A2.33: Marine Atlantic littoral mud with associated communities

Summary

Intertidal mudflats in fully marine open sea (coast) only develop under macrotidal conditions such as those found in the German Bight and Mont Saint Michel, France. Also they form part of a habitat complex on a landscape scale within bays, barrier systems and estuaries. Intertidal mudflats have a low species diversity but huge overall invertebrate productivity, resulting in an important and perpetually exploited food source for waders, waterfowl and fish as well as resting, pupping and feeding areas for seals and their young. Intertidal areas with biogenic structures such a mussel beds, oyster reefs, seagrass meadows and saltmarsh, dissipate wave energy, thus reducing the risk of eroding saltmarshes, damaging coastal defences and flooding low-lying land. The mud surface also plays an important role in nutrient chemistry. In areas receiving pollution, organic sediments sequester contaminants and may contain high concentrations of heavy metals. This habitat occurs across a wide geographical area and includes the Wadden Sea which has largest unbroken system of intertidal sand and mudflats in the world (4,700 km^2).

There are numerous threats and pressures on the intertidal mudflat habitat and its associated biotopes. They include waste/effluent discharge, invasion by alien species, pollution, land claim, climate change, shell fisheries/aquaculture, bait digging and saltmarsh encroachment. Conservation and management measures include: restoring water quality, strengthening development and coastal protection planning policy to ensure where possible the maintenance of all active sediment sources that supply intertidal flats; monitoring the implementation of strong development control policies; raising public awareness of the ecological and socio-economic value of mudflats, and ensuring no further loss, particularly in areas already subject to high loss.

Synthesis

There has been a very significant decrease in the extent of this habitat over the last centuries (possibly as much as 80%). The current situation is more stable although some reduction in extent continues, for example coinciding with coastal works such a harbour construction or channel dredging. Comparative studies have also recorded declines in quality in benthic communities of intertidal mudflats in the Waddensea for example biogenic structures disappeared in the 1930s and mussels and cockles decreased and almost disappeared around 1990. Since then recovery is slowly taking place.

Also relevant is the associated decline in the quality of habitat complexes (bays, barrier systems and estuaries) which include intertidal mudflats, but this is difficult to quantify. Localised reductions in quality are still taking place, for example in industrialised areas where the intertidal mudflat habitat may be degraded due to toxic contamination and elsewhere if run-off from the land leads to eutrophication. Invasive species such as the Pacific Oyster and razor clam have also modified the composition of the associated benthic communities, particularly in parts of the Wadden Sea. De-polderisation or managed retreat schemes (e.g. through the partial or total removal of dykes) have been undertaken on a small scale to try and restore areas of intertidal mudflat habitat. Overall the current situation is probably stable and with scope to improve with appropriate conservation and preservation measures. Nevertheless, because of the significant historical reduction in extent of this habitat it 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
Endangered	A3	Endangered	A3

Sub-habitat types that may require further examination

None.

Habitat Type

Code and name

A2.33: Marine Atlantic littoral mud with associated communities

Extensive intertidal mudflats in the Bay of Mont Saint-Michel, France (© S. Gubbay).

Pattern of gullies intersecting mudflats in the Eijerlandse inlet between Texel and Vlieland, the Netherlands (scale 30 x 30 km) (Baptist *et al.* 2007).

Habitat description

Intertidal flats along the open coast and near tidal inlets consist mainly of medium to coarse sand. In sheltered areas and near tidal watersheds the sediment is finer and may entirely consist of fine mud. This habitat type can occur in patches or grade into intertidal flats dominated by other soft sediments. Similarly whilst intertidal mudflats in large bays may be considered fully marine, there can still be a river influence and therefore reduced salinities across some of the habitat depending on location and outflow levels. Mudflats in fully marine waters, periodically falling dry at low tide, subject to great amplitudes of temperature, light and salinity, and may be subject to high eutrophication and input of organic substances from rivers and the open sea. Free of vegetation, of higher plants and of macroalgae but mostly covered by thin layers of diatoms and bluegreen algae. In some situations they may be colonised by seagrass. Sediments consist mainly of fine particles, mostly in the silt and clay fraction (particle size less than 0.063 mm in diameter), though sandy mud may contain up to 80% sand (mostly very fine and fine sand), often with a high organic content. Little oxygen penetrates these cohesive sediments, and an anoxic layer is often present within millimetres of the sediment surface. Intertidal mudflats in fully marine open sea (coast) only develop under macrotidal conditions such as those found in the German Bight and Mont Saint Michel, France. Also they form part of a habitat complex on a landscape scale within bays, barrier systems and estuaries. The intertidal mudflats support communities characterised by polychaetes, bivalves, snails and oligochaetes. The species composition of the macrobenthic communities are likely to show zoning from high to lower intertidal levels. In the Dutch, German and Danish Waddens Sea, for example, the high coastal tidal flats are generally characterised by a low number of species with numerous small individuals that are deposit feeders. Typical examples are *Corophium volutator* and *Hydrobia ulvae*. Large-sized species become numerous below mean tide levels and below this the biomass is dominated by the deposit feeding *Arenicola marina.* At mudflats well below mean low water, large filter-feeding bivalves such as *Cerastoderma edule, Mya arenaria, Mytilus edulis* and *Ensis directus* make up a significant proportion of the total biomass.

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.

Characteristic species:

Species recorded from sampling locations in the Wadden Sea in time-series studies include Polychaetes: *Arenicola marina, Eteone longa, Pygospio elegans, Heteromastus filiformis, Capitella capitata, Lanice conchilega, Nereis diversicolor, Phyllodoce mucosa,* and *Scoloplos armiger,* *Crustaceans: Bathyporeia sp. Corophium volutator, Crangon crangon and Gammarus locusta*, and Molluscs: *Abra tenuis, Cerastoderma edule, Hydrobia ulvae, Macoma balthica, Mya arenaria* and *Retusa obtusa.*

Classification

EUNIS (v1405):

Level 4. A sub-habitat of 'Atlantic littoral mud' (A2.3). Proposed new level 4 habitat to account for fully marine habitats in the Wadden Sea and elsewhere

Annex 1:

1140 Mudflats and sandflats not covered at low tide

1160 Large shallow inlets and bays

MAES:

Marine - Marine inlets and transitional waters

Marine – Coastal

MSFD:

Littoral sediment

EUSeaMap:

Not mapped

IUCN:

9.10 Estuaries

12.4 Mud Shoreline and Intertidal Mud Flats

Other relationships:

One of the biotope types in the Trilateral Wadden Sea Area - under 05.01

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

Yes

Regions
Atlantic

Justification
Large expanses of littoral mud are typical of much of the North Sea coastline of Denmark, Germany, and the Netherlands. Examples from further south can be found in the Bay of Morbihan and the Bay of Oleron in France and further north in Morecambe Bay, UK.

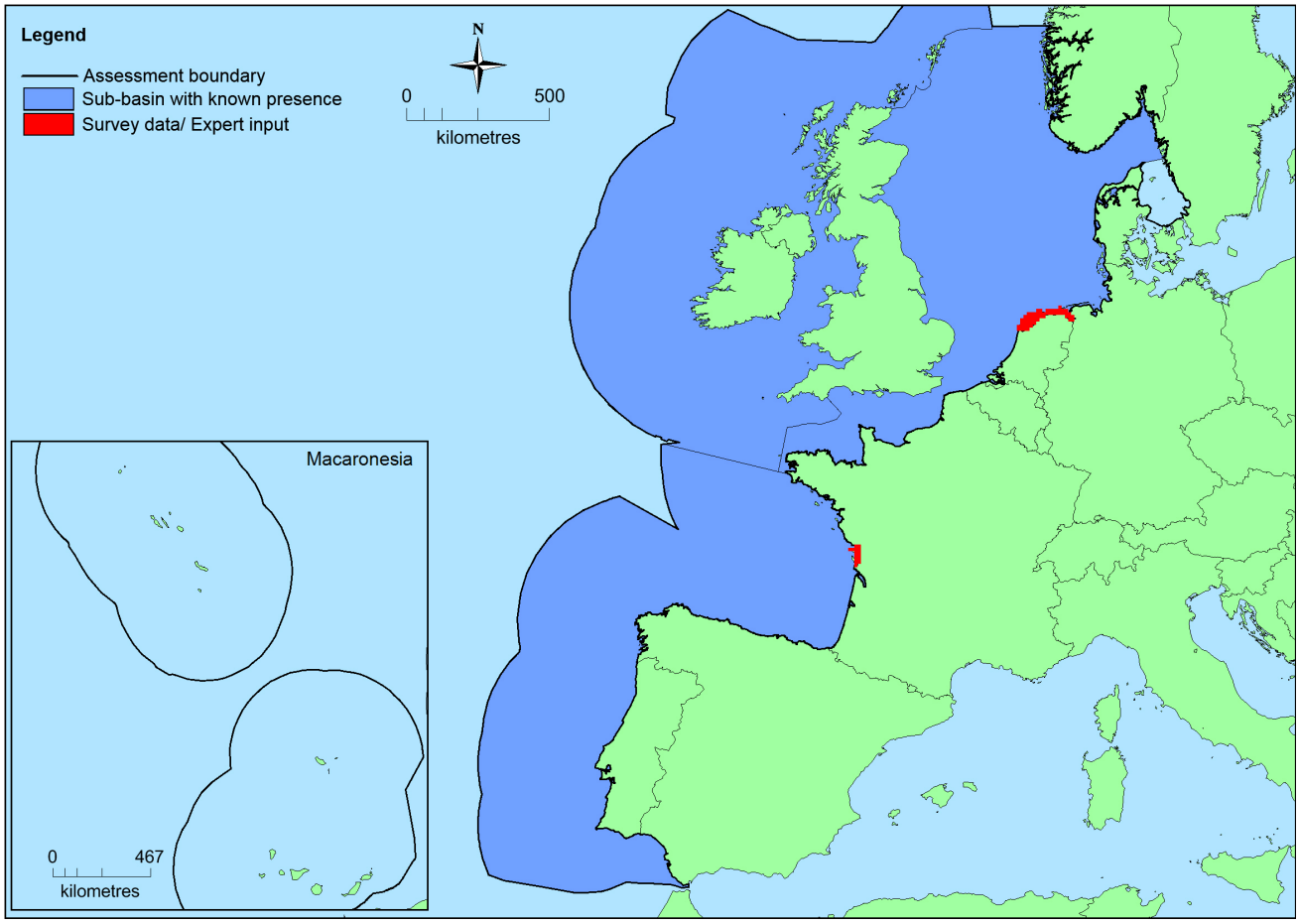
Geographic occurrence and trends

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	Unknown Km^2	Stable	Stable

Extent of Occurrence, Area of Occupancy and habitat area

	Extent of Occurrence (EOO)	Area of Occupancy (AOO)	Current estimated Total Area	Comment
EU 28	102,147 Km^2	71	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+	>102,147 Km^2	>71	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?

This habitat does occur in the EU 28+ (e.g.Norway) therefore less than 100% is hosted by EU 28. A precise estimate is not possible but EU 28 is likely to host more than 90% given the large area of this habitat in the Wadden Sea.

Trends in quantity

Reduction in the area of intertidal mudflats has occurred in many parts of the region although the full extent of this habitat and its loss in extent over time is not fully documented for most Member States. The decrease has been dramatic over the last centuries (possibly as much as 80%) but it is more limited at the present time coinciding with coastal works such a harbour construction or channel dredging. De-polderisation or managed retreat schemes (e.g. through the partial or total removal of dykes) have been undertaken on a small scale to try and restore areas of intertidal mudflat habitat.

- Average current trend in quantity (extent)
  EU 28: Stable
  EU 28+: Stable
- Does the habitat type have a small natural range following regression?
  No
  Justification
  This habitat occurs across a wide geographical area. Examples in the west of the region include the

mudflats of Marennes-Oleron bay on the French Atlantic coast, in the north in Morecambe Bay, UK and the Wadden Sea off the coast of the Netherlands, Germany and Denmark, which has largest unbroken system of intertidal sand and mudflats in the world (4,700 km^2).

- Does the habitat have a small natural range by reason of its intrinsically restricted area?
  No
  Justification
  This habitat occurs across a wide geographical area. Examples in the west of the region include the mudflats of Marennes-Oleron bay on the French Atlantic coast, in the north in Morecambe Bay, UK and the Wadden Sea off the coast of the Netherlands, Germany and Denmark, which has largest unbroken system of intertidal sand and mudflats in the world (4,700 km^2).

Trends in quality

Because of the significant loss in extent of this habitat in past centuries there has also been a historical reduction in quality. More recent studies have shown changes in relative abundance of typical benthic species (polychaetes, molluscs) as well as of invasive species. In the Waddensea for example biogenic structures disappeared in the 1930s and mussels and cockles decreased and almost disappeared around 1990. Since then recovery has slowly been taking place. Some introduced species have taken over part of the system with Pacific Oyster (*Crassostrea gigas*) and the Razor clam (*Ensis directus)* now among the most abundant molluscs. In recent decades there is localised reduction in quality, for example in industrialised areas that are often subject to a variety of pressures such as degradation through high levels of pollution and waste discharge.

Overall the situation is probably stable and with conservation and preservation measures may improve in the future.

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

Pressures and threats

OSPAR has identified the scale of the threat to intertidal mudflats from waste/effluent discharge, invasion by alien species, pollution, reclamation (localised) and climate change as high and from collecting, and shell fisheries as moderate. Disturbance, for example from recreational activities is also a significant threat in some locations.

Diffuse and point source discharges from agriculture, industry and urban areas, including polluted storm-water run-off, can create abiotic areas or produce algal mats which may affect invertebrate communities. They can also remove embedded fauna and destabilise sediments thus making them liable to erode. The increased coverage of 'green tide' mats of opportunistic green macroalgae such as *Ulva* sp. and *Enteromorpha* sp. result in anoxic conditions below the mats. The release of refinery effluent to intertidal mudflats will result in anoxic sediments, a degraded infaunal community and changes to predator-prey relationships through a possible decrease in the palatability of prey.

Invasion by alien species has had ecological consequences through alternations of the habitat and associated communities. In the Wadden Sea around 50 non-indigenous species are present, but the main issues of concern are the pacific oyster (*Crassostrea gigas*), which has also spread in the Thames estuary and along French intertidal flats and the slipper limpet (*Crepidula fornicata*). The introduction of new or non-native plant species also alters the habitat, for example the spread of cord-grass *Spartina anglica* which has vegetated some upper-shore mudflat areas with important ecological consequences in some areas.

Sea level rise is reducing the intertidal zone when sufficient sediment import is lacking. Higher sea level

and increased storm frequency, resulting from climate change, may further affect the sedimentation patterns of mudflats. A further cause for concern is the phenomenon called ‘coastal squeeze’. As sea levels rise, coastal habitats such as saltmarsh, if in an entirely natural situation, would respond by moving landward or 'rolling back' to adjust their position. Fixed man made structures such as seawalls prevent or severely limit this landward movement. The coastal habitats are therefore ‘squeezed out’ between rising sea levels and fixed defence lines.

Mussel, cockle and shrimp fisheries have either directly (through overexploitation) or indirectly (through the effects of fishing equipment on the sea bottom) been considered detrimental to the benthic community. For example, a study on oyster culture practices on the intertidal mudflats of France's Atlantic coast shows that oyster farming alters intertidal macrozoobenthic assemblages moderately, and off-bottom cultures cause more disturbance than on-bottom cultures. Hydrodynamics and seasons may interact with culture practices in smothering or strengthening biodeposition-mediated effects through dispersal/accumulation of biodeposits.

List of pressures and threats

Biological resource use other than agriculture & forestry

- Marine and Freshwater Aquaculture
- Fishing and harvesting aquatic resources
- Hunting, fishing or collecting activities not referred to above

Pollution

- Pollution to surface waters (limnic, terrestrial, marine & brackish)
  - Pollution to surface waters by industrial plants
  - Pollution to surface waters by storm overflows
  - Diffuse pollution to surface waters via storm overflows or urban run-off
  - Diffuse pollution to surface waters due to agricultural and forestry activities
  - Input of contaminants (synthetic substances, non-synthetic substances, radionuclides) - diffuse sources, point sources, acute events
- Marine water pollution
  - Oil spills in the sea

Invasive, other problematic species and genes

- Invasive non-native species

Natural System modifications

- Human induced changes in hydraulic conditions
  - Landfill, land reclamation and drying out, general
  - Polderisation
  - Reclamation of land from sea, estuary or marsh
  - Removal of sediments (mud...)
  - Estuarine and coastal dredging
  - Dykes, embankments, artificial beaches, general
  - Sea defense or coast protection works, tidal barrages

Climate change

- Changes in abiotic conditions
  - Water flow changes (limnic, tidal and oceanic)
  - Wave exposure changes

Sea-level changes
Changes in biotic conditions
Habitat shifting and alteration

Conservation and management

Management of both terrestrial and marine activities will be important to control factors leading to the decline and threats to this habitat. The water quality on mudflats is regulated by a number of EC Directives including the the Urban Waste Water Treatment Directive, the Nitrates Directive and the Water Framework Directive. These commitments provide for the regulation of discharges to the sea and have set targets and quality standards covering many metals and pesticides, and other toxic persistent and bioaccumulative substances.

The designation of protected areas and management schemes has led to the introduction of measures to protect or improve the quality of this habitat. The largest of these, agreed by the governments of the Netherlands, Germany and Denmark is the trilateral Wadden Sea Plan. Other management measures include the regulation of dredging, coastal developmet, aquaculture, hard coastal defence structures and the control of invasive species such as the cordgrass *Spartina anglica* and the Pacific oyster *Crassostrea gigas*.

List of conservation and management needs

Measures related to agriculture and open habitats

Other agriculture-related measures

Measures related to wetland, freshwater and coastal habitats

Other wetland related measures
Restoring/Improving water quality
Restoring/Improving the hydrological regime
Restoring coastal areas

Measures related to marine habitats

Other marine-related measures

Measures related to spatial planning

Other spatial measures
Establish protected areas/sites
Legal protection of habitats and species
Manage landscape features

Measures related to hunting, taking and fishing and species management

Regulation/Management of fishery in marine and brackish systems

Measures related to urban areas, industry, energy and transport

Urban and industrial waste management

Measures related to special resouce use

Regulating/Managing exploitation of natural resources on sea

Conservation status

Annex 1:

1140: MATL U2, MMAC XX

1160: MATL U2, MMAC FV.

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

Intertidal habitats pose special problems for restoration because (i) they are topographically and ecologically complex, (ii) they support many species of animals, some of which require specific habitats and linkages to other terrestrial or marine habitats, and (iii) they exist and evolve within dynamic coastal settings, subject to changing tidal levels, salinities and long term forcing factors associated with sea-level rise and climate change.

The littoral mudflat habitat is naturally resilient and can recuperate well from isolated physical and chemical disturbances, although they have been considered to be very sensitive to oil pollution as the oil enters lower layers of the mudflats where lack of oxygen prevents decomposition of the oil. Once the habitat disappears, due to agricultural land reclaim, infrastructure development or saltmarsh growth, the process is generally irreversible although since the 1980s there have been some intertidal habitat creation or restoration schemes (de-polderisation or managed retreat).

Effort required

10 years	20 years
Naturally	Naturally

Red List Assessment

Criterion A: Reduction in quantity

Criterion A	A1	A2a	A2b	A3
EU 28	<25 %	unknown %	unknown %	>70 %
EU 28+	<25 %	unknown %	unknown %	>70 %

There has been a very significant historical reduction in the extent of this habitat, possibly in the order of 80%. In more recent decades the situation has stabilised although there still localised losses taking place, for example, associated with coastal developments and channel dredging. This habitat has been assessed as Endangered 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	No	No	No	>50	No	No	No	No
EU 28+	>50,000 Km^2	No	No	No	>50	No	No	No	No

This habitat has a large natural range in the North East Atlantic region with a substantial expanse in the southern North Sea along the coastline of the Netherlands, Germany and Denmark. EOO >50,000 km^2 and AOO >50, and it is not limited to a few locations. There have been historical declines in quantity and quality but the current situation is considered to be largely stable. This habitat has therefore been assessed as Least Concern under criteria B.

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	unknown %	unknown %	unknown %	unknown %	unknown %	unknown %
EU 28+	unknown %	unknown %	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 %	>30 %	severe %
EU 28+	unknown %	unknown %	unknown %	unknown %	>30 %	severe %

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 historical reduction in the quality of this habitat as areas have been degraded and lost through primarily through land claim schemes for agricultural. Today there remains some localised reduction in quality, for example associated with industrial effluents, shell fisheries and bait digging, but on a much smaller scale than in previous centuries. Changes have also been observed in the benthic communities, for example in the relative abundance of polychaetes and molluscs. In the Dutch Wadden Sea biogenic structures disappeared in the 1930s and mussels and cockles decreased and almost disappeared around 1990. Since then recovery has slowly been taking place although some introduced species have taken over part of the system as the Pacific Oyster (*Crassostrea gigas*) and the Razor clam (*Ensis directus)* now among the most abundant molluscs.

The cyclical nature of recorded changes make it problematic to quantify the extent of reduction in quality of this habitat in the North East Atlantic.

Because of the historical severe decline in quality affecting over 30% of this habitat it has been assessed as Vulnerable under criteria C/D3 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 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	LC	DD	DD	EN	LC	LC	LC	DD	DD	VU	DD	DD	DD	DD	DD	DD	DD
EU28+	LC	DD	DD	EN	LC	LC	LC	DD	DD	VU	DD	DD	DD	DD	DD	DD	DD

Overall Category & Criteria	
EU 28	EU 28+

Overall Category & Criteria			
Red List Category	Red List Criteria	Red List Category	Red List Criteria
Endangered	A3	Endangered	A3

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

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