Nomination

Oceanic ridges with hydrothermal vents/fields
EUNIS code: A6.94
National Marine Habitat Classification for UK & Ireland code: Not defined

Definition for habitat mapping

Hydrothermal vents occur along spreading ridges (such as the mid-Atlantic ridge), subduction zones, fracture zones and back-arc basins (Gage & Tyler, 1991), and are caused by seawater penetrating the upper levels of the Earth's crust through channels formed in cooling lava flows, reacting chemically with hot basalt in the Earth's crust and then rising back to the sea-bed to vent as superheated water containing compounds such as sulphides, metals, CO_2 and methane (Tunnicliffe *et al*, 1998 in Gubbay, 2002). The water may trickle out from cracks and crevices on the seabed as hot springs (5-250°C), or as very concentrated jets of superheated water (270-380°C). As these concentrated jets of water cool, minerals dissolved in the water precipitate out in black clouds, giving them their common name of 'black smokers'. At lower temperatures, sulphides are mostly precipitated within the rocks, making the venting fluids appear cloudier. These are known as 'white smokers' (Gage & Tyler, 1991). Hydrothermal vent fields cover relatively small areas of the seabed in water depths of 850-4,000m. The biological communities associated with hydrothermal vents are unusual as they are able to derive energy under conditions where photosynthesis is not possible. These habitats contain a huge diversity of chemoautotrophic bacteria, which form the core of the trophic structure around the vent. Characteristic species include the mussel *Bathymodiolus azoricus* and its commensal worm *Branchipolynoe seepensis*, the shrimps *Mirocaris fortunata, Chorocaris chacei* and *Rimicaris exoculata* (this last one is dominant on the southern vent fields of Lucky Strike), the crab *Segonzacia mesatlantic*, the polychaete *Amathys lutzi*, the amphipod *Luckia strike* and the limpet *Lepetodrilus atlanticus*

Geographical extent

OSPAR Regions; I, V
Biogeographic zones: 24
Region & Biogeographic zones specified for decline and/or threat: V

Hydrothermal vents/fields have been found in areas of deep sea tectonic activity in the Pacific, Indian and Atlantic Oceans. In the Atlantic they are associated with the Mid-Atlantic Ridge (MAR).

The hydrothermal activity around vents is caused by seawater penetrating the upper layers of the earths crust through channels formed in cooling lava flows. The tall chimneys formed around the vents and the surrounding sediments are almost pure metallic sulphides and are a unique geological feature of hydrothermal vents (Tunnicliffe *et al.,* 1998). The associated animal communities are particularly unusual as the species derive energy under conditions where photosynthesis is not possible, tolerate great extremes and variability in the temperature and the chemical composition of the surrounding water, and cope with potentially toxic concentrations of various heavy metals.

Application of the Texel-Faial criteria

Hydrothermal vents/fields were nominated in a joint submission by three Contracting Parties citing regional importance, decline, rarity, and sensitivity, with information also provided on threat. The nomination was for Region V.

Regional importance

Hydrothermal vents are most commonly found where ridge of the earths plates are activity spreading but only occupy a small portion of the spreading ridges. The habitat is therefore only present at irregular intervals and the distance in between depending on nature of both volcanism and tectonism of that ridge. At the present time there are four known vent fields in the OSPAR area which are to the south-west of the Azores. These are the Menez Gwen, Lucky Strike, Saldanha and Rainbow vents.

Decline

The extent and distribution of active hydrothermal vents in the MAR is not fully known and will, in any case, change with time over a variety of time scales. As many of these sites only cover a small geographic area and include relatively fragile structures they can be under considerable exploration pressure. At some sites this has already reached a point where man-induced changes in the distribution and occurrence of vent fluid flows and of associated vent communities have been documented (Mullineaux *et al.,* 1998).

Rarity
Most, if not all the known hydrothermal vent fields in the OSPAR Maritime Area, occur in Region V. They cover very small areas in relatively shallow depths compared to fields outside the OSPAR area. These factors make them a rare habitat in the area under consideration.

Rarity is also a consideration in relation to the animal communities associated with hydrothermal vents. At the Lucky Strike vent field, for example, the fauna is dominated by dense beds of a new

species of mussel of the genus Bathymodiolus, as well as supporting a totally novel amphipod fauna including a new genus, and the echinoderm *Echinus alexandri*. These vent communities have a sufficiently unique fauna to be considered as representing a different biogeographic hydrothermal province to those previously described (Van Dover *et al.,* 1996).

Sensitivity

The specialised adaptations which allow organisms to exploit vent habitats include major reorganisation of internal tissues and physiologies to house microbial symbionts, biochemical adaptations to cope with sulphide poisoning, behavioural and molecular responses to high temperature, presence of metal-binding proteins and development of specialised sensory organs to locate hot chimneys (Tunnicliffe *et al.,* 1998). The result has been specialised faunas, which are rarely found in other environments. They are also not a very diverse group of species but because they can exploit an abundant energy source around vents they are often present in very high densities (Childress & Fisher, 1992). Vent species are therefore not as sensitive to fluctuations in environmental conditions as many other deep sea fauna but are specially adapted to these extreme conditions. They may also be sensitive to factors that have still to be studied such as blinding due to extensive use of lights and flash photography and damage to the vent chimneys.

Threat

The main threats to hydrothermal vent systems and their associated biological communities are from scientific research (including collecting), seabed mining, tourism and bioprospecting (InterRidge, 2000). The unusual nature of the marine communities that occur around hydrothermal vents makes them a focus for deep sea research. There are regular expeditions to the well-known sites to make observations and measurements, deploy instruments, and collect specimens of the marine life, seawater and rocks. As many of these sites only cover a small geographic area and include relatively fragile structures they can be under considerable exploration pressure (Mullineaux *et al.,* 1998).
Apart from research expeditions, it can be expected that hydrothermal vents will also be subject to pressures from other activities. The first tourist trips to deep sea hydrothermal vents took place in the OSPAR Maritime Area in 1999, at the Rainbow vent site, and are already reputed to have caused some damage to vent chimneys. The vent system on the Dom João de Castro Seamount in the Azores is in shallow waters and subject to some tourist use.

Seabed mining is a potential threat with mining companies seriously investigating the possibility of mining metal sulphide deposits. An exploration licence for such activity has been granted to one company already, but outside the OSPAR Maritime Area (Butler *et al.,* 2001). Bioprospecting, and particularly microbial sampling, is another threat. This usually causes less habitat destruction than many other types of sampling, but the ecological impact of redistribution micro-organisms between sites remains to be evaluated (InterRidge, 2000).

Relevant additional considerations

Sufficiency of data

Hydothermal vents and their associated animal communities were discovered in the late 1970's. Given the relatively short history of research, and the difficulties of conducting such research in the deep sea, it is clear that the study of vent habitat and faunas is at a relatively early stage. This relates to both the extent of active vents in the OSPAR Maritime Area and knowledge of the associated communities. The situation is different for particular vents, such as those to the west of the Azores, which have been the focus of intensive research programmes and it is work in these locations that has led to concerns about threats to vent habitats and their associated communities.

Changes in relation to natural variability

Hydrothermal vents are most commonly found where ridges of the earths' plates are actively spreading. On fast spreading ridges, such as the East Pacific Rise at 13°N vent sites appear to have a short lifetime (generally no longer than about 100yrs) and the zone of hydrothermal activity shifts along the ridge. On slow spreading ridges such as the Mid-Atlantic Ridge, the hydrothermal activity is spatially more focused and stable over the long term, even if the lifetime of an individual vent site is similar to that on fast spreading ridges (Comtet & Desbruyeres, 1998).

Vents and their associated communities are transient and variable not only on short time scales of days and seconds but also over decades. Variability in the hydrothermal discharge causes changes in the animals communities associated with vents. As a consequence, the vent fauna must adapt to unstable environmental conditions and nutrient supply by rapidly colonising new vents (Comtet & Desbruyeres, 1998). Evidence for the longer term variability can be seen in accumulations of dead giant bivalve shells which, as they are known to only persist for about 15yrs before being dissolved, must indicate quite recent change in conditions. Geophysical and geochemical evidence suggests short bursts

of hydrothermal activity lasting decades or less. The habitat is neither permanent nor contiguous; dispersal and migration are the major links between neighbouring vents (Tunnicliffe *et al.,* 1998).

Expert judgement

There is ample information to confirm the unique nature of hydrothermal vents and their associated community, and a good basis for considering them to be a rare habitat in the OSPAR Maritime Area. The threats to these habitats have been observed in particular locations and have led to calls by scientists for the co-ordination and management of research programmes to avoid damage. This has been taken up by the Regional Government of the Azores in particular, who are preparing a management plan for the first hydrothermal vent Marine Protected Area in the Atlantic. A combination of research data and expert judgement therefore suggests that hydrothermal vents/fields should be on the OSPAR list of threatened and/or declining species and habitats.

ICES evaluation

The ICES review of this nomination agrees that there is no empirical evidence to suggest that hydrothermal vents are in decline (ICES, 2002). In relation to threat, ICES consider that this habitat has not been proven to be under threat from present-day human activities and that potential future threats such as mining and bioprospecting will be localised and of relatively low impact.

This assessment needs to be viewed in context, as the habitat itself is relatively localised. The limited extent of current and potential threats could therefore still cause serious damage to vent fields and associated communities, and have a significant impact. The threats to hydrothermal vents have been described above and are believed to be a realistic description of human activities, which can have an impact on this habitat.

Threat and link to human activities

Cross-reference to checklist of human activities in OSPAR MPA Guidelines

Relevant human activity: mineral extraction, research, bio-prospecting, tourism. *Category of effect of human activity:* Physical – substratum removal, visual disturbance. Biological – physical damage to species, displacement of species, removal of target and non-target species, changes in population or community structure, introduction of microbial pathogens or parasites

Scientific research around hydrothermal vents can cause physical damage to the habitats and associated organism through sampling programmes, accidental damage and monitoring techniques. Tourist trips to hydrothermal vents and commercial mining activity are other potential threats that would be a result of human activity.

Management considerations

Research protocols, co-ordinated studies and protected areas are amongst the ideas being taken forward by scientists working on hydrothermal vents and the associated biological communities. Similar measures may also be required to manage and future tourist activity while issues concerning seabed mining will need to be raised with the International Seabed Authority if it is to take place beyond EEZs. Measures such as these can be supported by OSPAR to address concerns that the ecological quality of the hydrothermal vent habitats in OSPAR Region V might significantly decline if no protection or management measures are taken

Further information

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Useful References:

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