**Title/Name of the area:** SAA

**Presented by**

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**Abstract**

SAA (South of the Azores Area) EBSA encompasses a total of 18 structures: 7 hydrothermal vents (Bubbylon, Ewan, Lucky Strike segment, Menez Gwen, Menez Hom, Rainbow, Saldanha), 5 structures less studied, inferred from water column profiles (North Oceanographer, South Lucky Strike, South Oceanographer, SOH1, SOH2) and 6 other structures: 4 segments (AMAR, FAMOUS, North FAMOUS, South AMAR) and 2 fractures (Hayes, Oceanographer). The EBSA area includes 3 OSPAR high-seas Marine Protected Area – segment Lucky Strike, Menez Gwen and Rainbow. The structures described and included are hotspots of marine life and in general they represent areas of an enhanced productivity, especially when compared with nearby abyssal areas. This EBSA has a total area of 98841 km$^2$ with identified structures depths ranging from the deepest 3460 m (inferred deep – South oceanographer), 2320 m (measured deep – Rainbow); to the shallowest 840 m (Menez Gwen). The hydrothermal temperatures range between 10° C (Menez Hom and Saldanha) to 362° C (Rainbow). The area presents particular features which make this area eligible as an EBSA when assessed against the EBSA scientific criteria. All structures registered in the SAA EBSA fulfill all of the seven EBSA scientific criteria. A total of 342 species are present in this EBSA. The area is totally located under Portuguese national jurisdiction, with 10 of the 18 structures located on the extended continental shelf (seabed) and 8 on the Portuguese EEZ close to Azores.

**Introduction**

The SAA EBSA 18 structures; 7 hydrothermal vent studied (Bubbylon, Ewan, Lucky Strike segment, Menez Gwen, Menez Hom, Rainbow, Saldanha), 5 structures less studied, inferred from water column profiles (North Oceanographer, South Lucky Strike, South Oceanographer, SOH1, SOH2 - offsets) and 6 other structures: 4 segments (AMAR, FAMOUS, North FAMOUS, South AMAR) and 2 fractures (Hayes, Oceanographer). All of these structures, present particular features which make this area eligible as an EBSA when assessed against the EBSA scientific criteria. Most of them are hydrothermal vent fields.

Since the discovery of the first hydrothermal in 1977, an increasing number of vent fields were found. However, very little is still known about most of the 50,000 km of ocean ridges (Charlou *et al*., 2002; Kelley *et al*., 2002; Hein *et al*., 2013). See https://vents-data.interridge.org/

In the ridge areas, the tectonic plates move apart, magma migrates in the subsurface and erupts at the seafloor. Due to the rock deformation, seawater penetrates to great depth and is rejected to the surface being enriched with large amounts of dissolved material, especially hydrogen sulfide ($H_2S$), various sulfide minerals, metals, carbon dioxide ($CO_2$) and methane. Depending on the pressure of ejection and the ambient temperature, crystallization of the sulfide minerals forms chimneys known as "black" or "white smokers" for their precipitate color (Ohmoto *et al*., 2006; Gold, 2013) .

The vents can have a wide spectrum of distribution, ranging from the deeper Beebe Hydrothermal Vent Field, laying in the Cayman Trough, a deep section of the Caribbean south of Cuba at ~5000 meters (Tarasov *et al.,* 2005; Connelly *et al.,* 2012) to the shallower in the D. João de Castro Bank near to Azores at 20 m depth (Cardigos *et al.,* 2005; Tarasov *et al.,* 2005).

The systems presents in the EBSA area, are characterized by extreme conditions such as unique physical properties (temperature, pressure), chemical toxicity, and absence of photosynthesis (Edmond *et al*., 1979; Mottl & Wheat, 1994; Kadko *et al*., 1995; Elderfield & Schultz, 1996; Minic *et al*., 2006). The venting dynamic of hydrothermal fluids back into the ocean is of major importance as it is associated with enhanced cooling of the ocean floor, formation of deep-sea mineral deposits, and unique ecosystems that exist around vent sites in extreme environmental conditions (Lister, 1980; Tufar *et al*., 1986; Haymon *et al*., 1989; Fouquet *et al*., 1995; Cathles *et al*., 1997; Boetius, 2005; Kelley *et al*., 2005; Marques *et al*., 2007).

In fact, hydrothermal flow through the Earth's crust has frequently a first order control on major geological mechanisms of heat and chemical transfer from the interior of the earth to the ocean. For example, hydrothermal venting is closely linked to the genesis of oceanic crust. Seawater enters the young ocean floor along fractures and cracks to reach and react with a hot magmatic intrusion forming mineral-rich buoyant hydrothermal brine (Von Damm, 1990; Murton *et al*., 1994; Charlou *et al*., 1996, 2002; Wilcock, 1998; Allen & Seyfried, 2003; Cherkaoui *et al*., 2003; Bach *et al*., 2004; Lyer *et al*., 2008; 2010; Coumou *et al*., 2009). The active vents are hosted by a range of different rock types, including basalt, peridotite, and felsic rocks. The associated hydrothermal fluids exhibit substantial chemical variability, which is largely attributable to compositional differences among the underlying host rocks (Amend *et al*., 2011). The vent circulation accounts for approximately one third of the global geothermal heat flux to the oceans and strongly affects the chemical composition of the water (Elderfield & Schultz, 1996). In SAA EBSA there are many types of hydrothermal sites: high-temperature hydrothermal sites (250º–365° C) and low pH (<4); metal-rich chimneys, (Bubbylon, Lucky Strike segment, Menez Gwen and Rainbow), diffuse and pervasive seepages, withapparently low temperatures T (<30° C), and of unknown pH (Menez Hom and Saldanha) (Barriga *et al*., 1998; Charlou *et al*., 2010). The Lucky Strike segment, Menez Gwen and bubbylon

The dynamic of the hydrothermal processes, is still "poorly" known, in particular their heat. However in low-temperature ultramafic-hosted hydrothermal systems the heat source has been suggested to be derived from the exothermic reactions of serpentinization (e.g. Barriga *et al*., 1998; Kelley *et al*., 2001; Lowell & Rona, 2002; Schroeder *et al*., 2002), through heat balance models suggest that an additional heat source is necessary particularly for higher-temperature fields such as Rainbow (Lowell & Rona, 2002; Allen & Seyfried, 2004). In the high temperature vents, the fluids rise above a vent-orifice, they mix turbulently with seawater and form fine-grained polymetallic sulphides and oxides, which continue to precipitate as dilution progresses (Lupton *et al*., 1985; Feely *et al*., 1987; Mottl and McConachy, 1990; Douville *et al*., 2002). Sulphates, sulphides and other heavy minerals sink near the vent source (Dymond and Roth, 1988; Khripounoff and Alberic, 1991; German *et al*., 2002), but fine grained oxides, enriched in elements from seawater, are laterally advected tens of kilometers away from the source regions by bottom-current (Lilley *et al*., 1995).

Hydrothermal activity associated with ultramafic outcrops at mid ocean ridges (MOR) can be confined to slow and ultraslow spreading ridges and the ultramafic outcrops are usually associated with detachment faulting, low magma budgets, relatively thin crust and irregular faulting patterns (Cannat *et al*., 1997; Gràcia *et al*., 2000; Mevel, 2003). The frequency of tectonic and volcanic events that can disrupt the pathways for vent fluids are lower in this slow-spreading ridge system, thus resulting in greater temporal stability in the location and activity of the vent fields (Copley *et al*., 2007).

In terms of the biology the vent fields play also a primordial role sustaining abundant populations of faunal species in the deep sea by the autochthonous primary production of high chemosynthetic primary production (*e.g.* Lutz & Kennish, 1993; Bemis *et al*., 2012). The process use the reduced compounds (typically hydrogen sulfide, methane, or hydrogen) in vent fluids to fix inorganic carbon (Karl *et al.,* 1980) that can be oxidized by microbes to release energy for the formation of organic carbon from carbon dioxide, carbon monoxide, and/or methane (Van Dover *et al.,* 2002). The chemosynthetic organisms may be present in the water column, at the seafloor as microbial mats, within sediments, fractures of crustal rocks or the sub-seabed, or/and in symbioses with larger multi-cellular organisms (Dubilier *et al.,* 2008). The most favorable areas for colonization by these primary producers is therefore near enough to the venting waters to take up compounds before it is oxidized or too diluted, but far enough away to take up an oxidant from the surrounding seawater (Hessler *et al*., 1988; Childress & Fisher, 1992; Van Dover, 2000; Hawkes *et al*., 2013).

After the colonization by the microbiota fauna, there are facilities to the development and maintenance of densely populated ecosystems in which both biomass and faunal abundances are larger than is typical at the deep seafloor (e.g. Lutz & Kennish, 1993; Smith *et al*., 2008).

The hydrothermal communities have been studied worldwide and have led to the description of a number of new taxa. More than 400 new faunal species have been described (Desbruyères *et al.,* 2006), enhancing our knowledge of marine biodiversity (Van Dover *et al.,* 2002).

The knowledge about the animal communities and biology and ecology of individual species in these waters remains limited. The rugged terrain and great depths make the ridges particularly challenging study areas (Bergstad *et al.*, 2008).

All the 18 structures registered on SAA EBSA area (Figure 1) fulfill all of the EBSA Criteria. There are great differences in the information available for each structure included in the EBSA area (Table 1). Several structures were evaluated by inference and reassemble of all the information available (specific or more generalized). The segments are also classified as fulfilling all the criteria. These areas potentially can include more hydrothermal vents than those registered.

Table 1 – Resume of the SAA structures, EBSA scientific criteria fulfilled by each structure (Crit 1 (Uniqueness or rarity), 2 (Special importance for life-history stages of species, 3 (Importance for threatened, endangered or declining species and/or habitats), 4 (Vulnerability, fragility, sensitivity, or slow recovery), 5 (Biological productivity), 6 (Biological diversity) and 7 (Naturalness). Nº sps – total number of species in each structure. Nº refs - total number of references in each structure.

| Structures | **Crit 1** | **Crit 2** | **Crit 3** | **Crit 4** | **Crit 5** | **Crit 6** | **Crit 7** | **Nº sps** | **Nº refs** |
|---|---|---|---|---|---|---|---|---|---|
| AMAR Segment | √ | √ | √ | √ | √ | √ | √ | 37 | 30 |
| Bubbylon | √ | √ | √ | √ | √ | √ | √ | 37 | 6 |
| Ewan | √ | √ | √ | √ | √ | √ | √ | 37 | 5 |
| FAMOUS Segment | √ | √ | √ | √ | √ | √ | √ | 37 | 36 |
| Lucky Strike Segment | √ | √ | √ | √ | √ | √ | √ | 216 | 318 |
| Menez Gwen | √ | √ | √ | √ | √ | √ | √ | 306 | 198 |
| Menez Hom | √ | √ | √ | √ | √ | √ | √ | 38 | 16 |
| North FAMOUS segment | √ | √ | √ | √ | √ | √ | √ | 39 | 13 |
| North Oceanographer | √ | √ | √ | √ | √ | √ | √ | 37 | 6 |
| Rainbow | √ | | √ | √ | √ | √ | | 262 | 184 |
| Saldanha | √ | √ | √ | √ | √ | √ | √ | 79 | 39 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| SOH1 | √ | √ | √ | √ | √ | √ | √ | 37 | 2 |
| SOH2 | √ | | √ | √ | √ | √ | √ | 37 | 2 |
| South AMAR segment | √ | √ | √ | √ | √ | √ | √ | 37 | 7 |
| South Lucky Strike | √ | √ | √ | √ | √ | √ | √ | 46 | 2 |
| South Oceanographer | √ | √ | √ | √ | √ | √ | √ | 37 | 3 |

The SAA EBSA area is spread over a section of the Mid Atlantic Ridge (MAR), at south of Azores (see Figure 2). The area gathers different types of structures (hydrothermal vent field segments and fractures), with predominance and greater knowledge of hydrothermal vents (table 1).

**AMAR**

The AMAR segment has a well-defined, U shaped with 9-11 km wide axial valley, slightly narrowing at its center. A series of continuous, subparallel, rectilinear 200-300 m scarps form the symmetric axial valley walls, which rise to the valley shoulders at 1400 m water depth. Within the valley floor, a series of narrow linear ridges, 62 km long, 200 m high, are present at about 2300 m for most of the length of the segment. Outside of the central neo volcanic zone, the majority of the axial valley floor is characterized by sedimented volcanic terrain and locally deeply buried fault scarps (Parson *et al*., 2000; Marques *et al*., 2007) (see figure 1 and 3).

**FAMOUS**

The FAMOUS segment is 42 km long with a V-shaped axial valley with a narrow gate form ranging in width from 2 to 6 km. The rift valley walls are strongly asymmetric and the eastern axial valley wall is a gentle slope, comprising several subparallel fault scarps which rise step-wise, from a maximum depth of 2600 m to nearly 1700 m. The western wall is a single steep, inward-facing fault. The axial valley floor is composed of a series of fresh pillow mounds and ridges. The foot of the eastern wall is almost totally devoid of fresh volcanics, and the backscattering pattern is dominated by well-defined fault scarps and talus deposits (Arcyana, 1975; Ballard & Van Andel, 1977; Choukroune *et al*., 1978; Fouquet *et al*., 1997) (see figure 1 and 3).

**North FAMOUS**

The North FAMOUS segment is the shortest (<18 km) segment from this portion of the MAR, with a depth gradient from 2700 m at segment center to 3100 m at segment ends, and 3 km crustal thickness variations estimated from gravity. The mean depth of N. Famous is 2880 m. The segment has a well-developed axial volcanic ridge extending three quarters of its length (Detrick *et al*., 1995; Chin *et al*., 1998; Bastawros, 2012; Escartín *et al*., 2015) (see figure 1 and 3).

**South AMAR**

In the South AMAR segment, the well-defined rift valley walls subtend an axial floor that is gently sinuous, but of a fairly constant width between 9 and 10 km. Within the floor, similar to the AMAR segment, a further pair of major inward-facing faults lie parallel to the outer walls. These inner faults are 4-5 km apart, and bound the neo volcanic elongated ridge system dominating the central zone of the axial floor. In contrast to AMAR, however, some neo volcanics extend outside of the central axial rift onto the shoulders (Chin *et al*., 1998; Gràcia *et al*., 2000; Baker & German, 2004) (see figure 1 and 3).

**Rainbow**

The Rainbow vent field on the Mid-Atlantic Ridge (MAR) was discovered in 1997 (German *et al*., 1996b). Rainbow hydrothermal field is a high temperature (365°C) black smokers located on the western flank of the Rainbow massif along the Mid-Atlantic Ridge (MAR) (German *et al*.,1996a, 1999; Charlou *et al*., 1997; Fouquet *et al*., 1997, 1998). It is a massif is underlain by a cone shaped core of high-Vp mantle material that is elongated in the northeast-southwest direction (Canales *et al*., 2017). The hydrothermal are localized at a between 2270 - 2320 m depth in international waters. The Rainbow vent field comprises more than 30 groups of active small sulphide chimneys over an area of 15 $km^2$. There are numerous inactive structures among a large number of rather short-lived active venting sites (German *et al*., 1996b; Charlou *et al*., 1997; Fouquet *et al*., 1997).

Around the site and through the nontransform discontinuity, a relative chronology of normal dip-slip extensional faulting, the conjugate transtensional faulting, and Riedel shears are evident. The western border of the vent field is a 25m high fault scarp where extensive stock work mineralization and replacement of ultramafic rocks by sulfides are observed (Marques *et al*., 2006; 2007).

Local hydrography and flow regimes dictate that the non-buoyant plume, that can reaches neutral buoyancy at 2100 m water depth and disperses away from the by following the local topography and flows north eastward, clockwise, along and around Rainbow ridge and into the adjacent rift valley (German and Parson, 1998; Thurnherr & Richards, 2001; Thurnherr *et al*., 2002).

At many places of the Rainbow vents, unusual lithification of the sediment around the active field and near the top of the ridge, together with several places with dead mussels, may be related to diffuse low temperature of methane-rich fluid through the sediment. Similar processes were also proposed at low temperature Saldanha and Menez Hom sites, where large amount of methane discharge through the sediment cover at the top of the ultramafic ridge (Schroeder *et al*., 2002; Ribeiro da Costa *et al*., 2008).

Together with the vent fields of Lucky Strike segment and Menez Gwen it forms the group of the northern bathyal vents fields. The underlying basement and the vent fluid compositions differ from those in basalt hosted systems due in part to serpentinization of the host rocks at Rainbow. Key characteristics of the Rainbow fluids include high chlorinity (750 mM), low pH (2.8), high methane, and extremely high Fe concentrations (24 mM), resulting in a $Fe/H_2S$ molar ratio of 24 (Charlou *et al*., 1997; Douville *et al*., 2002). The High-temperature vent occur along the shoulder of a W-facing hanging wall of the tilted ultramafic block, and are associated with one of the largest hydrothermal plumes in terms of methane output (Charlou *et al*., 1996a), manganese (Aballea *et al*., 1998), sulfide (Radford-Knoery *et al*., 1998), helium and heat (Jean-Baptiste *et al*., 1998), and particles (German *et al*., 1998).

Since its discovery, Rainbow has been the frequent focus of scientific expeditions and is the only vent field on the Mid-Atlantic ridge that has been visited by tourist operators already several times. Different types of investigations such as long-term monitoring activities, manipulative experiments and geological sampling occur in this field (McCaig *et al*., 2007; Baker *et al*., 2010; Crawford *et al*., 2010).

**Lucky Strike segment**

The Lucky Strike vent field was discovered in 1993. Since this data these field like the Rainbow field has been extensively studied particularly during expeditions (DIVA1 and FLORES, 1994; LUSTRE, 1996; MoMARETO and Graviluck, 2006; MoMAR, 2008; Bathyluck, 2009; MoMARSAT 2010 and 2011), and is also the object of long-term monitoring (e.g., Ballu *et al*., 2009; Colaço *et al*., 2011), including a seafloor observatory (ESONET-EMSO European project (Ruhl *et al*., 2011)).

Lucky Strike is one of the largest hydrothermal areas known to date, with 21 active chimney sites distributed over an area of approximately 150,000 $m^2$ at depth range of 1620-1730m. In spite of its proximity to the Azores hot spot, the Lucky Strike segment exhibits a morphological and tectonic architecture with many of the characteristics of a slow spreading ridge. The Lucky Strike segment is characterized by a well-developed of approximatively 13–20 km wide axial rift valley, whose depth increases from 1550m at the segment center to 3700m at the nodal basins near the segment ends.

Beyond the rift walls, the seafloor morphology is dominated by fault-controlled abyssal hills (Detrick *et al*., 1995). The center of the segment is dominated by the 8 km wide, 15 km long, and 500m high Lucky Strike volcano, one of the largest central volcanoes along the MAR axis. The crust is 7.5 km thick beneath the volcano and has thinned to less than 5.5 km at 20 km from the segment center (Crawford *et al*., 2010; Seher *et al*., 2010).

The Hydrothermal activity is located on the periphery of the lava lake. Submersible dive programs documented the presence of high temperature black smoker chimneys, extensive areas of diffuse flow and sulfide deposits distributed around the lava lake margins (Fouquet *et al*., 1994; Langmuir *et al*., 1997; Ondreas *et al*., 2009]. The presence of a lava lake at the summit also suggests recent magmatic activity and the potential for an active magma chamber directly beneath the edifice (Singh *et al*., 2006).

The physical/chemical qualities of the vent gases and waters are distinct from other Mid Atlantic Ridge sites due to low sulphur/high methane contents. Vent fluid temperatures range from 330º C in black smokers, to 200-212ºC and even 20° C in diffuse emissions (Von Damm *et al*., 1998; Charlou *et al*., 2000; Cooper *et al*., 2000). The larger active edifices exhibit small zones of high temperature discharge. Elsewhere in the chimneys discharge is mostly diffuse, as leakage of transparent fluid, through the mussel-covered outer walls of the chimneys.

The chimneys depict clear evidence of oxidation provoked by sea water. In the more active chimneys oxidation is restricted to an outer layer, few millimeters thick, of oxides (mainly of iron). Once fluid flow ceases, oxidation progresses inwards. Primary sulphides are replaced by secondary sulphides and subsequently by oxides. Chimneys become rapidly friable, fall and break into progressively less recognizable fragments. Nearly half of the area of the Lucky Strike field is covered with chimney debris, deeply oxidized. Most of the remaining of Lucky Strike is composed of exposed “slabs” (Barriga & Santos, 2003).

**Menez Gwen**

Menez Gwen is discovered in 1991, during submersible dives on the ridge segment north of the Lucky Strike segment (Fouquet *et al*., 1994). This segment is characterized by the absence of a central rift and volcano. Circular in shape, it has a diameter of 17 km and height of 700 m, while at its summit there is an axial graben, 6 km long, 2 km wide and 300m deep. At the graben’s northern end there is a new volcano of 600 m diameter and 120 m height, composed entirely of fresh pillow lavas with no sediment cover.

Menez Gwen is located near the top of this new volcano at the bottom of the graben at 840-870 m depth. Its hydrothermal fluids are characterized by temperatures ranging between 265° C and 281° C and these temperatures mark its characteristic physiochemical diversity and presence of anhydrite and barite. The vent is located in a basaltic environment, methane is produced by outgassing of carbon from the mantle and is related to the carbon-enriched character of basalt (Charlou *et al*., 1997). In addition, the low pH and low Fe and Si concentrations are consistent with a short duration of fluid-rock interaction linked to a shallow circulation system (Douville *et al*., 1999).

This shallow system can be affected by explosive volcanic activity (Fouquet *et al*., 1999) on an area of several square kilometres as disclosed by the distribution of volcanic ejecta on the bottom (ash, sand

and lapilli). According to Fouquet *et al*. (1994), the Menez Gwen is, geologically speaking, very young (probably few decades): chimneys are very small, growing directly on fresh pillow lava. Its relatively young age gives an excellent opportunity to monitor the early stages of hydrothermal vent activity and thus yield new knowledge on the development of vents and their associated animal communities (Marcon *et al*., 2013; Sarrazin *et al*., 2014; Konn *et al*., 2015). The vent fluids are the least toxic of the sites along the Mid-Atlantic Ridge, and make it possible for non-endemic deep sea species to live here (Desbruyères *et al*., 1997; Tunnicliffe *et al*., 1998; Colaço *et al*., 2002).

**Saldanha**

The Saldanha hydrothermal field was discovered in 1998 during the SALDANHA Cruise (Barriga *et al*., 1998). The hydrothermal field is located on NTO5, between the FAMOUS and AMAR second-order segments, and consists of a faulted peridotite massif detached from its segment flanks, almost parallel to the ridge segment. It is composed mainly of ultramafic and gabbroic rocks and a strong methane anomaly within the overlying water column (Charlou *et al*. 1997; Dias & Barriga, 2006).

Although no chimneys are present, the hydrothermal activity is expressed as discharge of clear fluid from several small orifices through sediment over an area of at least 50 $m^2$, and micro chimneys with silica and sulfides were observed (Dias, 2001; Dias *et al*., 2002).

The discovery of these particular diffuse venting confirmed the presence of hydrothermal activity related to serpentinization processes, which had been inferred from the detection of geochemical (intense $CH_4$) anomalies in the water column (Charlou *et al*., 1997; Bougault *et al*., 1998). During the serpentinization of the ultramafic rock, overlying rocks were pushed upward, generating the observed mélange. Talc-rich rocks (steatite) and spilite are commonly observed (Costa, 2001; Costa *et al*., 2002). Diving operations (Fouquet *et al*., 1997, 2000; Barriga *et al*., 1998) revealed intensely altered and locally silicified ultramafic and basaltic rocks is consistent with low magma budgets, relatively thin crust and irregular faulting patterns (Gràcia *et al*. 2000) at the top of the massif. Discrete low-temperature diffuse discharge (<6°C) from the sediment was observed near the top of the structure (Biscoito *et al*., 2006).

The studies discovered that the site is hosted in a melange of folded lithified sediment, relatively fresh to deeply altered basalt, variably deformed ultramafic rocks and some gabbroic rock, in large part covered by sedimentary ooze. The ensemble is interpreted as resulting from active serpentinite protrusion. Sulphide precipitation is taking place within the top of the rock pile, under a blanket of sediment (Dias, 2001; Barriga 2003).

**Menez Hom**

Similar to the Saldanha, the Menez Hom ultramafic dome is situated at an inside corner position relative to the non-transform offset at the south of the Lucky Strike segment. Diving operations revealed the general outcrop of ultramafic rocks at the top of the dome. No active vents were seen. However, one small carbonate chimney was sampled and anomalous rapid lithification of the sediment covers was observed at the northern side of the dome, near the limit between the ultramafic rocks and the basalt coverage. This may indicate a preferential discharge of diffuse low-temperature $CH_4$-rich fluids at the contact between the ultramafic and the basalt cover (Fouquet *et al*., 2010).

There are two attributes in common to the EBSA deep-sea hydrothermal systems: their insularity and their gradient regimes of fluid flow and chemistry suggested a priori that measures of community structure and similarity at vents would be especially sensitive to the degree of proximity between sites being compared, to the age of the sites and to within-site heterogeneity (Mullineaux & France, 1995, Marsh *et al*. 2001, Van Dover *et al*. 2001). These different vents characteristics "create" distinct habitats dominated by different chemosynthetic bacterial mats, and endemic and non-endemic species of tubeworms, mussels, gastropods, clams, shrimp and crabs. The habitat can support also other associated invertebrate species and also vertebrate one (Figure 4).

The majority of the SAA EBSA organisms have a peculiarity of the development of different strategies which ensure their adaptation to the extreme environments present in the EBSA area, for example, the biological stabilization of metal (e.g., iron, copper) from hydrothermal vents under dissolved or colloidal organic complexes for long-range export in the water column (Wu *et al*., 2011; Hawkes *et al*., 2013). In the total absence of photosynthesis, the food chain is based on primary production of energy and organic molecules by chimiolithoautotrophic bacteria. Hydrothermal vent plumes sustain high number of microbial communities with potential connections to zooplankton communities and biogeochemical fluxes in the deep ocean (Dick *et al*., 2013). These microbial communities are able to extract chemical energy starting from the oxidation of reduced mineral compounds present in their habitat (Minic *et al*., 2006; Boetius & Wenzhöfer, 2013). Studies in community hydrothermal evolution, initial colonization, growth, development and demise, show that colonization at vents is rapid (Lutz *et al*. 1994, Tunnicliffe *et al*. 1997, Shank *et al*. 1998).

The EBSA area has an unbalanced number of studies for the different structures (see table 1). Nevertheless, there is a big number of studies focused in the communities and species of these particular areas. A total of 342 species is identified all over the EBSA (see feature description of the proposed area).

**Location**

The SAA EBSA is located on the Atlantic Ocean – South of Azores (Figure 2) and the polygon is defined by 18 points, see Table 2. This EBSA has a total area of 98841 km$^2$ with structures depths ranging from the deepest 3460 m (inferred depth – South oceanographer), 2320 (measured depth – Rainbow); to the shallowest 840 m (measured depth – Menez Gwen). The datum used is World Geodetic System 1984 (WGS84).

Table 2 – Geographic coordinates in two different formats: Decimal degrees and Degrees, Minutes and Seconds, corresponding to the vertices of the polygon that defines the SAA EBSA.

| Vertices | Latitude | Longitude | Latitude | Longitude |
|---|---|---|---|---|
| 1 | 38.035689° | -31.565483° | 38° 2'8.48"N | 31°33'55.74"W |
| 2 | 37.902529° | -31.273537° | 37°54'9.10"N | 31°16'24.73"W |
| 3 | 37.583989° | -31.163169° | 37°35'2.36"N | 31° 9'47.41"W |
| 4 | 37.079933° | -31.874703° | 37° 4'47.76"N | 31°52'28.93"W |
| 5 | 36.090125° | -33.177239° | 36° 5'24.45"N | 33°10'38.06"W |
| 6 | 35.174914° | -34.328636° | 35°10'29.69"N | 34°19'43.09"W |
| 7 | 34.271500° | -36.338175° | 34°16'17.40"N | 36°20'17.43"W |
| 8 | 33.219517° | -38.187214° | 33°13'10.26"N | 38°11'13.97"W |
| 9 | 33.376903° | -38.888650° | 33°22'36.85"N | 38°53'19.14"W |
| 10 | 33.769578° | -38.703522° | 33°46'10.48"N | 38°42'12.68"W |
| 11 | 34.164322° | -38.387603° | 34° 9'51.56"N | 38°23'15.37"W |
| 12 | 34.522431° | -37.854553° | 34°31'20.75"N | 37°51'16.39"W |
| 13 | 34.873764° | -37.040906° | 34°52'25.55"N | 37° 2'27.26"W |
| 14 | 35.927744° | -35.731756° | 35°55'39.88"N | 35°43'54.32"W |
| 15 | 36.279069° | -34.561794° | 36°16'44.65"N | 34°33'42.46"W |
| 16 | 36.767611° | -33.978797° | 36°46'3.40"N | 33°58'43.67"W |
| 17 | 37.894561° | -32.576061° | 37°53'40.42"N | 32°34'33.82"W |
| 18 | 38.035689° | -31.822178° | 38° 2'8.48"N | 31°49'19.84"W |

The SAA EBSA encompasses 18 structures: 7 hydrothermal vents (Bubbylon, Ewan, Lucky Strike segment, Menez Gwen, Menez Hom, Rainbow, Saldanha), 5 structures less studied, inferred from water column profiles (North Oceanographer, South Lucky Strike, South Oceanographer, SOH1, SOH2) and 6 other structures: 4 segments (AMAR, FAMOUS, North FAMOUS, South AMAR) and 2 fractures (Hayes, Oceanographer). The area is totally located under Portuguese national jurisdiction (Figure 3), with 10 of the 18 structures located on the extended continental shelf (seabed) and 8 on the Portuguese EEZ close to Azores.

**Feature description of the proposed area**

The knowledge on the SAA EBSA area is based on the analysis of 533 scientific articles containing relevant information about the proposed area. Several of the structures are well known with a great number of geological and biological studies. The total number of 342 species reported was estimated from scattered taxonomical literature and online species database the species number is probably underestimated. The knowledge of each structure is not even and it is possible to observe these differences in table 1. In the same table it is also possible to evaluate how many EBSA scientific criteria each structure meet.

A large number of species living in the EBSA area was discovered or described "recently" (around 40% of the EBSA species in the last 30 years), a great part of them have their distribution restrict to the hydrothermal vents habitat. There is no legislation or protection figure for the EBSA species with the exception of the sharks surrounding this area. Of the 342 species, shark species *Centrophorus squamosus*, *Centroscymnus coelolepis* and *Centrophorus granulosus* are the only 3 protected under the OSPAR Convention.

The species studied in the EBSA belong to several phylum, subphylum, superclass, class, subclass or family (figure 4). Of all the species described for the SAA EBSA area there is a predominance of species belonging to the subphylum Crustacea, Phylum Echinodermata and Mollusca. The most common is the order Decapoda, Class Gastropoda and Ophiuridae (Figure 5).

The Crustacea subphylum (Figure 5A) includes many different species from different classes: Malacostraca (*e.g. Pseudonebaliopsis atlantica*), Ostracoda (*e.g. Bathyconchoecia pauluda*); Subclass: Copepoda (*e.g. Ambilimbus arcuscelestis*); Infraclass: Cirripedia (*e.g. Newmaniverruca ferruginea*); Order: Amphipoda (*e.g. Luckia strike*), Cumacea (*e.g. Thalycrocuma sarradini*), Decapoda (*e.g. Leontocaris smarensis*), Euphausiacea (*e.g. Thysanoessa parva*), Isopoda (*e.g. Heteromesus calcar*), Tanaidacea (*e.g. Armaturatanais atlanticus*) and Family: Mysidae (*e.g. Anchialina typical*). Phylum Mollusca (Figure 5B) with species belonging to 3 different classes: Gastropoda (*e.g. Laeviphitus desbruyeresi*), Bivalvia (*e.g. Bathymodiolus azoricus*) and Monoplacophora (*e.g. Veleropilina segonzaci*). In the Figure 5C are represented species of different classes belonging to Echinodermata Phylum: Asteroidea (*e.g. Pseudarchaster gracilis*), Crinoidea (*e.g. Anacalypsicrinus nefertitii*), Echinoidea (*e.g. Sperosoma grimaldii*), Holothuroidea (*e.g. Ellipinion Alani*), and Ophiuridae (*e.g. Ophiactis tyleri*).

There is a small number of physiological studies on the specific morphologic evolution for the life in the vents. The characteristics are very peculiar, for example: *Rimicaris exoculata* and *Rimicaris chacei* are morphologically similar (Gebruk *et al*., 1993; 2000) and are reported living in the same camps (Lucky strike segment, Menez Gwen, Rainbow and South of Lucky strike); both develop epibiotic bacteria supporting structures, namely modified mouthparts and the inside of the carapace, during metamorphosis to the adult form (Gebruk *et al*., 2000). The main food of adult *R. exoculata* is filamentous bacteria that grow on these structures. *R. chacei* in intermediary sizes feed on such bacteria, however on adult stage their feeding habits rely on scavenging and predation (Gebruk *et al*., 2000). The results of a study on *Mirocaris fortunata* show that this species has an opportunist feeding behavior, ingesting tissues of mussels, other shrimp and invertebrates when available (Gebruk *et al*., 2000; Kádár *et al*., 2006; 2007).

There is a deep-sea fish, *Hydrolagus pallidus,* that is found near hydrothermal environments and like *M. fortunata* feeds mainly on vent mussels (Marques & Porteiro, 2000). Other successful example of fitted species is the bivalve *Bathymodiolus azoricus*,a dominant member of the SAA EBSA fauna (Van Dover, 1995; Colaço *et al*., 1998; Desbruyères *et al*., 2001). In common with its vent and seep-dwelling relatives, *B. azoricus* contains endosymbiotic bacteria within its gills which enable it to derive a significant portion of its food energy from the reduced sulphur compounds and methane released by the vents (Cavanaugh, 1983; Cavanaugh *et al*., 1992; Pond *et al*., 1998; Fiala-Medioni *et al*., 2002). However, *B. azoricus* also possesses a functional gut which enables it to feed on small particles in typical mytilid fashion (Le Pennec & Hily, 1984; Le Pennec *et al*., 1990).

**Feature condition and future outlook of the proposed area**

Most of studies are qualitative and often focus on specific taxonomic groups, such as amphipods (*e.g* Myers *et al*., 2004; Bellan-Santini *et al*., 2007), cirripeds (*e.g*. Young, 1998; 2001), copepoda (e.g. Ivaneko *et al*., 2004; Komai & Segonzac, 2005; Komai & Chan, 2010), cumeacea (*e.g.* LeBris *et al*., 2000; Corbera *et al*., 2008), echinoderms (*e.g.* Stöhr & Segonzac, 2005), elasmobranchii (*e.g.* Biscoito *et al*., 2002; Biscoito, 2006; Linz, 2006), mussels (*e.g.* Colaço *et al*., 2006; Duperron *et al*., 2006; 2013), polychaeta (*e.g.* Desbruyères & Hourdez, 2000; Hourdez & Desbruyères, 2003), shrimps (*e.g.* Shank & Martin, 2003; Nye *et al*., 2012) and Tanaidacean (Larsen *et al*., 2006). The great part of study cruises which visited the EBSA area were focused in the deep-sea hydrothermal vent fields south of the Azores (Menez Gwen, Lucky strike, Rainbow and Saldanha), that were part of the MoMAR concept (“Monitoring the Mid-Atlantic Ridge”). . The OSPAR MPAs (Lucky Strike, Menez Gwen and Rainbow) have a higher number of scientific articles and reports, consequently are until now the best studied (See table 1). This vent fields which are inside the NAGFo/NEAFAC areas were also subject to Ices report of the WGDEC (Working Group on Deep-Water Ecology))=.

In this section the importance of the hydrothermal vents is reinforced. The dissolved constituents of the venting fluids play an important role in the geochemical mass balance of the oceans (Edmond *et al*., 1979), but its singularity is also a threat. The high concentrations of valuable minerals make this kind of structures to be considered as targets for deep-ocean mining (Hoagland *et al*., 2010; Van Dover, 2011) with a high risk of “break” the balance of these fragile ecosystems. The unusual nature of the marine communities that occur around hydrothermal vents makes them particularly important areas in terms of the biodiversity of the deep sea as well as being a focus for deep sea research. This type of ecosystem is sensitive because of its high percentage of endemic species and the unique nature of many of the species found there (e.g. Vrijenhoek, 2010; Ramirez-Llodra *et al.,* 2011).

Other hydrothermal related threat for these type ecosystems is the bioprospecting for possible sources valuable to biotechnology, for example bacteria (Gubbay, 2003; Synnes, 2007). This is already a true threat. There are regular expeditions to already described sites (*e.g.* rainbow) 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. 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).

The fishing effort in SAA is inexistent, the vents occur in waters that lie well below of fishing depths. Also, the current fishing techniques are not sufficiently advanced for the SAA EBSA vents depths and the high toxicity of vent emissions makes catches unsuitable for human consumption, reducing the threat posed by fisheries (Biscoito & Almeida, 2004).

Nevertheless, there is a biological balance in the vents. Well documented examples of biological interactions are predation and competition based, for instance, on trophic (e.g. access to hydrogen sulfide or other resources) and topographic (optimal positioning on the structure or limitation on available space) grounds (Hessler *et al*., 1985; Fustec *et al*., 1987; Comtet and Desbruyères, 1998).

All six (Menez Gwen, Lucky Strike segment, Ewan, Menez Hom, Saldanha and Rainbow) fields are included on the Azores Marine Park, which was created in 2007 and expanded in 2016. Lucky Strike segment, Menez Gwen and Rainbow are included in the OSPAR MPA network. Lucky Strike segment and Menez Gwen has been a part of the Natura 2000 network since 2009. All fields are classified under the reef habitat type of the EU Habitats Directive. Lucky Strike segment and Menez Gwen (MPAs) are also recognized by WWF, the conservation organization, as a Gift to the Earth (GttE).

Actions to protect vents and seeps has taken place at national and international levels through the development of informal or voluntary protection plans or codes of conduct and formal protection measures under State or international law. An example of informal measures is the adoption by the scientific community of the InterRidge Statement of Commitment to Responsible Research Practices (Devey *et al*., 2007). The marine mining industry has also produced the International Marine Minerals Society Code for Environmental Management of Marine Mining (IMMS, 2011), which outlines principles and best practice for use by industry, regulatory agencies, scientists and other interested parties (Boschen *et al*., 2013). The OSPAR Commission recommended strengthening the protection of hydrothermal vents/fields occurring on oceanic ridges as a threatened and/or declining habitat in order to recover the habitat, to improve its status and ensure its effective conservation in Region V of the OSPAR maritime area (OSPAR, 2014).

Given the relative geochemical and biological stability of the fields, their management as MPAs accommodates different scientific interests, from long-term, passive observation to experimental studies. The areas composing the Azores Marine Park, and all the regional protected areas beyond the territorial sea, are classified under IUCN criteria. Lucky Strike segment (288 $km^2$) and Menez Gwen (95 $km^2$) have zoning plans ranging from “full protection” (Cat. 1) to “sustainable exploitation”

(Cat. IV and VI), while Rainbow, a smaller vent field, is only classified under IUCN category IV. Lucky Strike has also been selected as a target field for the installation of the long-term seafloor former MoMAR observatory , and now EMSO-Azores (Santos *et al*., 2002; Person *et al*., 2008; Colaço et al, 2012;Sarradin et al, 2016; Chavagnac et al, 2015) ).

The Contracting Parties to OSPAR Convention committed themselves to establish an ecologically coherent network of MPAs in the OSPAR Maritime Area by 2010 (the so-called OSPAR Network of Marine Protected Areas). The regional delivery mechanism is based on Annex V to the OSPAR Convention. The first national MPA designated under the high seas is the Rainbow vent field located in the High Seas sector of the OSPAR Maritime Area (Ribeiro, 2010).

In 2012, the United Nations Conference on Sustainable Development reaffirmed the importance of area-based conservation measures, including marine protected areas, as a tool for conservation of biological diversity and sustainable use of its components, and noted decision X/2 of the Convention on Biological Diversity, that, by 2020, 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are to be conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures.

In 2015, the 2030 Agenda for Sustainable Development on its Goal 14 “Conserve and sustainably use the oceans, seas and marine resources for sustainable development”, recognized that when effectively managed and well resourced, marine protected areas are important mechanisms for safeguarding ocean life and established the targets 14.2 “By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans”, and 14.5 “By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information”.

**Assessment of the area against CBD EBSA Criteria**

| CBD EBSA Criteria (Annex I to decision IX/20) | Description (Annex I to decision IX/20) | Ranking of criterion relevance (please mark one column with an X) | | | |
|---|---|---|---|---|---|
| | | No information | Low | Medium | High |
| **Uniqueness or rarity** | Area contains either (i) unique (“the only one of its kind”), rare (occurs only in few locations) or endemic species, populations or communities, and/or (ii) unique, rare or distinct, habitats or ecosystems; and/or (iii) unique or unusual geomorphological or oceanographic features. | | | | X |

The SAA EBSA encompasses 12 hydrothermal vent classified with a high relevance for the EBSA criteria of Uniqueness or rarity.

Deep-sea vents represent one of the most physically and chemically unusual biomes on Earth (Takai & Nakamura, 2011). These habitats are geologically and biologically unique features on earth. Hydrothermal processes control the transfer of energy and matter from the earth core to its crust, hydrosphere and biosphere (Pirajno & Kranendonk, 2005). The hydrothermal fauna also participate in the trace metal biogeochemical cycling. Recent studies have shown that hydrothermal fluids may contribute significantly to global deep-ocean dissolved trace metal budgets (Chu *et al*., 2006; Bennett *et al*., 2008; German *et al*., 2010; Yücel *et al*., 2011).

Rarity should also be considered in relation to the animal communities associated with hydrothermal vents. The vent communities have a sufficiently unique fauna that can be considered to represent a biogeographic hydrothermal province (Van Dover *et al*., 1996). There are unique and rare specialized adaptations in the species living in these areas. Particular features allow the organisms to exploit vent habitats, endowed with major reorganization of internal tissues and physiologies to house microbial symbionts, biochemical adaptations to cope with sulphide poisoning, behavioral and molecular responses to high temperature, presence of metal-binding proteins and development of specialized sensory organs to locate hot chimneys (Tunnicliffe *et al*., 1998). The result has been specialized 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). The most numerous and conspicuous organisms are those which have developed symbiotic relationships with chemoautotrophic bacteria and these are the species which dominate the primary production in the vent community (Gibson *et al*., 2005).

The EBSA includes the largest hydrothermally active areas known in the North Atlantic, the Lucky Strike segment and Menez Gwen hydrothermal vent fields.

| | | | | | |
|---|---|---|---|---|---|
| **Special importance for life-history stages of species** | Areas that are required for a population to survive and thrive. | | | | X |

The hydrothermal vent habitats are very particular features. These places on mid-ocean ridges are fragmented systems that occur as small islands of habitat along a narrow corridor of hard substratum. All the fauna living in these habitats are also very unique (McClain & Hardy, 2010). The organisms develop unique characteristics in their life cycles (Minic & Thongbam, 2011). Rapid growth rates, early maturation, large reproductive output, and well-developed dispersal capabilities (Grassle, 1986).

The hydrothermal biota are characterized also by a high level of endemism with common specific lineages at the family, genus and even species level, as well as the prevalence of symbioses between invertebrates and bacteria (Dubilier *et al*., 2008; Kiel, 2010). Most of the organisms colonizing these habitats are invertebrates and have larval stages that are subject to dispersal in an open system, although mechanisms of larval retention are developed to account for the large settlement events observed (Mullineaux & France 1995, Marsh *et al*. 2001, Van Dover *et al*. 2001). For example on the chimneys in the EBSA vents a large numbers of small mussels were observed attached to large mussels indicating a recent recruitment event (Van Dover *et al*., 1996).

Surrounded by species-rich, low biomass deep sea benthos, hydrothermal vents locally constitute small, species-poor oases of very high productivity and biomass (Heip *et al*., 2009).

There are also unique and taxonomical important species living in the EBSA area. For example in the Rainbow hydrothermal new species (*Pachycara azoricus*) (Biscoito and Almeida, 2004) was described and previous studies have indicated that these areas may hold clues to the evolution and origin of life (Martin *et al*., 2008).

The area of SAA contains a high number of species associated to the structures (see Feature description of the proposed area). Species present have different characteristics and use unique strategies for survival, consequently high relevance were attributed to the EBSA criteria of Special importance for life-history stages of species.

| | | | | | |
|---|---|---|---|---|---|
| **Importance for threatened, endangered or declining species and/or habitats** | Area containing habitat for the survival and recovery of endangered, threatened, declining species or area with significant assemblages of such species. | | | | X |

The SAA EBSA contains one threatened and/or declining habitat, contained in the OSPAR List (OSPAR publication 2008/358): Oceanic ridges with hydrothermal vents/fields.

The Mid Atlantic Ridge is considered to be a slow-spreading ridge and hydrothermal vents are estimated to be up to 1000’s of years in age, although possibly not active continually. However, some of the individual vents are only short-lived naturally, and new venting sites can form easily. Therefore, the EBSA vent fields are relatively stationary in position, but dynamic regarding the individual smokers and long-term activity (Hannington *et al*., 1995).

Hydrothermal vents support some of the most unusual animal communities on earth. All deep sea animals have to cope with extremely high pressure. But contrary to the fauna of the surrounding uniformly cold, oxidized and sulfur-free deep sea waters, the vent associated organisms are adapted to locally very steep temperature gradients, transient extremes topping up to 113° C, low oxygen and potentially toxic concentrations of sulphur, heavy metals and radionuclides in the water. Similar to photoautotrophic plants on land, chemolithoautotrophic bacteria form the basis of the hydrothermal vent food web, using hydrogen sulfide to fuel the production of organic carbon (Wahl, 2014).

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|---|---|---|---|---|---|
| **Vulnerability, fragility, sensitivity, or slow recovery** | Areas that contain a relatively high proportion of sensitive habitats, biotopes or species that are functionally fragile (highly susceptible to degradation or depletion by human activity or by natural events) or with slow recovery. | | | | x |

The Vulnerability, fragility, sensitivity, or slow recovery in SAA EBSA was classified with a high relevance.

These particular areas and their organisms experience variations in the temperature and chemistry of their environment on the timescale of seconds as a result of turbulent mixing of hydrothermal fluids and ambient seawater, typically overlaid on longer period tidal variations. On longer timescales, volcanic events at mid-ocean ridges can disturb vent communities directly, while tectonic events can disrupt the subsurface plumbing of hydrothermal systems. As a consequence of the local variations in hydrothermal activity that result from such processes, temporal variation has been noted in the composition, abundance and distribution of megafauna at vents on subannual to interannual timescales (Glover *et al.*, 2010). The small spatial extent and site-specific communities make the EBSA vent fields potentially very sensitive to a different exterior disturbance including the scientific exploration and commercial exploitation. Immediate concern is arising from the direct effects of sampling (substrate and specimens), the related risk of unintended species transfer between vents within a field, as well as impacts caused by movement of vehicles and litter. Due to the small scale, the individual venting sites have potentially a very low resistance to human impact (Van den Hove & Moreau, 2007; Motoori *et al.*, 2015; Walter *et al.*, 2015).

Vent ecosystems, have relatively high proportions of endemic species (Tunnicliffe & Fowler, 1996). The associated vent fauna is primarily composed of a small set of large organisms relying on symbioses with chemoautotrophic bacteria, able to withstand extreme conditions. A larger set of accompanying smaller species relying on heterotrophy (deposit or suspension feeders, carnivores or scavengers) is also a conspicuous member of this fauna. A large majority (82% according to McArthur & Tunnicliffe, 1998) is unrecorded from other marine settings and thus has been described as specialized or “endemic” to these toxic, unstable and patchy environments.

The occurrence of 3 species under OSPAR legal protection was registered in the area: *Centrophorus granulosus*, *Centrophorus squamosus* and *Centroscymnus coelolepis*. These species have particular features attending to biological factors such as longevity, low fecundity, and slow growth rates characteristic to these shark species (*e.g.*, Clark, 2001; Morato *et al.*, 2008).

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|---|---|---|---|---|---|
| **Biological productivity** | Area containing species, populations or communities with comparatively higher natural biological productivity. | | | | X |

Particularly in the vent biotopes, the primary producers of energy and organic molecules are composed by chimiolithoautotrophic bacteria (Synnes, 2007; Le Bris *et al*., 2016). Their specialized phyla is adapted to a range of environmental constraints. Many species live in intimate and complex symbiosis with these sulfo-oxidizing and methanogene bacteria. These symbioses imply a strategy of nutrition and a specific metabolic organization involving numerous interactions and metabolic exchanges, between partners. The organisms have developed different adaptive strategies, like the capacity to adapt to high temperatures. Moreover to survive in these environments, living organisms have developed various strategies to protect themselves against toxic molecules such as $H_2S$ and heavy metals. The hydrothermal vent and cold seep animals have evolved traits that allow them to not only tolerate extreme environmental conditions, but in some cases to accumulate and transport chemicals toxic to most other marine species (Childress & Fisher, 1992; Le Bris & Gaill, 2007). The primary consumers often occur with extremely high population densities compared with non-chemosynthetic deep-sea environments, generally covering all available surfaces around vent fluid exits (Hessler & Smithey, 1983; Tunnicliffe, 1991).

Recent assessments of these iron sources indicate their significance for deep-water budgets at oceanic scales and underscore the possibility for fertilizing surface waters through vertical mixing in particular regional settings (Tagliabue *et al*., 2010) and supporting long-range organic carbon transport to abyssal oceanic areas (German *et al*., 2015).

Nevertheless, such areas are highly biologically productive (Rousse *et al*., 1997; Little and Vrijenhoek, 2003; van Dover & Lutz, 2004). Amongst the life forms associated with the chimneys of the hydrothermal sources the bivalve mussels (*Bathymodiolus* sp.) are normally found living in high densities (van Dover *et al*., 1996; von Cosel *et al*., 1999; Desbruyères *et al*., 2001; Hardivillier *et al*., 2004; Miyazaki *et al*., 2004).

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|---|---|---|---|---|---|
| **Biological diversity** | Area contains comparatively higher diversity of ecosystems, habitats, communities, or species, or has higher genetic diversity. | | | | X |

Deep-sea vents and seeps represent one of the most physically and chemically diverse biomes on Earth and the least understood environments also. These habitats have a strong potential for the discovery of new species (Ramirez-Llodra *et al*., 2010; Takai & Nakamura, 2011).

Hydrothermal vent communities generally do not host a high diversity of species. Vents are characterized by a high degree of specialization among the associated fauna, and relatively high productivity and species abundances compared with the surrounding deep sea. However, slow-spreading ridges such as the Mid Atlantic ridge present in the SAA EBSA, present the highest species diversity found at vent communities (Dubilier *et al*., 2008; Bernardino *et al*., 2012). The most numerous and conspicuous organisms are those which have developed symbiotic relationships with chemoautotrophic bacteria and these are the species which dominate the primary production in the vent community (Ott *et al*., 2004; Ramirez-Llodra *et al*., 2010).

As self-supporting systems, seasonally they can export larvae to the surrounding deep sea. This may lead to a general enhancement of food web activity near vents, in particular at hydrothermal vents located at slow-spreading ridges (Glover *et al*, 2010; Ramirez-Llodra *et al*., 2010).

Nevertheless, such areas are highly biologically diverse (Rousse *et al*., 1997; Little and Vrijenhoek, 2003; Van Dover & Lutz, 2004), and hotspots of biodiversity (Gubbay, 2003; Clark & Bowden, 2015). A total of 342 different species were until now registered for the SAA, with a large number discovered or described “recently” (around 40% of the EBSA species in the last 30 years). The likelihood that the number of species present is far greater than the number currently recorded in the SAA area vents is high (Gubbay, 2003; Clark & Bowden, 2015).

The EBSA integrates different types of species belonging to different groups (see Figure 4): Phylum Annelida (*e.g. Laonice asaccata*), Bryozoa (*e.g. Spiralaria florea*), Porifera (*e.g. Janulum spinispiculum*); Superclass Osteichthyes (*e.g. Pachycara saldanhai*); Class Anthozoa (*e.g. Heteropathes opreski*), Ascidiacea (*e.g. Myopegma midatlantica*), Cephalopoda (*e.g. Cirrothauma magna*), Hydrozoa (*e.g. Halecium profundum*), Pycnogonida (*e.g. Sericosura heteroscela*); Subclass Acari (*e.g. Thalassarachna mollis*), Elasmobranchii (*e.g. Deania calcea*); and most common subphylum Crustacea, Phylum Echinodermata and Mollusca and the order Decapoda, Class Gastropoda, Ophiuridae (Figure 5A). The Crustacea subphylum includes many different species from different class: Malacostraca (e.g. Pseudonebaliopsis atlantica), Ostracoda (e.g. *Bathyconchoecia pauluda*); Subclass: Copepoda (e.g. *Ambilimbus arcuscelestis*); Infraclass: Cirripedia (e.g. *Newmaniverruca ferruginea*); Order: Amphipoda (e.g. *Luckia strike*), Cumacea (e.g. *Thalycrocuma sarradini*), Decapoda (e.g. *Leontocaris smarensis*), Euphausiacea (e.g. *Thysanoessa parva*), Isopoda (e.g. *Heteromesus calcar*), Tanaidacea (e.g. *Armaturatanais atlanticus*) and Family: Mysidae (e.g. *Anchialina typical*). Phylum Mollusca (Figure 5B) with species belonging to 3 different classes: Gastropoda (e.g. *Laeviphitus desbruyeresi*), Bivalvia (e.g. *Bathymodiolus azoricus*) and Monoplacophora (e.g. *Veleropilina segonzaci*). In the Figure 5C is presented the Class represented by the species belonging to Echinodermata Phylum: Asteroidea (e.g. *Pseudarchaster gracilis*), Crinoidea (e.g. *Anacalypsicrinus nefertitii*), Echinoidea (e.g. *Sperosoma grimaldii*), Holothuroidea (e.g. *Ellipinion alani*), Ophiuridae (e.g. *Ophiactis tyleri*).

| | | | | | |
|---|---|---|---|---|---|
| **Naturalness** | Area with a comparatively higher degree of naturalness as a result of the lack of or low level of human-induced disturbance or degradation. | | | | X |

The naturalness rank is classified as high. However there is a large number of threats and some records of damages caused by underwater vehicles, extensive sampling, and litter.

One of the threats for these ecosystems is the bioprospecting for possible sources of biotechnology (for example bacteria on hydrothermal vents) and metals mining that may occur in the future (Gubbay, 2003; Synnes, 2007).

The fishing effort in SAA is inexistent, as the vents occur in waters that lie well below of fishing depths. The current fishing techniques are not sufficiently advanced for the EBSA hydrothermal depths and the high toxicity of vent emissions makes catches unsuitable for human consumption, reducing the threat posed by fisheries (Biscoito & Almeida, 2004).

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**Maps and Figures**

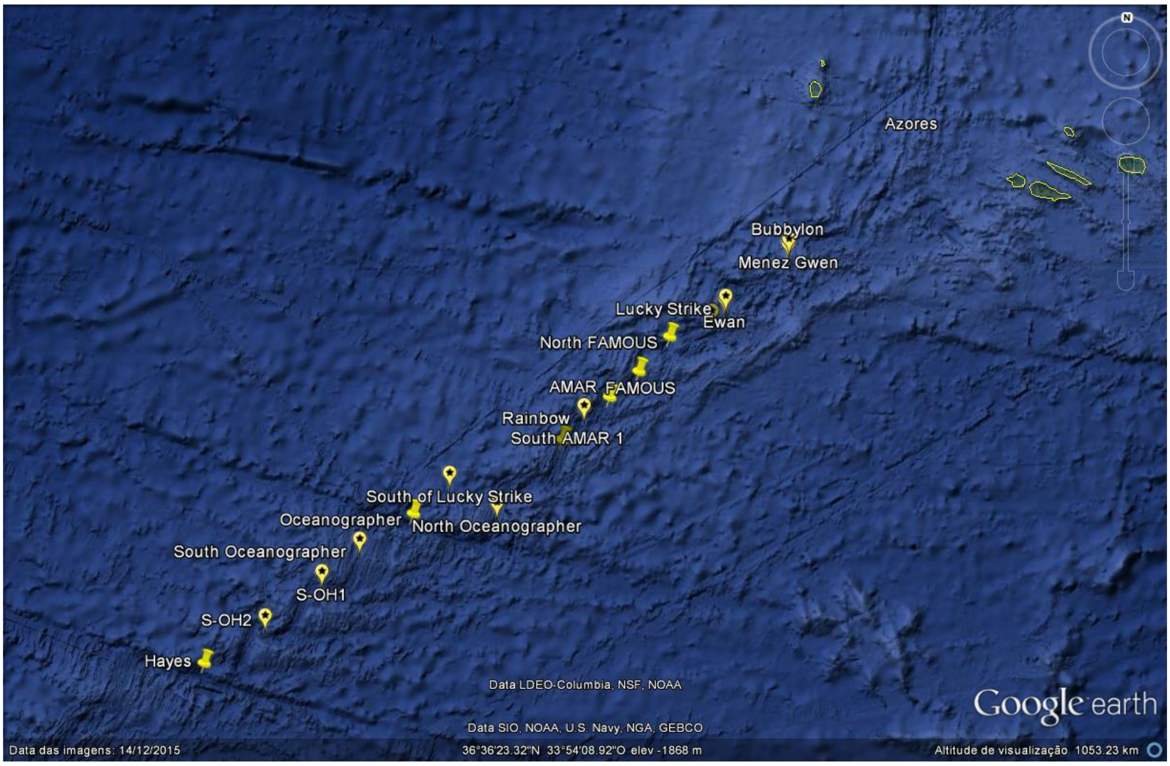


Figure 1 – Structures included in SAA EBSA

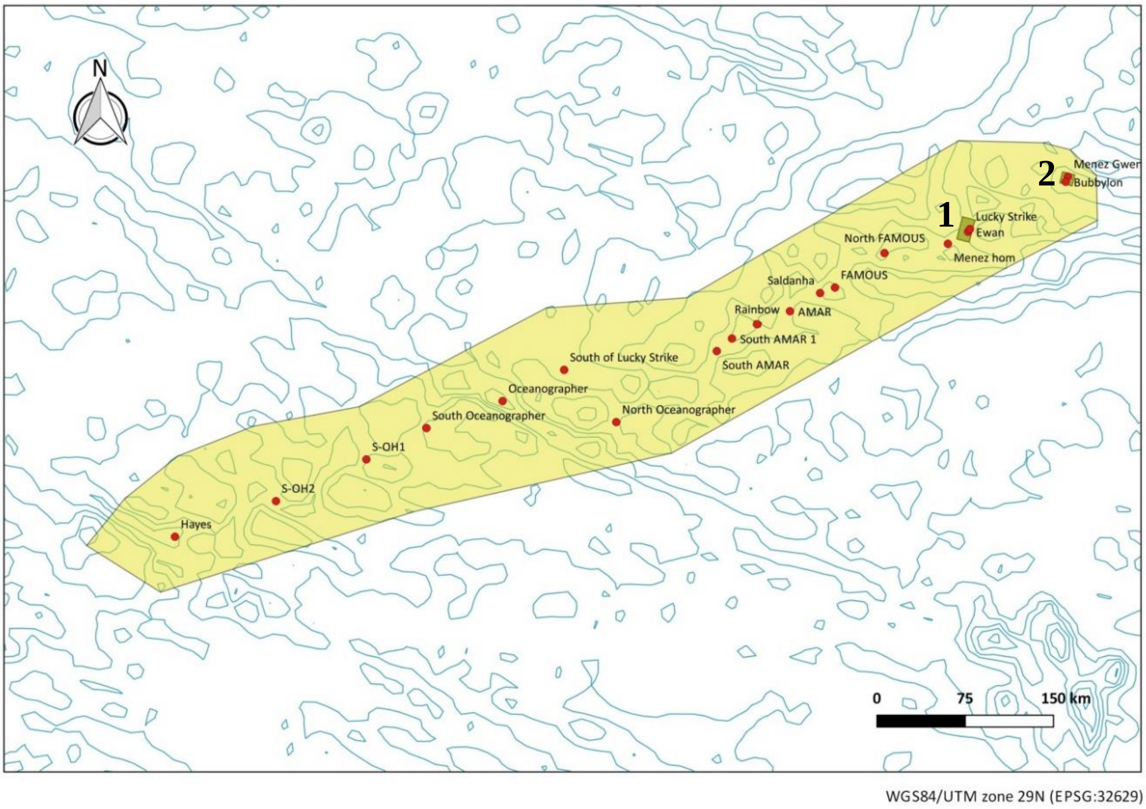


Figure 2 – SAA EBSA. Yellow shadow – EBSA polygon (total area). Olive shadows 1- Lucky Strike segment OSPAR High Seas MPA; 2 – Menez Gwen hydrothermal vent field OSPAR High Seas MPA.

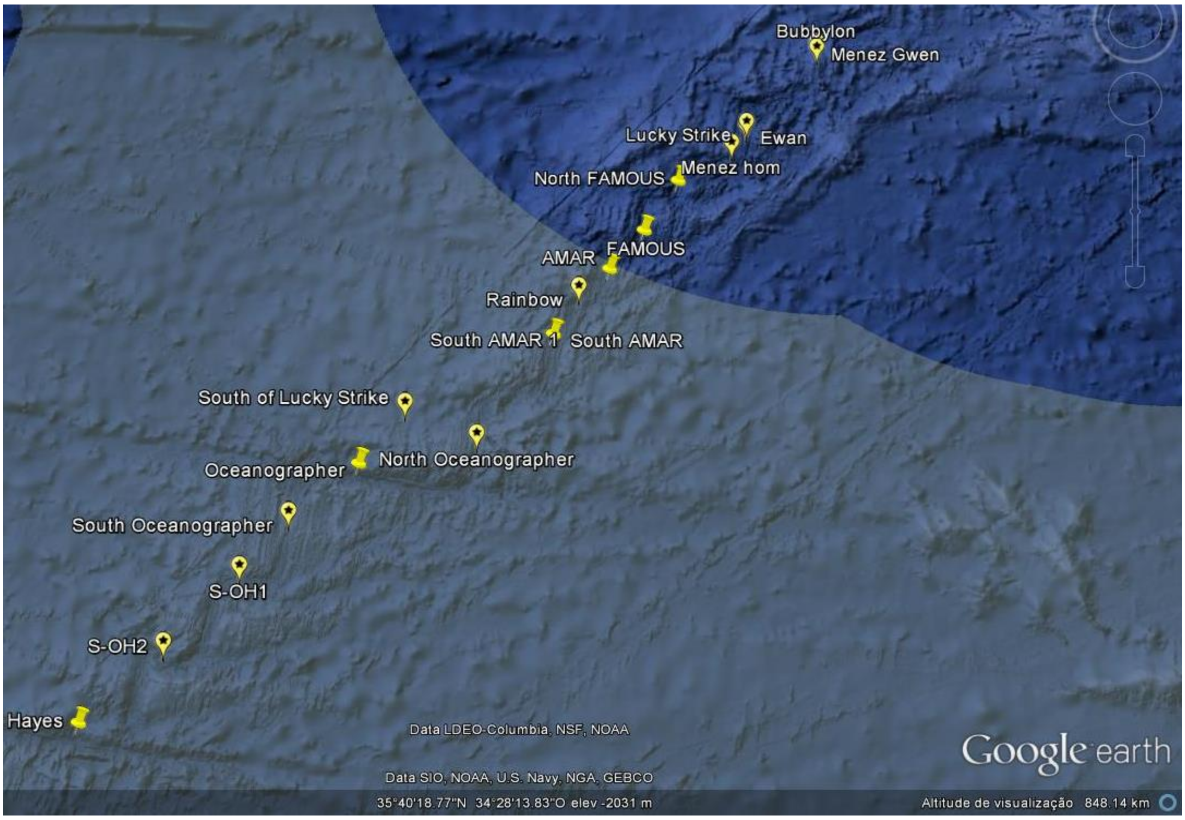


Figure 3 – Structures included in the SAA EBSA. The grey area show the extended continental shelf while the blue area shows the exclusive economic zone.

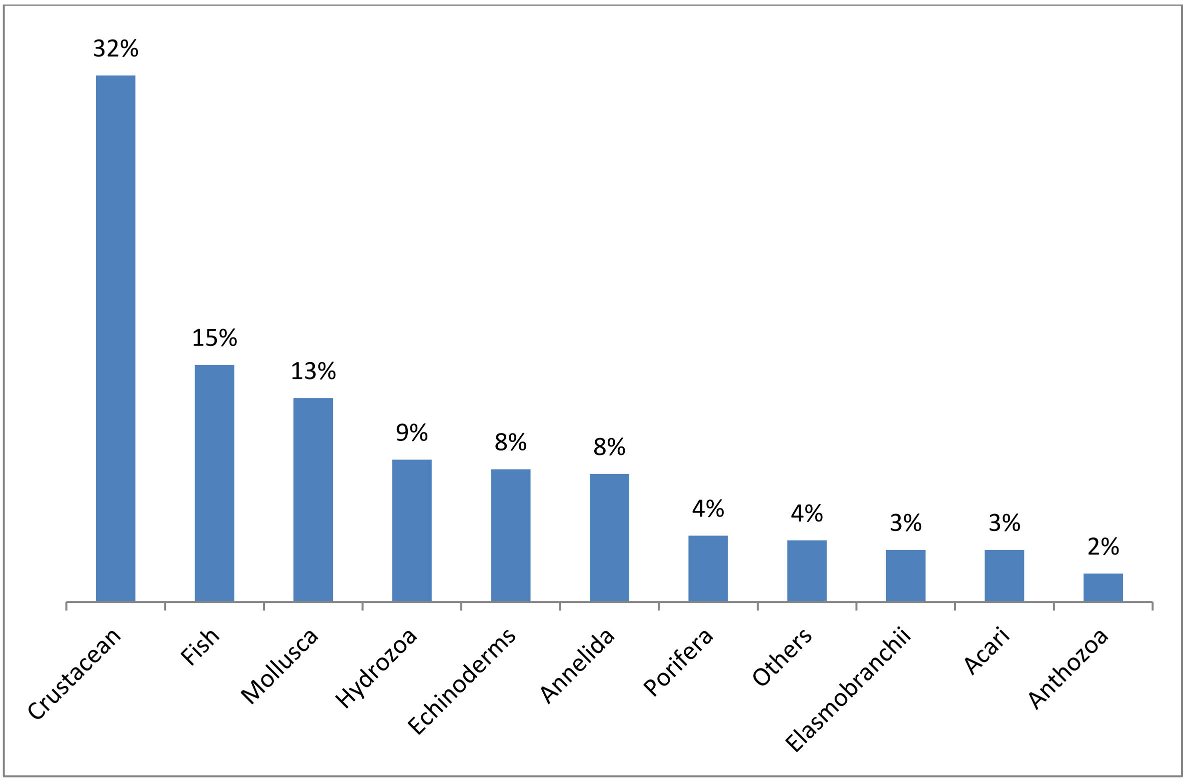


Figure 4 - Relative frequency (%) of the different phylum/class/order of the species identified in the SAA EBSA.

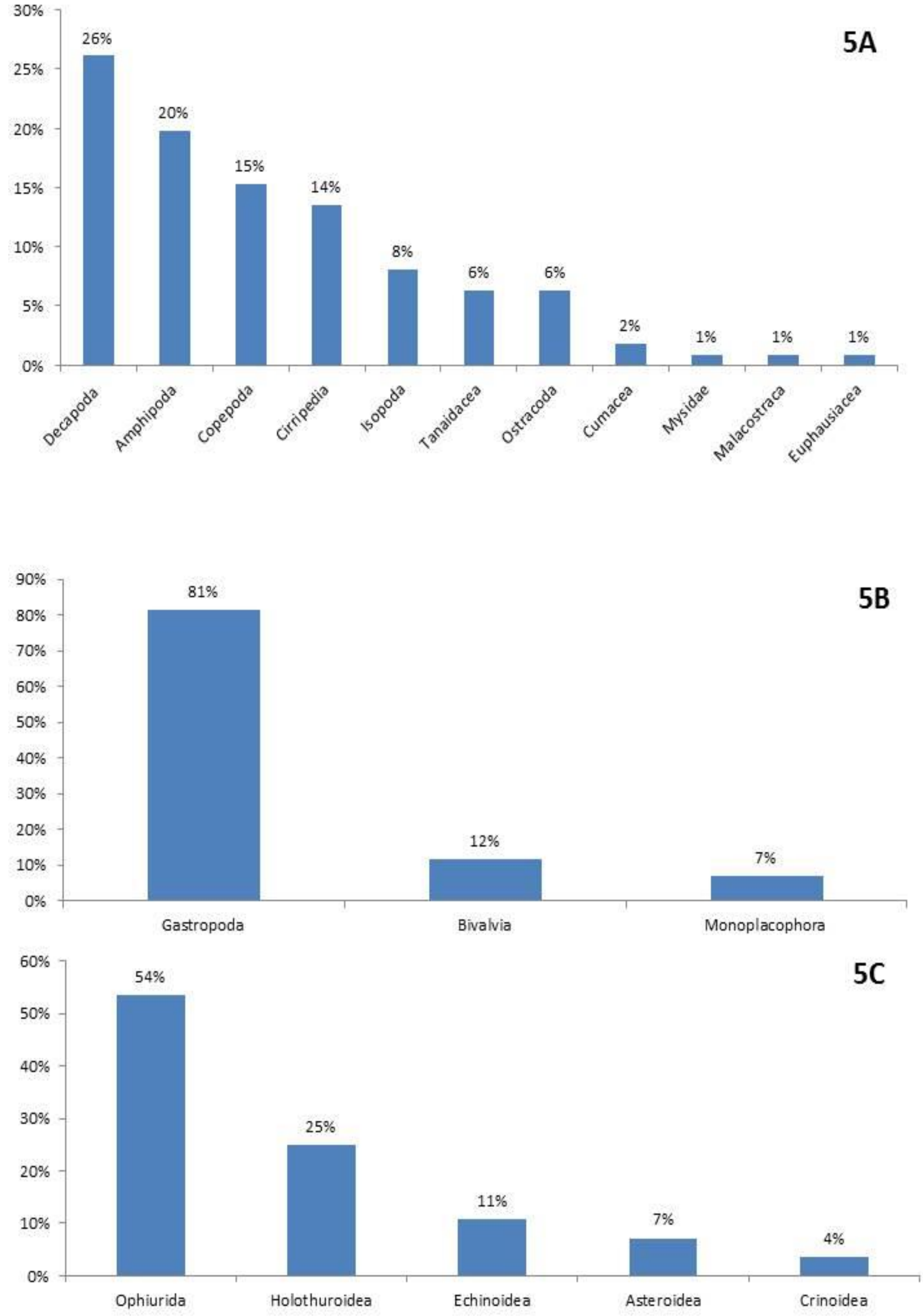


Figure 5 - Relative frequency (%) of the different species identified in the SAA EBSA belonging to different taxa included in the subphylum Crustacea (5A), Phylum Mollusca (5B) and Echinodermata (5C).

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