A5.37 Atlantic lower circalittoral mud

Summary

This habitat typically occurs below 50m (although shallower in very sheltered areas). The relatively stable conditions often lead to the establishment of communities of burrowing megafaunal species where bathyal species may occur together with coastal species. The burrowing megafaunal species include crustaceans such as the Norway lobster *Nephrops norvegicus* and *Callianassa subterranea*. The mud habitats in deep water can also support seapen populations and communities with *Amphiura* spp. The bioturbating activities of the infauna are particularly important in controlling chemical, physical and biological processes, especially when the influences of physical disturbances such as wave action or strong currents are minimised (owing to their depth).

The most significant and widespead effect on this habitat is believed to have been caused by demersal fishing, especially trawling for the Norway lobster *Nephrops norvegicus.* Studies show that epifaunal species are particularly adversely affected and that intensively trawled sites have a lower species richness than untrawled areas. The negative effects are most severe in relatively species rich, deep areas of the sea with fine grained sediments. Decline in quality has also been attributed to other factors (oxygen depletion of bottom waters in the Kattegat, drilling and dredging). The main approachs to the conservation and management of this habitat are spatial and temporal controls as well as gear design and deployment regulations on fishing methods that damage or disturb seabed communities. Identification in Biodiversity Action Plans (e.g. as priority features) is also being used to raise awareness of pressures and threats to this habitat and the need for conservation measures.

Synthesis

This habitat is present across the region in deep basins as well as deep sheltered inlets. There are well known extensive and well-developed deep water mud basins in the North East Atlantic in the Kattegat, the Grand Vasiere off Gascony, France and to the west of Ireland. This habitat is also present in deep, sheltered inlets such as some of the Scottish sea lochs. Some declines in habitat quantity (as a result of shifts to different sediment composition) have been recorded and there are many well documented examples of decline in quality.

Most sedimentary benthic systems of the continental shelf of Europe have been modified by fishing activity in the last 100 years, particularly by mobile demersal gears, and this remains a significant pressure. Disturbance of the substratum due to intensive fishing activities using bottom trawls or dredges can damage or modify infaunal communities, with burrowing echinoderms and bivalves being particularly vulnerable.research suggests that some gears may also be modifying the biogeochemistry of the sediments by affecting organic matter remineralization and nutrient cycling through sediment resuspension and burial of organic matter to depth. Analysis by ICES (for the period 2009-2012) shows considerable overlap of this habitat with fishing intensity by gears which are known to have damaging effects on the epifauna and shallow infauna. More recent data for a single year (2013/2014) have revealed that more than 95% of modelled area of deep circalittoral mud across in the North Sea and Celtic Sea is considered to have been subject to fishing pressure by EU trawlers (bottom otter, beam and mid-water trawls) and that more than 80% of the deep circalittoral mud habitat across the North East Atlantic shelf area has been subject to abrasion disturbance. There are also regional studies, such as in the Kattegat, which show a similar pattern of overlap of this habitat type with the use of bottom gears that are known to alter the quality and take place at a frequency which maintains a disturbed condition. Much the same footprint of activity is likely each year and as this type of fishing pressure has been ongoing for many decades, there has most likely been a cumulative impact on habitat quality. Signficant effects have been

observed in response to long-term chronic disturbance from otter trawling, for example, with negative effects on benthic infauna abundance, biomass and species richness with clear changes in community composition that may have far-reaching implications for the integrity of marine food webs.

Expert opinion is that there has been a very substantial reduction in quality of this habitat, most likely an intermediate decline affecting more than 80% of its extent although it is clear that in some locations there has also been a severe decline. The severity will depend on factors such as the intensity and frequency of disturbance. This habitat has therefore been assessed as Endangered for both the EU 28 and EU 28+ because of both past and likely continuing declines in quality.

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

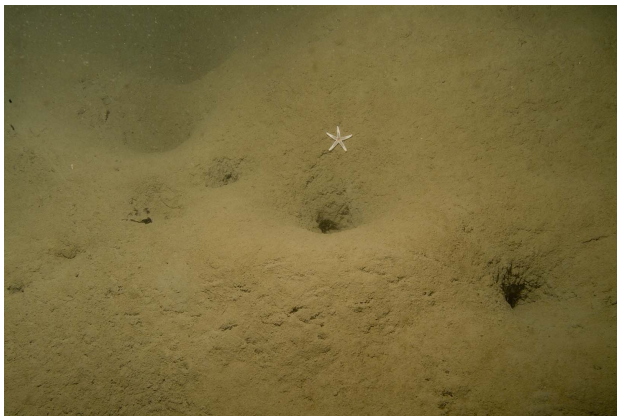
Sub-habitat types that may require further examination

A5.373 *Styela gelatinosa, Pseudamussium septemradiatum* and solitary ascidians on sheltered deep circalittoral muddy sediment.

Habitat Type

Code and name

A5.37 Atlantic lower circalittoral mud



Fine mud habitat in the circalittoral zone, with *Nephrops* burrows visible. Loch Sween, Scotland (© G.Saunders).

Habitat description

In mud and cohesive sandy mud in the offshore circalittoral zone, typically below 50-70m, a variety of faunal communities may develop, depending upon the level of silt/clay and organic matter in the sediment. The relatively stable conditions associated with deep mud habitats often lead to the establishment of communities of burrowing megafaunal species where bathyal species may occur together with coastal species. The burrowing megafaunal species include burrowing crustaceans such as *Nephrops norvegicus* and *Callianassa subterranea*. The mud habitats in deep water can also support seapen populations and communities with *Amphiura* spp. The bioturbating activities of the infauna present in these biotopes are particularly important in controlling chemical, physical and biological processes, especially when the influences of physical disturbances such as wave action or strong currents are minimised (owing to their depth). The presence of burrowing fauna such as polychaetes significantly influence nutrient fluxes of nitrogen and phosphorus at the sediment-water interface, as their burrowing

activity promotes oxygenation of the substrata. The organisms in these biotopes, particularly polychaetes and foraminiferans, are an important food source for higher trophic levels, particularly demersal fish and other benthic macrofauna. As such, the species characteristic of this habitat represent an important bentho-pelagic link increasing the overall biodiversity and ecological value of the habitat.

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. Examples of indicators of damage and naturalness have been proposed for offshore deep sea muds include; the presence of typical benthic invertebrate communities and other large burrowing megafauna, the sediment composition or sedimentation rates/disturbance, the presence of the climax community including crustacean and polychaetes populations, and an absence of *Beggiatoa* mats. A reduction in the abundance of less sessile and fragile species and an increase in more carnivorous and scavenging species are potential indicators of disturbance.

Characteristic species:

Communities are typically dominated by polychaetes but often with high numbers of bivalves such as *Thyasira* spp., echinoderms and foraminifera. Offshore mud habitats can be characterised by the burrowing urchin *Brissopsis lyrifera*, the brittlestar *Amphiura chiajei* and the Norway lobster *N. norvegicus*. In water deeper than 100 m, the soft muds are dominated by a community of foraminiferans (e.g. Saccammina, Psammosphaera, Haplophragmoides, Crithionina and Astorhiza) and hatchet shells *Thyasira* spp. with polychaete worms such as *Paraonis gracilis, Myriochele heeri, Spiophanes kroyeri, Tharyx* sp., *Lumbrineris tetraura*. There can be thousands of dead foraminiferan tests per square metre. Seven associated biotopes have been described for this habitat the rarest being the deep mud biotope which is notable for the very high density of the rare sea squirt *Styela gelatinosa*.

Classification

EUNIS (v1405):

Level 4. A sub-habitat of ‘Atlantic circalittoral mud’ (A5.3).

Annex 1:

No relationship

MAES:

Marine - Marine inlets and transitional waters

Marine - Coastal

Marine - Shelf

MSFD:

Shallow sublittoral mud

Shelf sublittoral mud

EUSeaMap:

Shallow mud

Shelf muds

IUCN:

9.6 Subtidal muddy

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

Regions
Atlantic

Justification
This habitat is present in across the North East Atlantic, most especially in deep basins as well as in deep sheltered inlets.

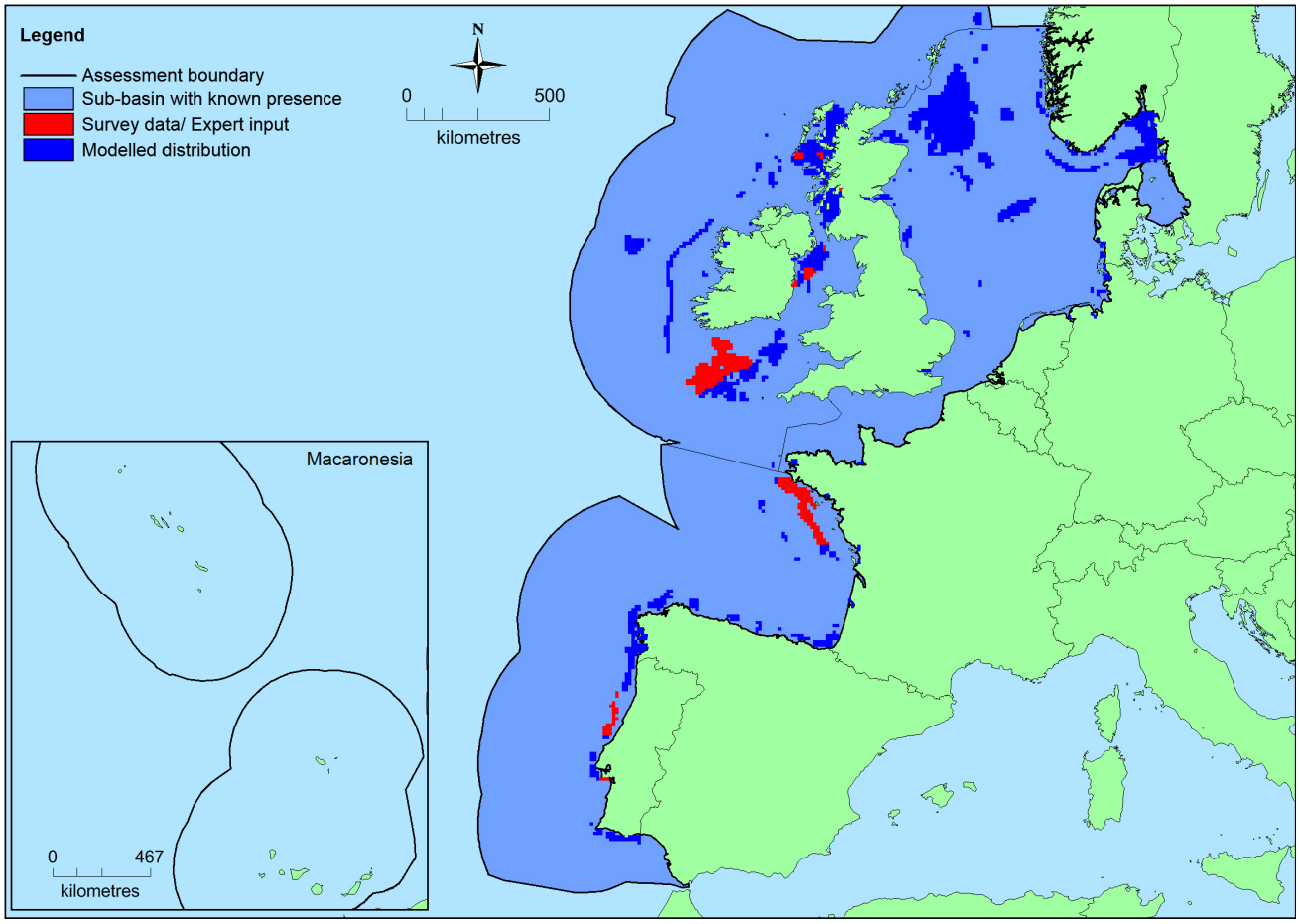
Geographic occurrence and trends

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 Kattegat: Present Greater North Sea: Present Macaronesia: Uncertain	64,816 Km^2	Unknown	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	2,576,337 Km^2	1,868	>64,816 Km^2	The area estimate for this habitat has been derived from a synthesis of EUNIS seabed habitat geospatial information for the European Seas but is recognised as being an underestimate.
EU 28+	>2,576,337 Km^2	>1,868	>64,816 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?

This habitat occurs in Norway therefore the percentage hosted by EU 28 is less than 100%. The proportion cannot be estimated as detailed distribution of this habitat is unknown.

Trends in quantity

There are some estimates of the extent of this habitat in the North East Atlantic derived from modelling studies, but no widely agreed figures. Trends in quantity cannot be determined with any accuracy although some habitat loss is known to have occurred in some locations such as the shift to a less muddy substrate in the Grande Vasiere, in the Bay of Biscay.

- Average current trend in quantity (extent)
  EU 28: Unknown
  EU 28+: Unknown
- Does the habitat type have a small natural range following regression?
  No
  Justification
  This habitat does not have a small natural range. It is widespread, being found as far east as the Kattegat trench, as far west as the edge of the continental shelf of Ireland, and south into the Bay of Biscay.
- 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. It is widespread, being found as far east as the Kattegat trench, as far west as the edge of the continental shelf of Ireland, and south into the Bay of Biscay.

Trends in quality

The communities that characterise this habitat are believed to have been substantially changed by demersal fishing activities, especially those which target the Norway lobster *Nephrops norvegicus*. Intensively trawled sites have been documented with lower species richness and with the negative effects worst in relatively species rich, deep areas with fine grained sediments. One example, reported from an area circalittoral mud habitat in the Irish Sea, is a change in dominant species, from the brittle star *A.filiformis* whose growth is known to be inhibited by large quantities of suspended sediments such as those generated by trawling, to the less affected burrowing shrimps such as *Callianassa subterranea*. In the central and eastern parts of the Kattegat, for example, where the seabed is predominantly muddy and an important fishing area for *Nephrops*, an estimated 70-80% is affected by fisheries each year. Furthermore an estimated 41% of this is being affected by fishing gear more than twice a year and therefore considered to remain in a disturbed condition. It is a similar picture for pressures on this habitat across the North East Atlantic shelf. A single year of data for 2013/2014 has indicated that more than 80% of the lower circalittoral mud habitat is subject to abrasion disturbance from mobile demersal fishing gears. This type of pressure is not unsual and has been taking place for decades. Frequent trawling across this habitat type is well documented known to lead to a permanently altered community dominiated by fast-growing scavenger/predator species. Signficant negative effects have also been observed in response to long-term chronic disturbance, for example from otter trawling. A study of otter trawl disturbance in Irish Sea, for example revealed negative effects on benthic infauna abundance, biomass and species richness with clear changes in community composition and possible far reaching implications for the integrity of marine food webs.

Decline in quality has also been attributed to other factors. For example, the dramatic decline of the biodiversity of sof t substrates in open Danish waters observed in Kattegat between the mid-1990s and the end of the 2000s has been linked to 8-10 week period of low bottom water oxygen concentration. This is compared to the more typical short term periods of anoxia in that area.

- Average current trend in quality
  EU 28: Decreasing
  EU 28+: Decreasing

Pressures and threats

Demersal fishing gears (such as otter trawls, beam trawls) disturb the upper layers of the sediment and damage both the associated epifauna and shallow infaunal communities. Associated increases in suspended sediments may also have a smothering effect on filter feeders. The degree of any damage will depend on the gear, frequency of use and species present. Mapping of the fishing intensity of these gears by ICES (for the period 2009-2012) shows a clear overlap with this habitat type, for example in the northern Celtic Sea and in the coastal waters of the Netherlands, Germany and Denmark and "La Grande Vasiere" in the Bay of Biscay. Frequent trawling may lead to a permanently altered community dominated by fast growing scavenger/predator species.

Nutrient enrichment leading to significant periods of reduced bottom water oxygen concentrations has also changed the character of associated biotopes and can be severe enough to cause the community to collapse. Infrastructure development may affect the local hydrodynamic and sediment transport regime where this habitat occurs close to the coastline. On a longer timescale it is possible that climate change could lead to variable recruitment through changes in mortality rates of early life stages of some of the characteristic species e.g. of larval *Nephrops.*

List of pressures and threats

Urbanisation, residential and commercial development

Discharges

Biological resource use other than agriculture & forestry

Fishing and harvesting aquatic resources
- Professional active fishing
- Benthic or demersal trawling
- Demersal seining
- Benthic dredging

Pollution

Nutrient enrichment (N, P, organic matter)

Natural System modifications

Human induced changes in hydraulic conditions
- Modification of hydrographic functioning, general

Conservation and management

The regulation of the use of fishing gears that damage or disturb seabed communities is key to the conservation of this habitat. This may be achieved by spatial and temporal controls as well as gear design and deployment regulations using fisheries management measures as well as conservation legislation in marine protected areas. Identification in Biodiversity Action Plans (e.g. as priority features) is also being used to raise awareness of pressures and threats to this habitat and the need for conservation measures.

List of conservation and management needs

Measures related to spatial planning

Other spatial measures
Establish protected areas/sites

Measures related to hunting, taking and fishing and species management

Regulation/Management of fishery in marine and brackish systems

Measures related to special resouce use

Regulating/Managing exploitation of natural resources on sea

Conservation status

This habitat does not correspond directly to any Annex 1 habitat type.

Sea pen and burrowing megafauna communities are on the list of OSPAR threatened and/or declining habitats.

This habitat is present in the Kattegat and corresponds to the HUB biotope "Baltic aphotic muddy sediment dominated by seapens (AB.H2T1)" which HELCOM (2013) has assessed as endangered based on a decline in extent of more than 50% over the last 50 years.

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

Timescale between incidents of damaging activity, the type of damaging activity and the predominant species, influences recovery. Studies have shown that recovery times following dredging were significantly

shorter for short-lived species (<1 – 3 years), free-living and tube-dwelling species and for scavenging or opportunistic species, than for medium-lived species (3 – 10 years), burrow-dwelling species and suspension feeders. Free living species are also likely to recolonise areas more quicky that those that grow attached to the substratum and have an erect or stalked body form such as seapens. Recovery times of communities in deep circalittoral mud habitats following oxygen depletion and pollution has been investigated in several studies of the Gullmarsfjord, Sweden where they reported to be between 2-8 years.

Differences in the recoverability of different species groups following fishing may result in changes in community composition and ecosystem functioning over the long term.

Effort required

10 years
Naturally

Red List Assessment

Criterion A: Reduction in quantity

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

Estimates of the area and extent of this habitat show considerable variation and are recognised as being biased and an underestimate. No assessment of trends in quantity have therefore been made. This habitat is Data Deficient under criteria A 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	Yes	No	>50	Yes	Yes	No	No
EU 28+	>50,000 Km^2	Yes	Yes	No	>50	Yes	Yes	No	No

This habitat has a large natural range in the North East Atlantic region. The precise extent is unknown however as EOO >50,000 km^2 and AOO >50, this exceeds the thresholds for a threatened category on the basis of restricted geographic distribution. There has been a decline in the biotic quality of this habitat and the major threat (demersal fisheries) is likely to cause continuing declines in quality within the next 20 years, however, 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 criterion B for both the EU 28 and EU 28+.

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	>80 %	Intermediate %	unknown %	unknown %	unknown %	unknown %
EU 28+	>80 %	Intermediate %	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%

Substantial reductions in quality in at least some parts of this habitat are known to have occurred and continue to take place (as revealed by fishing distribution and intensity maps). Disturbance of the substratum due to intensive fishing activities using bottom trawls or dredges can damage or modify infaunal communities, with burrowing echinoderms and bivalves being particularly vulnerable. Research suggests that some gears may also be modifying the biogeochemistry of the sediments by affecting organic matter remineralization and nutrient cycling through sediment resuspension and burial of organic matter to depth. An analysis of the fishing intensity of EU trawlers (bottom otter, beam and mid-water trawls) using Automatic Identification System (AIS) ship tracking data over one year (2013/2014) shows high coverage in all European coastal waters and over the continental shelf. When combined with the modelled distribution of EUNIS marine habitat types it is possible to examine the extent of likely impact on a particular benthic habitat. For example, over this time period more than 60% of deep circalittoral mud was subject to trawling fishing pressure in the North Sea with over 15% of this being interpreted as a high or moderate pressure. When combining data for the North Sea and Celtic Sea more than 95% of this habitat type is considered to have been subject to such fishing pressure. The extent of the likely impact of bottom fishing gears on this habitat throughout the North East Atlantic region is also apparent from other analyses which have combined VMS data with sensitivity maps of benthic habitats and disturbance caused by surface abrasion for the continental shelf area of the North East Atlantic. In the case of deep mud habitats for just 2013 this has shown that more than 80% of its occurrence across the shelf area has been subject to abrasion disturbance.Given that this is based on a single year of data, and that this type of pressure has been taking place for decades, it is likely to be an underestimate of the total area of this habitat which has been subject to such pressure. Signficant negative effects have also been observed in response to long-term chronic disturbance, for example from otter trawling with negative effects on benthic infauna abundance, biomass and species richness with clear changes in community composition.

Expert opinion is that there is likely to have been a very substantial reduction in quality of this habitat - an intermediate decline in quality affecting more than 80% of this habitat in the North East Atlantic region although it is also possible that more than 30% has been subject to a severe decline. This will depend on factors such as the intensity and frequency of disturbance. This habitat has therefore been assessed as Endangered under criteria C/D 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	DD	DD	DD	DD	LC	LC	LC	EN	DD	DD	DD	DD	DD	DD	DD	DD	DD
EU28+	DD	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	C/D1	Endangered	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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