial planning

Legal protection of habitats and species

Measures related to hunting, taking and fishing and species management

Regulation/Management of fishery in marine and brackish systems

Specific single species or species group management measures

Measures related to special resource use

Regulating/Managing exploitation of natural resources on sea

Conservation status

Annex 1:

1140: MATL U2, MMAC XX

1160: MATL U2, MMAC FV

1170: MATL U2, MMAC FV

Intertidal *Mytilus edulis* beds on mixed and sandy sediments are identified by OSPAR as a threatened and/or declining habitat in all OSPAR regions.

Intertidal mussel beds are on the Red List of biotopes and biotope complexes of the Wadden Sea.

When severely damaged, does the habitat retain the capacity to recover its typical character and functionality?

The mussel beds which characterise this habitat may be transient and dynamic or permanent and persistent. Their capacity to recover is generally strong where there are good spatfalls although development into established beds will be influenced by many factors, such as the presence of predators, local hydrographic conditions, and exposure of the location.

Blue mussels are sessile, attached organisms that are unable to repair significant damage to individuals. They do not reproduce asexually and therefore the only mechanism for recovery from significant impacts is larval recruitment to the bed or the area where previously a bed existed. Recruitment is often sporadic, occurring in unpredictable pulses, although persistent mussel beds can be maintained by relatively low levels or sporadic recruitment. Recovery from human activity impacts may take at least 5 years, although in certain circumstances and under some environmental conditions (e.g. recurring physical disturbance or sporadic recruitment) recovery may take significantly longer. Nearly complete recovery from disturbance is a characteristic common to *Mytilus* beds throughout the world.

Effort required

10 years
Naturally

Red List Assessment

Criterion A: Reduction in quantity

Criterion A	A1	A2a	A2b	A3
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Criterion A	A1	A2a	A2b	A3
EU 28	>50 %	unknown %	unknown %	unknown %
EU 28+	>50 %	unknown %	unknown %	unknown %

There has been a significant decline in biomass and extent of this habitat, both historically and over the last 50 years. The declines differ in extent in different parts of the region. For example in Schleswig Holstein, Niedersachsen, in the Netherlands and Denmark the losses were so substantial that this habitat was almost lost in 1990. There has been a slow recovery but this is still only around half the level of 50 years ago. The intertidal beds in the Wash (UK) also almost completely disappeared in the 1990s which is attributed to a combination of heavy exploitation and poor spatfalls.

Where there is good evidence, the decline in extent in recent years has been greater than 50%. In some cases it has been greater than 80% and in the Eastern Scheldt the decline has been 100% in the last 100 years with only a small area of artificial lays present now. However, as this large scale decline is not the case for all examples of this habitat, the overall decline over the last 50 years is estimated to be >50%. This habitat has therefore been assessed as Endangered under criterion A1 for both the EU 28 and EU 28+.

Criterion B: Restricted geographic distribution

Criterion B	B1				B2				B3
	EOO	a	b	c	AOO	a	b	c	
EU 28	>50,000 Km ²	Yes	Unknown	No	>50	Yes	Unknown	No	No
EU 28+	>50,000 Km ²	Yes	Unknown	No	>50	Yes	Unknown	No	No

This habitat has a large natural range in the North East Atlantic region as it occurs in locations as widely separated as the Wadden Sea coast of the Netherlands, Germany and Denmark, and in UK waters. The precise extent is unknown however as EOO >50,000km² and AOO >50, this exceeds the thresholds for a threatened category on the basis of restricted geographic distribution. Future trends are unknown but the distribution of the habitat is such that the identified threats are unlikely to affect all localities at one. This habitat has therefore been assessed as Least Concern under Criteria B1(a,c), B2 (a,c) & B3 and Data Deficient under all other criteria.

Criterion C and D: Reduction in abiotic and/or biotic quality

Criteria C/D	C/D1		C/D2		C/D3	
	Extent affected	Relative severity	Extent affected	Relative severity	Extent affected	Relative severity
EU 28	50 %	severe %	unknown %	unknown %	unknown %	unknown %
EU 28+	50 %	severe %	unknown %	unknown %	unknown %	unknown %

Criterion C	C1		C2		C3	
	Extent affected	Relative severity	Extent affected	Relative severity	Extent affected	Relative severity
EU 28	unknown %	unknown %	unknown %	unknown %	unknown %	unknown %
EU 28+	unknown %	unknown %	unknown %	unknown %	unknown %	unknown %

Criterion D	D1		D2		D3	
	Extent affected	Relative severity	Extent affected	Relative severity	Extent affected	Relative severity
EU 28	unknown %	unknown%	unknown %	unknown%	unknown %	unknown%
EU 28+	unknown %	unknown%	unknown %	unknown%	unknown %	unknown%

There has been a very substantial reduction in biotic quality of this habitat over the last 50 years in many locations. Expert opinion is that this is at least a severe decline affecting more than 50% of the extent of this habitat. There has also been a historical reduction in quality. The scale of historical change is harder to estimate but is not believed to be above the thresholds for Red Listing. This habitat has therefore been assessed as Endangered under criteria C/D1 for both the EU 28 and EU 28+.

Criterion E: Quantitative analysis to evaluate risk of habitat collapse

Criterion E	Probability of collapse
EU 28	unknown
EU 28+	unknown

There is no quantitative analysis available to estimate the probability of collapse of this habitat type.

Overall assessment "Balance sheet" for EU 28 and EU 28+

	A1	A2a	A2b	A3	B1	B2	B3	C/D1	C/D2	C/D3	C1	C2	C3	D1	D2	D3	E
EU28	EN	DD	DD	DD	LC	LC	LC	EN	DD	DD	DD	DD	DD	DD	DD	DD	DD
EU28+	EN	DD	DD	DD	LC	LC	LC	EN	DD	DD	DD	DD	DD	DD	DD	DD	DD

Overall Category & Criteria			
EU 28		EU 28+	
Red List Category	Red List Criteria	Red List Category	Red List Criteria
Endangered	A1, C/D1	Endangered	A1, C/D1

Confidence in the assessment

Medium (evenly split between quantitative data/literature and uncertain data sources and assured expert knowledge)

Assessors

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Reviewers

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