A dossier of data to assist marine protected area planning within the Amundsen-Bellingshausen, Weddell Sea and Bouvet-Maud domains

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Introduction

At the CCAMLR marine protected areas (MPAs) workshop held in Brest, France in 2011, scientists adopted nine domains to plan for and assess progress towardsarepresentative system of MPAs under the CCAMLR MPA workplan. To assist the workshop to plan for MPAs within the Amundsen-Bellingshausen, Weddell Sea and Bouvet-Maud domains, we have collated available data and described important environmental features for these domains. The data summarised includes the environmental drivers that influence the distribution of Southern Ocean biota, biological data and previous classifications of the benthic and pelagic environments. Existing protected areas are also outlined. Supplementary material of the distribution of the environmental data across all domains within the CCAMLR Area is available as maps in appendix 1 and as tables downloadable (S1-benthic classification and S2- pelagic classification) from www.conservationgeography.org. Statistics regarding the coverage of sea ice, seabed temperature and persistent summer productivity across all domains is also provided in appendix 2.

Environmental drivers are the physico-chemical processes and other factors that set the habitat conditions and influence the distribution and abundance of taxa, including their connectivity between similar habitats [1]. Two major environmental drivers within the Southern Ocean are depth and geomorphology [2-6]. Niche separation of species can occur with depthgiving rise to different assemblage structures within depth ranges which can be characterized as bathomes[7-9]. Geomorphic features are a classification of the seabed based on the attributes of the surface substratum.Different habitat characteristics are provided by a varying surface substratumincluding the availability of hard rock surfaces and the erosion or deposition of sediment and their physical attributes [4,10]. For example, Antarctic shelf depressions eroded during glacial maxima now have low currents and fine sediments, providing appropriate habitats for mobile deposit feeder and infaunal communities [10-12]. Geomorphic mapping has also been identified as having utility for indicating where Vulnerable Marine Ecosystems (VME) might occur [10]. Geomorphic features known or predicted to support Vulnerable Marine Ecosystems include seamounts, seamount ridges, mid-ocean ridge rift valleys, volcanoes, margin ridges, margin plateaus and shelf commencing canyons [10]. For instance, mid-ocean ridge rift valleys are known sites of hydrothermal vents where VMEs occur [13]. Seamounts and seamount ridges are often regions of high biodiversity but are also vulnerable to impacts [14-17]. Shelf commencing canyons can contain vulnerable and species rich coral-sponge communities below the influence of iceberg scour[5]. Other important environmental drivers include seabed temperature, icebergs and sea ice coverage, sea-surface productivity and ocean currents [12,18-20]. The spatial and temporal variability of seabed temperature contributes to the distribution and composition of benthic assemblages and is suspected to constrain the migration of benthic fauna which may lead to their genetic variation and eventual speciation [18,21]. Ice regimes are a key structuring element in the ecology of the Antarctic benthos and pelagic environments [20,22-25]. Sea surface productivity provides a vital food source and phytoplankton blooms are highest; (i) where frontal activity has created an upwelling of nutrient-rich water, (ii) down-stream from iron-rich landforms and (iii) within the ice-melt zones and polynyas[23,26-31]. Canyons can act as a conduit for organically laden bottom water that is generated in polynyas from rejected brine during ice formation. This process provides a mechanism for transfer of food nutrients to the benthos [32,33].

Data

The data collated is listed inTable 1. The benthic classification was adapted for use at a domain scale by nesting geomorphic features and bathomes within each domain and taking ecoregion boundaries into consideration during interpretation of the data. Seamounts and seamount ridges were classed only according to the bathome into which their mount penetrated. Canyons were classed only by whether the head commenced on the shelf or slope. The pelagic regions were also assessed according to the ocean sector within which they occurred [34,35]. The features within these two regionalisations were deemed 'critical' where the domain contained >90% of the feature area across all domains and 'very important' where the domain contained 75-90% of the feature area across all domains. Features were deemed 'important' where any of the following three criteria were met; (i) the domain contained between 50-75% of the feature area across all domains, (ii) a high amount relative to the other domains, (iii) were highly spatially separated from the other locations of the feature (e.g. if the other locations are off the opposite side of the Antarctic continent or within a different ocean basin). An indication of the distribution in terms of the rarity and isolation of seamountsand seamount ridges wasalso determined. Seamounts and seamount ridges were grouped with other seamounts within a 200km proximity [1,36]. A seamount was noted as rare and/ or isolated if it met one of two criteria; (i)it was one of two or less seamounts within the seamount group to have that specific bathome at its mount or, (ii) it was one of eleven or less seamounts within the Southern Ocean with that specific bathome at its mount. The Southern Ocean is defined here as the CCAMLR Area.To identify areas of persistently high and persistently low summer productivity, the chlorophyll data was processed as per Constable et al., [37]. A dataset of polynya locations were created by cross referencing the sea ice data in table 1 with digitizing published data [including 30,38,39,40]. Species richness was indicated by the number of species with a high probability of occurrence (i.e. >0.6) from an analysis of 879 marine species from the Aquamaps database [41,42]. Aquamaps predicts the distribution of species using specifically designed models based on the species environmental tolerance to environmental drivers which is then refined by including occurrence data and expert knowledge of the species distribution. We also display penguin colonies with a buffer of 93km to indicate feeding area [43,44].The coastline used differs slightly from the coastline dataset now used by the CCAMLR Secretariat which is depicted within the maps in two shades of grey for land and ice shelf. The difference is shown through white patches and the black domain outline.

Table 1: Circumpolar data collated for the analysis

Data	Spatial resolution	Temporal resolution	Source
Depth	1 minute	Not applicable	Smith and Sandwell, [45]
Geomorphology	1-12km	Not applicable	O'Brien *et al*,.[10] and Douglass et al., [1]
Seafloor temperature	1 degree	Annual mean for all years available in the World Ocean Atlas 2005	Clarke et al., [21]
Sea surface chlorophyll-a	9km	Mean values for each austral summer season (20th Dec to 20thmarch) for years 1998-2010	Feldman and McClain, [46]
Sea ice concentration	6.25km	The proportion of the year where sea ice concentration was at least 85% derived from daily estimates during the 1st January 2003 to 31st December 2009	Spreen et al., [47]
Frontal systems	100km	Annual mean calculated across 1992–2007	Sokolov and Rintoul, [48]
Pelagic primary regionalisation	0.1 degree	Not applicable	Raymond [35]
Benthic classification	10-100km	Not applicable	Douglass et al., [1]
Marine protected area dataset	Not applicable	Not applicable	Douglass et al., [1]
AquaMaps	0.5 degree	Not applicable	Kaschner et al., [42]

Bouvet-Maud domain

The 6.2 mill km^2 Bouvet-Maud domain is the largest CCAMLR planning domain spanning 18% of the CCAMLR Area. It is located in the Southern Atlantic Ocean between 20°W to 30°E and 50°S to the coastline which occurs around 70°S (Figure 1). The domain consists of abyssal environments (87%), the oceanic shallow (4%) features of the mid-Atlantic ridge, Maud rise and Astrid ridge and their associated slope environments (9%) (S1). The ice free oceanic shallow regions of the mid-Atlantic ridge correspond with warmer seabeds (>0.25°C) relative to much of the Southern Ocean and high frontal activity. The coldest (-1.5°C to -1°C) deep open ocean seabed temperatures in the CCAMLR Area occur within the domain and correspond with the Weddell Gyre. The domain represents a high diversity of pelagic regions and ice environments (ranging from 0-82% of the year with high ice cover) within the Atlantic ocean sector (Figure 2, S2). The high ice cover region in the south occurs over the shelf and slope with a lower ice cover region just to the west of Astrid ridge. The domain has mostly variable inter-annual summer productivity with areas of persistently high productivity over the shelf and in the northwest corner of the domain. The region contains a large proportion of margin ridges, fracture zones and mid-ocean ridge rift valleys relative to other domains.

At Maud Rise, oceanography, sediment characteristics and sea ice processes have been linked to high biodiversity throughout all trophic levels from pelagic predators to benthic species [49]. Maud Rise is an underwater plateau and slope region with two associated seamounts. High local concentrations of higher trophic order predators and zooplankton have been found over the northern slope of Maud Rise in the ice melt zone. High concentrations of krill are found under denser ice on the southern slope which attracts minke whales and seabirds [49]. The Maud Rise seamount which creates an eddy on its north west flank is suspected to have contributed to the formation of a large open ocean polynya forming in the Weddell Sea from 1973-1976 [40,49]. Over Maud Rise occurs the Maud polynya which is one of only two recurring open ocean polynyas in the Southern Ocean. The other polynya is the Cosmonaut polynya in eastern Antarctica. These polynyas form due to the upwelling of warm water and are self-sustaining since heat is lost to the atmosphere at the surface creating denser water that sinks driving future convection. This process influences interaction between surface productivity, the benthos and the upwelling of nutrients all of which may contribute to the rich and prospering food web in the region [49].

The shelf region of the domain has persistently higher productivity corresponding with numerous canyons that are likely to be a conduit for the transfer of nutrient rich water which can support enhanced levels of biodiversity. Three of these canyons commence on the shelf which has been shown to be associated with vulnerable coral sponge communities and one canyon corresponds with one of the five coastal polynyas within the domain [5]. These coastal polynyas are areas of rapid ice formation and can contain high levels of productivity and drive bottom water formation. Organic matter can be transferred with sinking water rejected from brine during ice formation and can influence enhanced benthic biodiversity within deep sea areas [32,33].

Similarly to Maud rise, marginal ridges and plateaus are other examples of geomorphic features that have unusual substrates and modify local ocean currents and are therefore expected to support enhanced biological communities [10]. Astrid ridge is the only margin ridge in the domain and one of only five margin ridges in the Southern Ocean the closest being Gunnerus ridge located approximately 800km to the east. Margin ridges protrude from the continental margin hundreds of meters above the sediment plain. Astrid ridge is postulated to be shallow enough to significantly modify the flow of the east wind drift causing upwelling and consequently influencing primary productivity and ecosystems [10]. The shallowest part of Astrid ridge and the region just to its west have persistently high summer productivity and a lower ice region than the surrounding local area. Marginal plateaus have a relatively level seafloor that extends from the continental margin but where a saddle occurs between the raised area and the shelf. There are only two mapped marginal plateaus within the Southern Ocean, Bruce Rise in eastern Antarctica and the marginal plateau just north of Astrid ridge.

Current marine protection within the Bouvet-Maud domain is extremely low with only 0.03% of the domain captured by the marine protected area of Bouvet island. The Bovetoya or Bouvet island nature reserve in the Norwegian territorial waters surrounding Bovet island is the only protected area within the domain. This reserve includes 3.7% of seamounts and 0.2% of seamount ridges within the domain and contributes to the protection of 1.1% of seamounts and 0.07% of seamount ridges within the Southern Ocean. The wider marine region near Bouvet island is important to protect the island ecosystems of Bouvet island including the foraging grounds of breeding species such as Antarctic fur seals, southern fulmars and black-bellied storm petrels and the many other seabirds that frequently visit the island [50]. A study of the benthic fauna of the Bouvet and nearby spiess seamounts suggests that the lack of biodiversity recorded in the region is due to under sampling rather than a lack of biodiversity [51]. Areas of higher species richness occur within the domain across the shelf, at Bouvet Island and at the seamounts in the northernmost section of the domain that interact with the polar front (Figure 3). There are six emperor penguin colonies within the domain located at Ragnhild Coast, Princess Astrid Coast, Sanae, Atka Bay, Riiser Larsen and Drescher Inlet.

The Bouvet Maud domain is critical (i.e contains >90% across all domains) to representing:

- The only Mid-Ocean Ridge rift valleys in the Atlantic ocean. The only other domain to contain this geomorphic feature is the Ross Sea domain.
- The only marginal plateau in the Atlantic ocean sector and one of only 2 marginal plateaus in the CCAMLR Area with the other occurring in eastern Antarctica. The marginal plateau within the Bouvet-Maud domain is the deepest plateau in the CCAMLR Area with 64% of its area spanning the 3000-4500m bathome which is not represented in the other marginal plateau.
- Three of the four fracture zones mapped within the CCAMLR Area including 82% of the shallowest fracture zones (i.e. within the 3000-4500m bathome). The other fracture zone occurs within the North Scotia Arc domain.
- The deepest seamounts in the Southern Ocean containing the only 2 seamounts with a mount in the 4500m+ bathome.
- Astrid Ridge, one of only five margin ridges in the CCAMLR Area.
- Shelf commencing canyons that stretch into the 4500m+ bathome

The Bouvet Maud domain is very important (i.e. contains >75% across all domains) to representing:

- Margin ridges within the 2000-3000m bathome
- Deepest Mid-Ocean ridge rift valleys, the MOR rift valleys of the Bouvet Maud domain are the only to stretch into the 3000-4500m bathome
- Upper slope within the 0-100m bathome
- Pelagic region 11 especially within the Atlantic Ocean sector. This pelagic region is part of the sea ice zone including pelagic regions 8-11 which represent a deep water continuum of increasing ice cover and decreasing sea surface temperature [35].

The Bouvet Maud domain is important to representing:

- Margin ridges in the 1500-2000m and 3000-4500m bathome
- Seamount and seamount ridge habitats. Bouvet-Maud contains 193 seamount and seamount ridges. All other domains contain less than 86. These seamounts represent a diversity of bathomes at their mount. 29 seamounts (70%) have a mount in the 1500-2000m bathome where all other domains contain less than 5 of this environmental type
- Upper slope within the 100-200m bathome
- Pelagic regions 3,9,10,11 and15 in the Atlantic ocean sector. Regions 8-11 represent the aforementioned sea ice zone. Pelagic region 3 spans shallow shelf areas with 25-60% ice cover and has a restricted distribution mostly within Eastern Antarctica. Pelagic region 15 represents the deep oceanic waters of the ACC front and polar front. The majority of these pelagic regions within the Atlantic Ocean sector is located within the Bouvet-Maud domain.

Summary (Figure 4)

Area 1

- Shelf commencing canyon corresponding with a coastal polynya
- A very deep shelf commencing canyon that stretches into the 4500m+ bathome
- Shelf area of persistently high summer productivity
- Pelagic regions 1, 3, 6, 7,9
- Only location of pelagic region 4 in the domain
- Higher species richness within the domain
- Four emperor penguin colonies at Sanae, Atka Bay, Riiser Larsen and Drescher Inlet.

Area 2

- Maud Rise and Maud Seamount
- The most persistent recurring open ocean polynya in the CCAMLR Area
- Representation of pelagic region 11 within the Atlantic ocean
- The only seamount within 200km with a mount in the 3000-4500m bathome
- The only seamount within 200km with a mount in the 1500-2000m bathome
- One of two seamount ridges within 200km with a mount in the 1000-1500m bathome
- Pelagic regions 9, 11

Area 3

- The only marginal plateau in the Atlantic ocean sector and one of only 2 in the CCAMLR Area
- Astrid Ridge, one of only five margin ridges in the CCAMLR Area
- Upper slope within the 0-100m and 100-200m bathomes
- Shelf area of persistently high summer productivity
- Meso-scale circulation feature of the ACC
- One of two seamounts within 200km with a mount in the 1000-1500m bathome
- Pelagic regions 1, 2, 3, 6, 7,9
- Only location of pelagic region 4 in the domain
- One of only 3 other small patches of pelagic region 5 in the domain
- One of only 2 small patches of pelagic region 8 in the domain
- Higher species richness within the domain
- Emperor penguin colony at Princess Astrid Coast

Area 4

- The two deepest seamounts in the Southern Ocean
- Representation of pelagic region 11 within the Atlantic ocean
- Pelagic regions 10, 11

Area 5

- Island ecosystems of Bouvet Island and region of higher species richness
- Two Mid-Ocean Ridge rift valleys
- Three of the four fracture zones mapped within the CCAMLR Area
- Shallow seamount environments interacting with the southern ACC front
- The only seamount in the domain and one of only five in the CCAMLR Area with a mount in the 0-100m bathome
- Three of eleven seamounts in the CCAMLR Area with a mount in the 500-1000m bathome
- Pelagic regions 10, 14, 15
- One of two small patches of Pelagic region 13 in the domain

Area 6

- Mid-Ocean Ridge rift valley
- Shallow seamount environments interacting with the polar front
- Seamounts in year round ice-free open ocean
- Two of eleven seamounts in the with a mount in the 500-1000m bathome
- Pelagic regions 14, 15
- Higher species richness within the domain

Area 7

- Shallow seamount environments interacting with the southern ACC front
- Representation of ocean troughs
- Pelagic regions 11, 15

Area 8

- Mid-Ocean Ridge rift valley
- Shallow seamount environments interacting with the southern ACC front
- Seamounts in year round ice-free open ocean
- Representation of ocean troughs
- Pelagic region 15

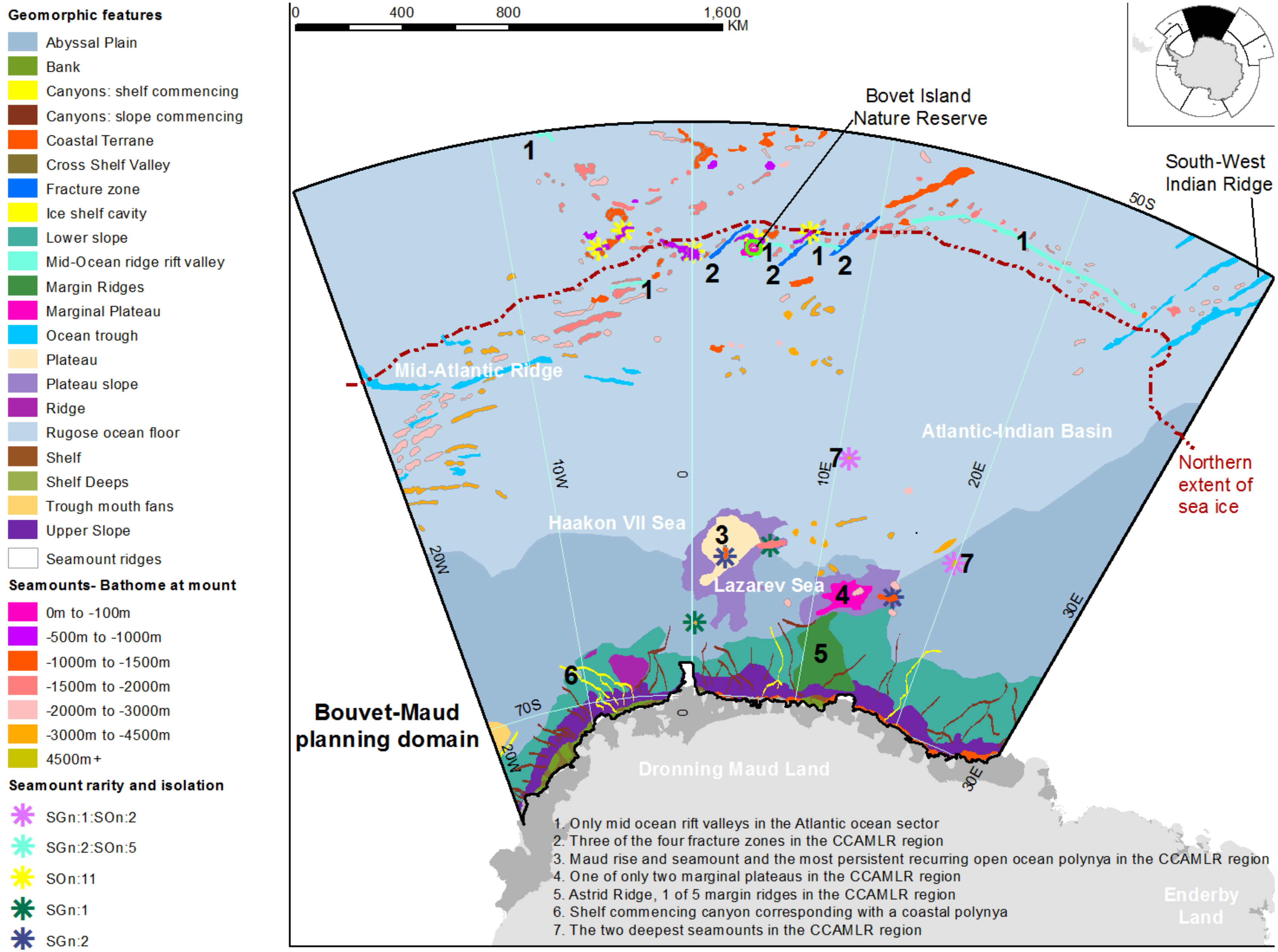

Figure 1: Benthic features of the Bouvet-Maud domain. The number beside 'SGn' is the number of seamounts or seamounts ridges with a specific bathome located within the seamount group. The number beside 'SOn' is the number within the CCAMLR Southern Ocean region. For instance, for SGn:2:SOn:5, there are two seamounts with the same bathome in the seamount group (i.e within 200km) and five seamounts with this bathome in the Southern Ocean.

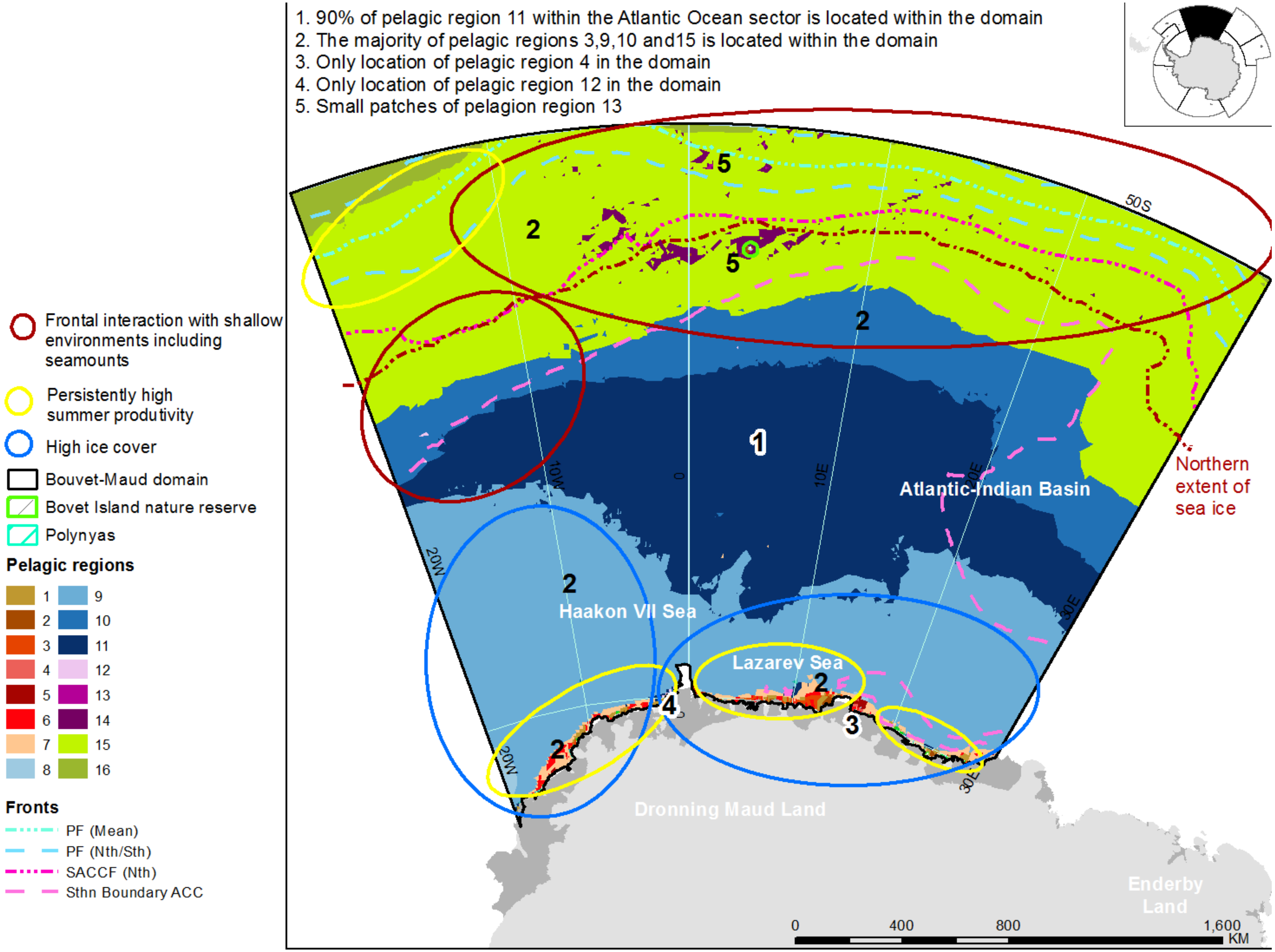

Figure 2: Pelagic features of the Bouvet-Maud domain

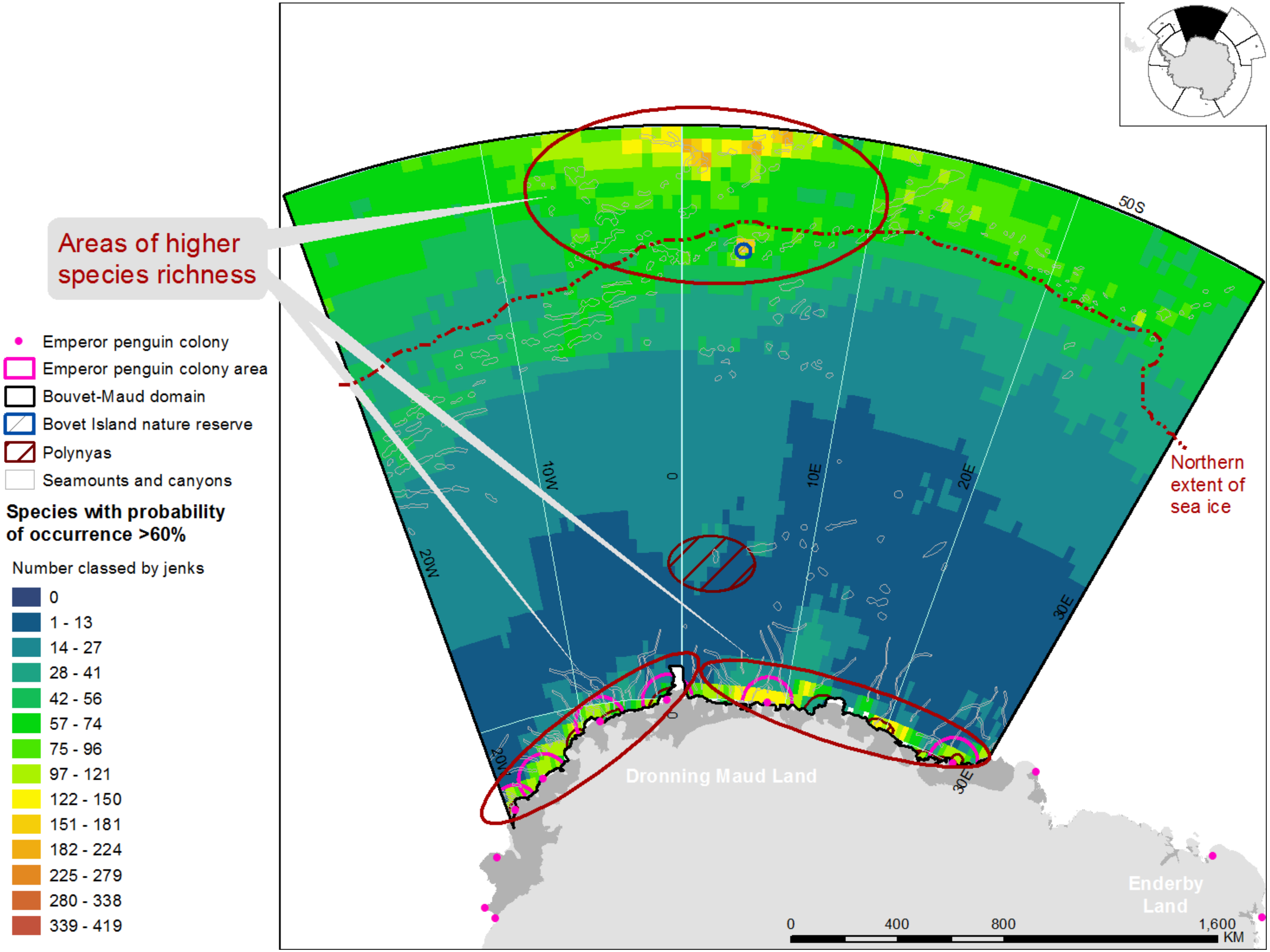

Figure 3: Species richness of the Bouvet-Maud domain

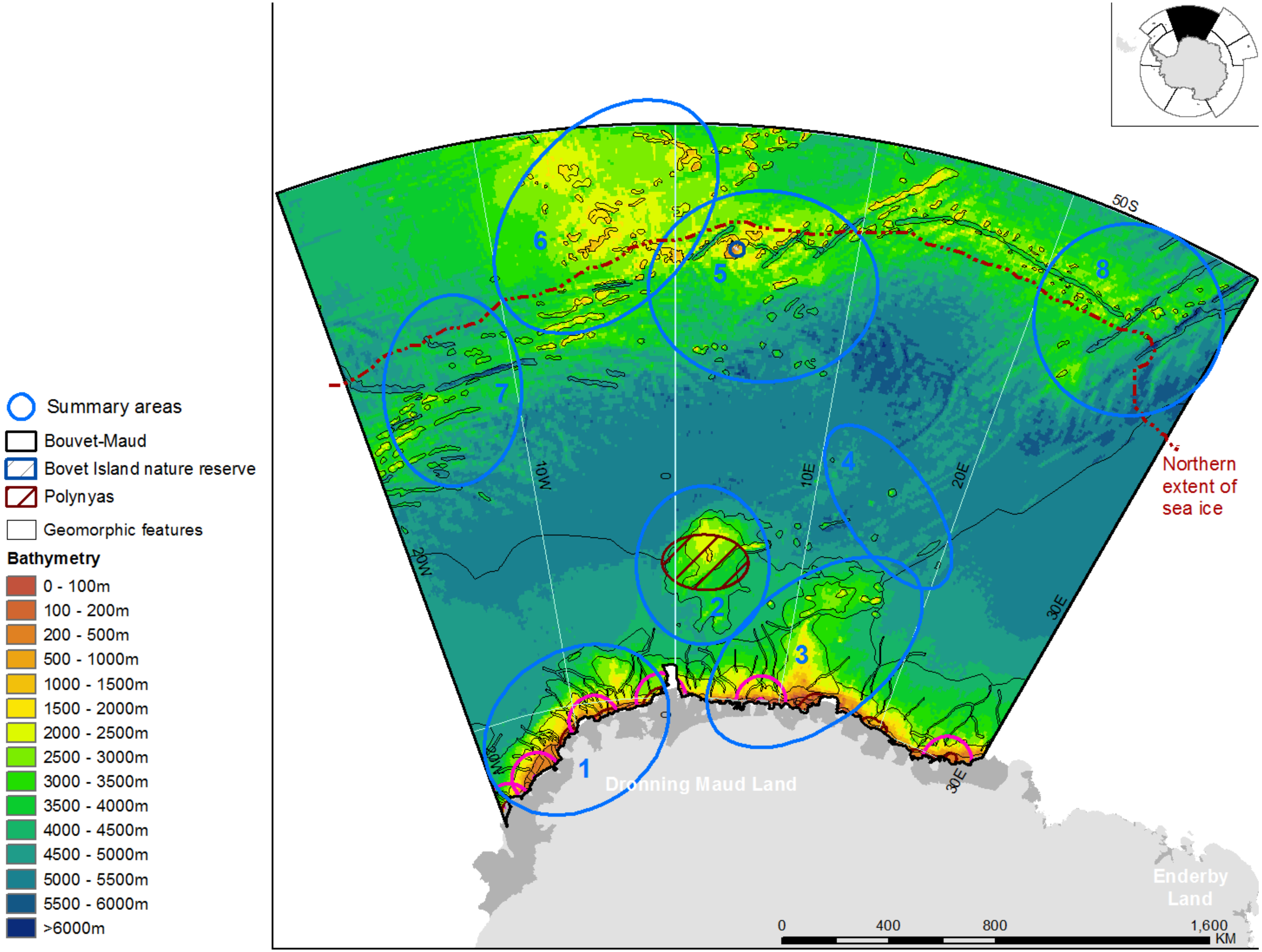

Figure 4: Summary of environmental features within the Bouvet-Maud domain

Weddell Sea domain

The 2 mill km^2 Weddell Sea domain represents the coldest, high sea ice covered area within the CCAMLR Area with a persistently high productive shelf and is a key location for the formation of Antarctic bottom water. The Weddell Sea is located within the Atlantic ocean sector of the CCAMLR Area and includes the clockwise flowing Weddell gyre that stretches across the Atlantic sector to approximately 40°E [52]. Regions of higher species richness within the domain occur across the shelf especially off the coast from Coates Land and Brunt Ice Shelf and also around James Ross Island and off the Larsen Ice Shelf (Figure 7). There are eight emperor penguin colony areas in the Weddell Sea domain located from east to west at Drescher inlet, Stancomb wills, Halley Bay, Dawson Lambton, Luitpold Coast, Gould Bay, Smith Peninsula and Snow Hill Island. There are no existing marine protected areas within the Weddell Sea domain.

The domain includes 12 of the 30 geomorphic features present within the CCAMLR Area (Figure 5). There is a high proportion of representation of the 200-500m and 500m-1000m bathomes and a high proportion of geomorphic shelf features, particularly banks, cross shelf valleys and ice shelf cavities. The Filchner trough which is described as a cross shelf valley within the data used here is the deepest section of the Weddell Sea shelf. The troughs outflow is a source of annual dense shelf water that is responsible for bottom water formation within the Weddell Sea. The enhanced availability of nutrients within the outflow is expected to create a dependable supply of prey for seals and other predators [53]. Water from the Filchner trough flows into the large Crary trough mouth fan and is channeled through the shelf commencing Polarstern canyon into the Weddell gyre [54]. There is only one seamount ridge within the domain. However, this seamount ridge is part of the South Scotia Arc and Mid Atlantic Ridge seamount chain and therefore should be planned for when considering these features. The shelf region of the Weddell Sea and Ross Sea domains contain the largest regions of very cold (<-1.5°C) seabeds in the CCAMLR Area. There are smaller patches of very cold seabeds in eastern Antarctica. Most of the Weddell Sea domain contains seabed temperatures of -1 to -0.25°C. However, the domain has the coldest (-2.06°C) seabed temperature in the CCAMLR Area.

The domain includes 10 of the 19 pelagic regions present within the CCAMLR Area (Figure 6). The domain mostly consists of pelagic regions 8 (41% of domain), 9 (30% of domain) and 5 (26% of domain). Pelagic regions 8 and 9 have a similar sea surface temperature SST and are deep water regions with depths greater than 2000m. Pelagic region 9 is deeper extending to around 5000m rather than 4000m and has a lower ice cover [35]. Pelagic region 5 represents shelf areas that are almost always covered with ice (75-100%). The domain captures one of the largest high sea ice cover areas in the CCAMLR Area (appendix 1). A large portion of the domain has high sea ice cover for more than 90% of the year and no part of the domain remains free of high sea ice cover year round (appendix 2). Almost all of the domain has high sea ice cover for more than 60% of the year. Most of the domain has highly variable inter-annual summer productivity. There are patches of persistently high summer productivity over the shelf region.

The Weddell Sea domain is critical (i.e contains >90% across all domains) to representing:

- Pelagic regions 5 and 8 in the Atlantic ocean sector. Also contains the majority of pelagic region 5 and 8 (>50%) within the CCAMLR Area.
- The polarstern canyon, a shelf commencing canyon
- The filchner trough is the deepest section of the Weddell Shelf
- The Crary trough mouth fan which is the largest trough mouth fan mapped within the CCAMLR Area and includes the only representation of this geomorphic feature within the 1500-2000m bathome and almost all (98%) within the 3000-4500m bathome.

The Weddell Sea domain is very important (i.e. contains >75% across all domains) to representing:

- Pelagic region 4 in the Atlantic ocean sector. These are shallow areas with high ice cover of approximately 75-95% and are scattered around the Antarctic continental shelf [35].
- ice shelf cavity in the 1000-1500m bathome and is 1 of only 3 domains to contain this environment type

The Weddell Sea domain is important (i.e. contains >50% or majority across all domains) to representing:

- Cross shelf valley in the 0-100m bathome and the 200-500m bathome. The domain contains 47% of cross shelf valley area within the CCAMLR Area, all other domains contain <18%.
- Ice shelf cavity in the 200-500m bathome. The domain contains 41% of ice shelf cavity area within the CCAMLR Area, all other domains contain <29%.
- Shelf deeps within the 200-500m bathome (48%)
- Pelagic region 6 in the Atlantic ocean sector (52%). These are relatively shallow areas (approximately 200-500m) and moderate ice cover (40-70%) and are often located around polynyas[35].

Summary (Figure 8)

Area 1

- The Filchner trough
- The shelf commencing Polarstern Canyon and several slope commencing canyons
- The Crary trough mough fan
- Pelagic regions 1 and3 to 9
- Only patches of pelagic regions 11 and 12 within the domain
- Three polynyas
- Area of persistent summer productivity
- Area of higher species richness with the domain
- Six emperor penguin colony areas including at Drescher inlet, Stancomb wills, Halley Bay, Dawson Lambton, Luitpold Coast, Gould Bay
- Cross shelf valley in the 200-100m bathome

Area 2

- Belgrano and Berkner Banks
- A polynya across the front of the Ronne ice shelf
- Area of persistent summer productivity
- Emperor penguin colony at Smith Peninsula
- Pelagic region 5 and 7
- Cross shelf valley in the 200-100m bathome
- Shelf deep in the 200-500m bathome

Area 3

- Area of higher species richness with the domain
- only regions of coastal terrane within the domain
- Emperor penguin colony at Snow Hill Island
- Area of persistent summer productivity
- Pelagic regions 1 to 7
- Very Shallow cross shelf valley in the 0-100m bathome
- Cross shelf valley in the 200-100m bathome

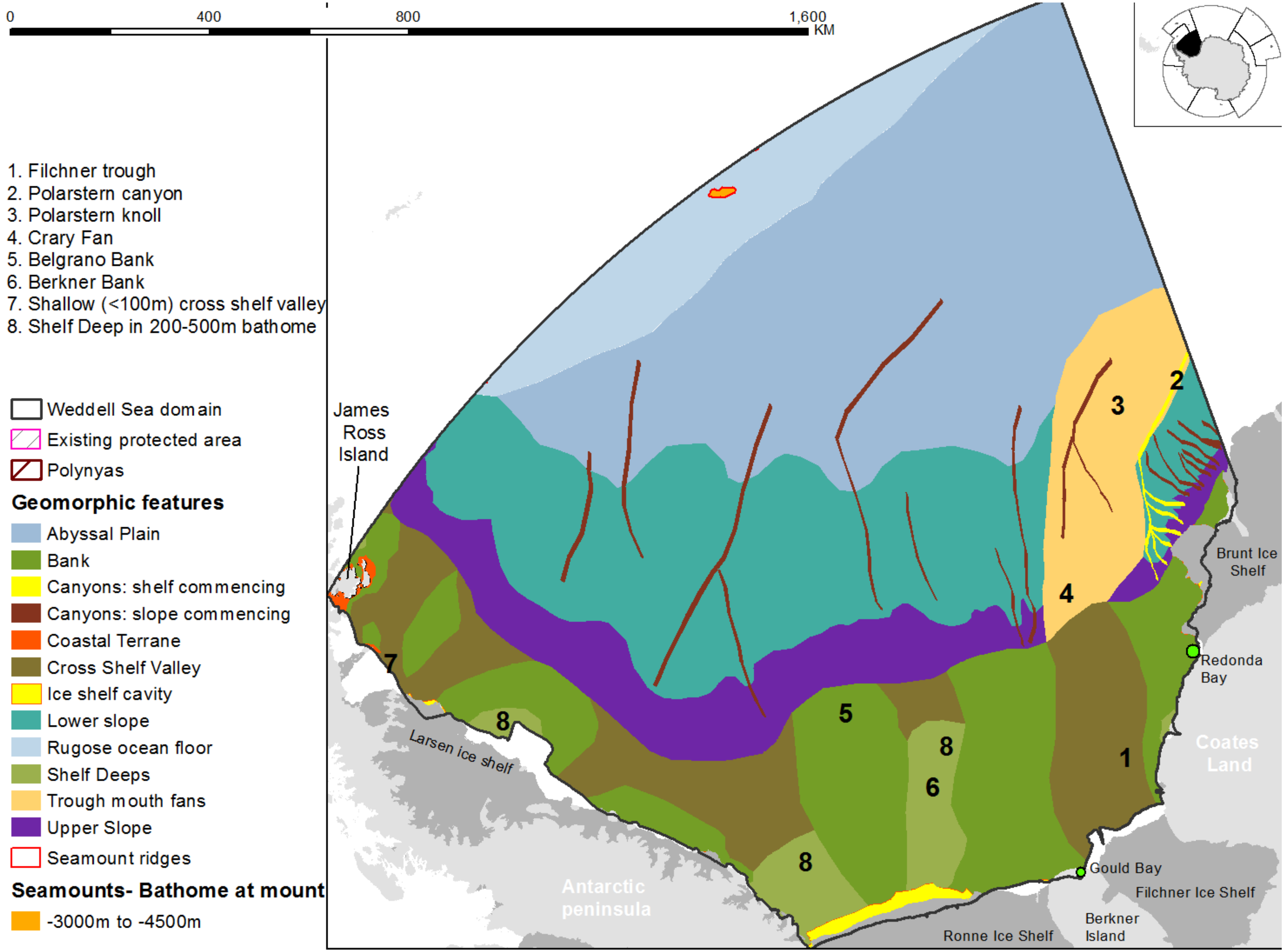

Figure 5: Benthic features of the Weddell Sea domain.

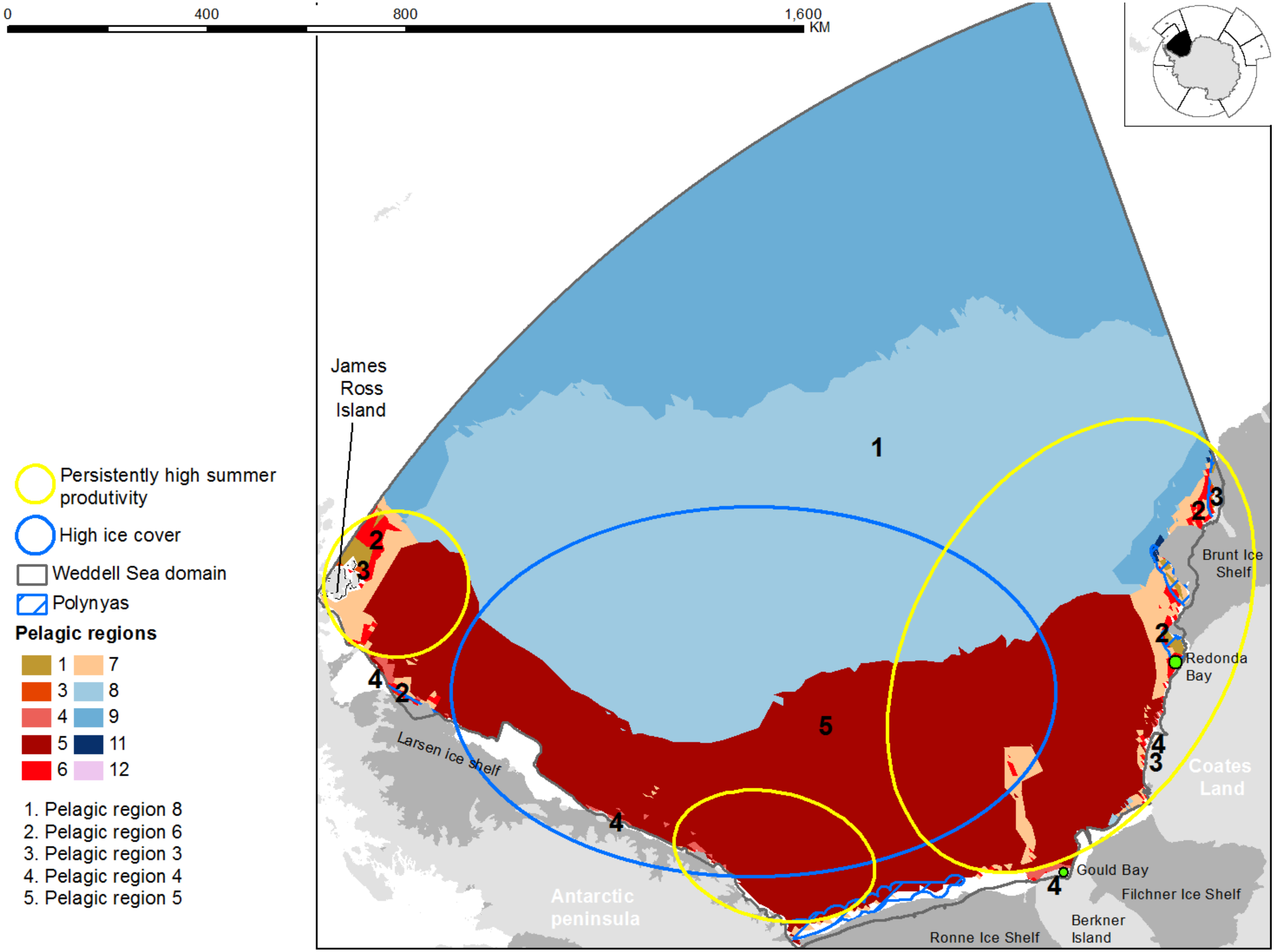

Figure 6: Pelagic features of the Weddell Sea domain

Data dossier for the AB-WS-BM MPA workshop, prepared by the Centre for Conservation Geography.

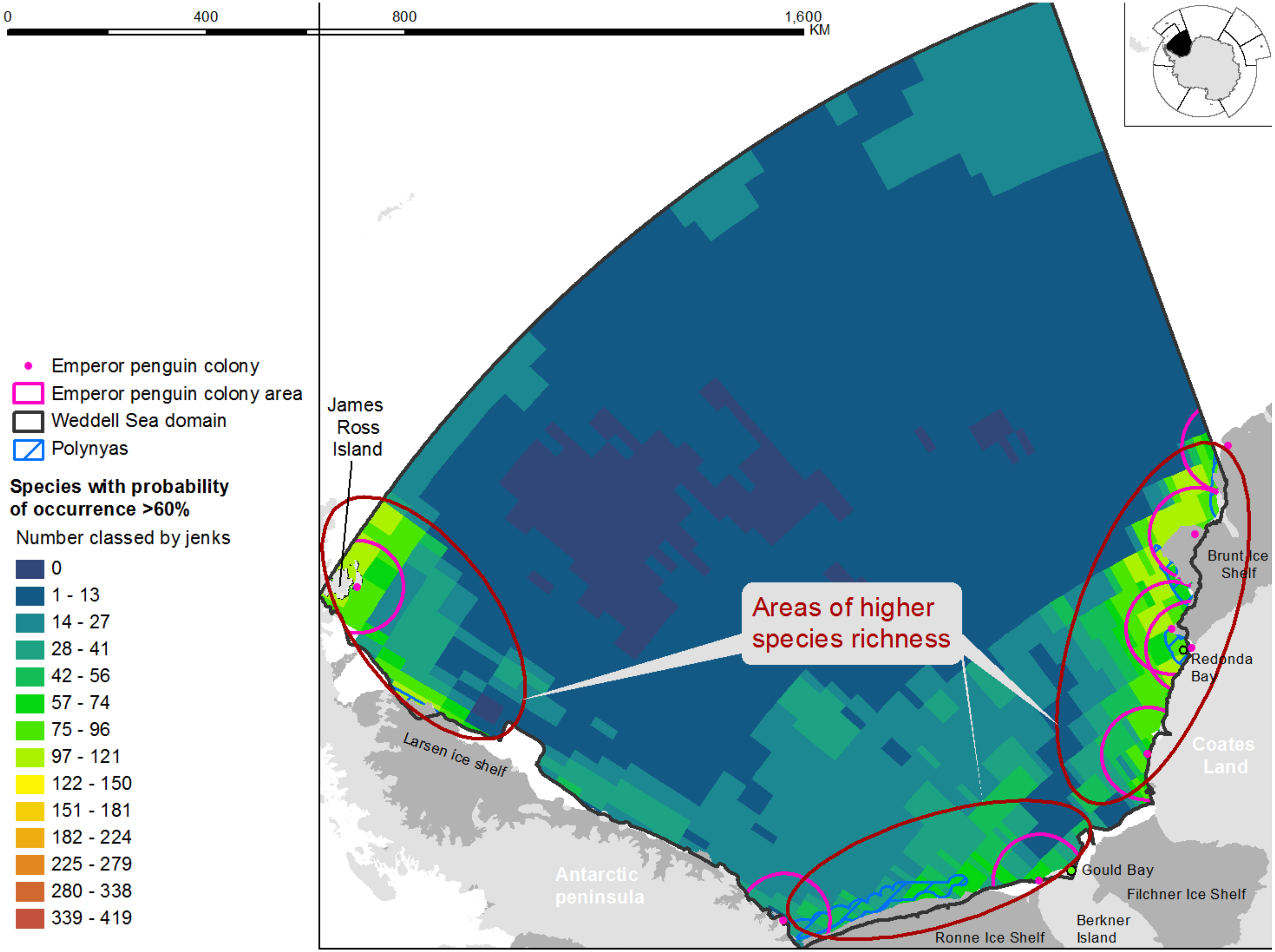

Figure 7: Species richness of the Weddell Sea domain

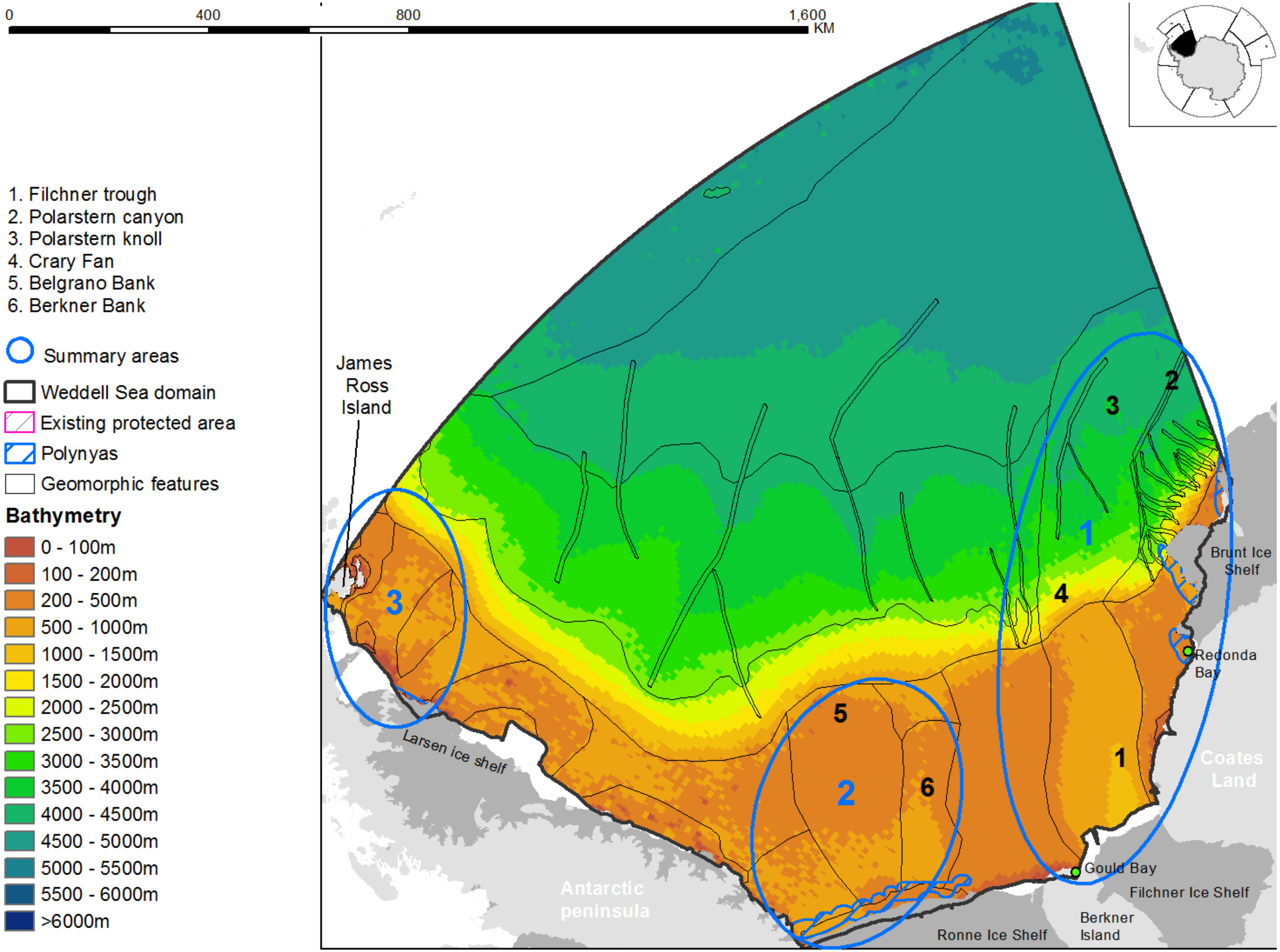

Figure 8: Summary of environmental features within the Weddell Sea domain

Amundsen-Bellingshausen

Benthic features (Figure 9)

At4.3 mill km^2 theAmundsen-Bellingshausen domain (AB) is the third largest CCAMLR planning domain. A diversity of benthic environments are present including14 of the 30 geomorphic features found in the CCAMLR Area. These features span the abyssal (68% of domain), slope (22% of domain), shelf (8% of domain) and oceanic shallow (2% of domain)geomorphic classes [1,10]. Fifty five seamounts and seamounts ridges are found within the domain of which 17 have a rare or isolated distribution. The island coastal terrane around Peter I island and the coastal terrane within Pine Island Bay are the deepest coastal terrane environmental types within the CCAMLR Area. This rugged terrain with its diversity of depths and shallow areas in the photic zone provides an array of habitats and is therefore likely to contain a diversity of biota [10]. Furthermore, the deeper (i.e<500m) sections of these environmental types are likely to be protected from ice berg scour [10]. There are data gaps within the seabed temperature dataset across much of the shelf (appendix 1). Where data exists, it shows the eastern section of the shelf to have very warm seabed temperatures and indicates that the whole shelf area is likely to be warm relative to many other shelf regions of the Antarctic continent. The deep ocean seabeds of the domain are also warm compared to other deep ocean regions within the CCAMLR Area (appendix 1).

The Amundsen-Bellingshausendomain is critical to representing:

- The Belgicaguyot, one of only two seamounts in the CCAMLR Area with a mount in the 100-200m bathome. The other seamount is located within the Ross Sea.
- One of only two seamounts ridges with a mount in the 200-500m bathome and 98% of the area spanned by this environmental type in the CCAMLR Area. The other seamount is located within the Ross Sea.
- Deep island coastal terrane and coastal terrane - the Amundsen-Bellingshausen domain is the only domain to contain these geomorphic features deeper than 1000m and contains 82% of island coastal terrane in the 500-1000m bathome.
- The only two seamount ridges in the Southern Ocean with a mount in the 4500m+ bathome

The Amundsen Bellingshausen domain is important to representing:

- One of five seamounts within the 0-100m bathome
- One of eleven or 66% of the area spanned by seamount ridges within the 500-1000m bathome
- Deep cross shelf valleys containing the majority of this feature within both the 1500-2000m and 2000-3000m bathomes.
- 74% of the upper slope within the 1500-2000m bathome which spans the east-west length of the upper slope region
- Contains the majority (58%) of the Rugose ocean floor within the 1000-1500m bathome

Pelagic features (Figure 10)

TheAmundsen-Bellingshausen planning domain is located within the Pacific Ocean sector of the CCAMLR Area and contains the Amundsen Sea and the western section of the Bellingshausen Sea. It represents 16 of the 19 pelagic regions present within the CCAMLR Area. The domain mostly consists of pelagic regions 15 (41%), 9 (17%), 10 and 11 (both 12%). The other 12 pelagic regions each span less than 5% of the domain. The LecointeGuyot corresponds with the only location of pelagic region 13 in the Pacific Ocean sector of the CCAMLR Area. Other locations of this pelagic region include the shallow areas of approximately 200-1000m depth of the northern Kerguelen, Crozet and South Georgia plateau areas[35]. The deeper (~500–2000m) pelagic region 14 is also located upon these plateau areas[35]. Within the Pacific Ocean basin, pelagic region 14 is mostly located within the Ross Sea domain (80%) and the Amundsen-Bellingshausen domain (19%) where it occurs over both the Lecointe and nearby Belgicaguyots.These guyotsare within the Bellingshausen Sea and belong to a seamount group that interacts with the polar front. The deeper seamount group to their north corresponds with the southern region of the Sub-Antarctic front. The seamount group within the Amundsen Sea which includes the Marie Byrd seamount interacts with the Southern Antarctic Circumpolar Current Front.

The shelf area near to the coast has high ice cover for most of the year with patches of polynyas and highly persistent summer productivity. The pelagic regions 1 and 2 north-west of both Grant and Siple islands and west of the Thwaitesiceburg tongue correspond with polynyas with persistently high productivity. The polynya off the coast of Martin Peninsula and west of the Thwaitesiceburg tongue has the most persistently high summer productivity in the CCAMLR Area. Pelagic region 2 represents polynya margins upon shallow areas (approximately <1000m depth) with high sea ice cover for 0-20% of the year and cold sea surface temperatures of <2°C [35]. The WAPSSA domain is important to representing Pelagic region 2 containing 72% of this region within the Pacific Ocean sector. Pelagic region 1 is similar to region 2 however with higher sea ice cover of 20-50% of the year [35]. The domain also contains year round ice free region of open ocean.

Species richness and existing protection(Figure 11)

Within the domain, the areas of higher species richness occur across the shelf, at Peter I island and the Belgicaguyot. Four colonies of the ice breeding emperor penguins have been located within the domain using remote sensing to identify fecal stains [43]. The colony on the Thurston glacier off Siple Island was previously known and was confirmed at this site. The other locations at Ledda Bay of Grant Island, Noville Peninsula of Thursten Island and Bear Peninsula were found by the study in 2009. Apart from the Thursten Island colony, these colonies correspond with polynyas that may be important for foraging.

There is one small Vulnerable Marine Ecosystem with benthic protection provided under CCAMLR conservation measure 22/07. This provides for protection of 2.1% of seamount ridge and 0.1% of lower slope benthic environmental types and 0.2% of both pelagic regions 9 and 11 within the domain. No other features are captured within protected areas.

Summary (Figure 12)

Area 1

- Seamount cluster corresponding with the Sub-Antarctic front
- Representation of deep, ice-free open ocean
- Representation of pelagic regions 16 and 15
- Only 2 seamounts with a mount in the 4500+ bathome in the CCAMLR Area

Area 2

- The island ecosystems, higher species richness, persistently high summer productivity and deep island coastal terraneassociated with of Peter I island
- Belgicaguyot and corresponding higher species richness. The Belgicaguyot is one of two seamounts with a mount in the 100-200m bathome within the CCAMLR Area
- Lecointeguyot is one of only five seamounts with a mount in the 0-100m bathome within the CCAMLR Area
- The only area of pelagic region 13 in the Pacific Ocean.
- The De Gerlache seamount cluster interacting with the polar front
- Representation of pelagic regions 9, 10, 11, 13, 14 and 15

Area 3

- Emperor penguin colony at Noville Peninsula of Thursten Island
- Slope commencing canyons
- Deep cross shelf valley

Area 4

- Polynya with the most persistently high summer productivity in the CCAMLR Area
- Emperor penguin colony at Bear Peninsula
- Deep coastal terrane within Pine Island Bay
- Areas of higher species richness

Area 5

- Five seamounts with a restricted distribution including:
    - One of only two seamount ridges in the CCAMLR Area to have a mount in the 200-500m bathome
    - Only location within the domain to represent seamount ridges within the 200-500m, 500-1000m and 1500-2000m bathomes.
- CCAMLR registered vulnerable marine ecosystem corresponding with a seamount ridge in the 1000-1500m bathome
- Marie Byrd seamount cluster interacting with the Southern ACC front
- Persistently high summer productivity
- Patches of higher species richness

Area 6

- Two polynyas with persistently high summer productivity
- Emperor penguin colonies on the Thurston glacier off Siple Island and Ledda Bay of Grant Island
- Higher species richness across the shelf especially within the polynyas
- Area of high sea ice cover
- Deep cross shelf valley

Area 7

- Only location with domain to represent a seamount within the 2000-3000m bathome
- Isolated seamount cluster between the polar front and Southern ACC frontal zones
- Year round ice free region and northern most extent of sea ice

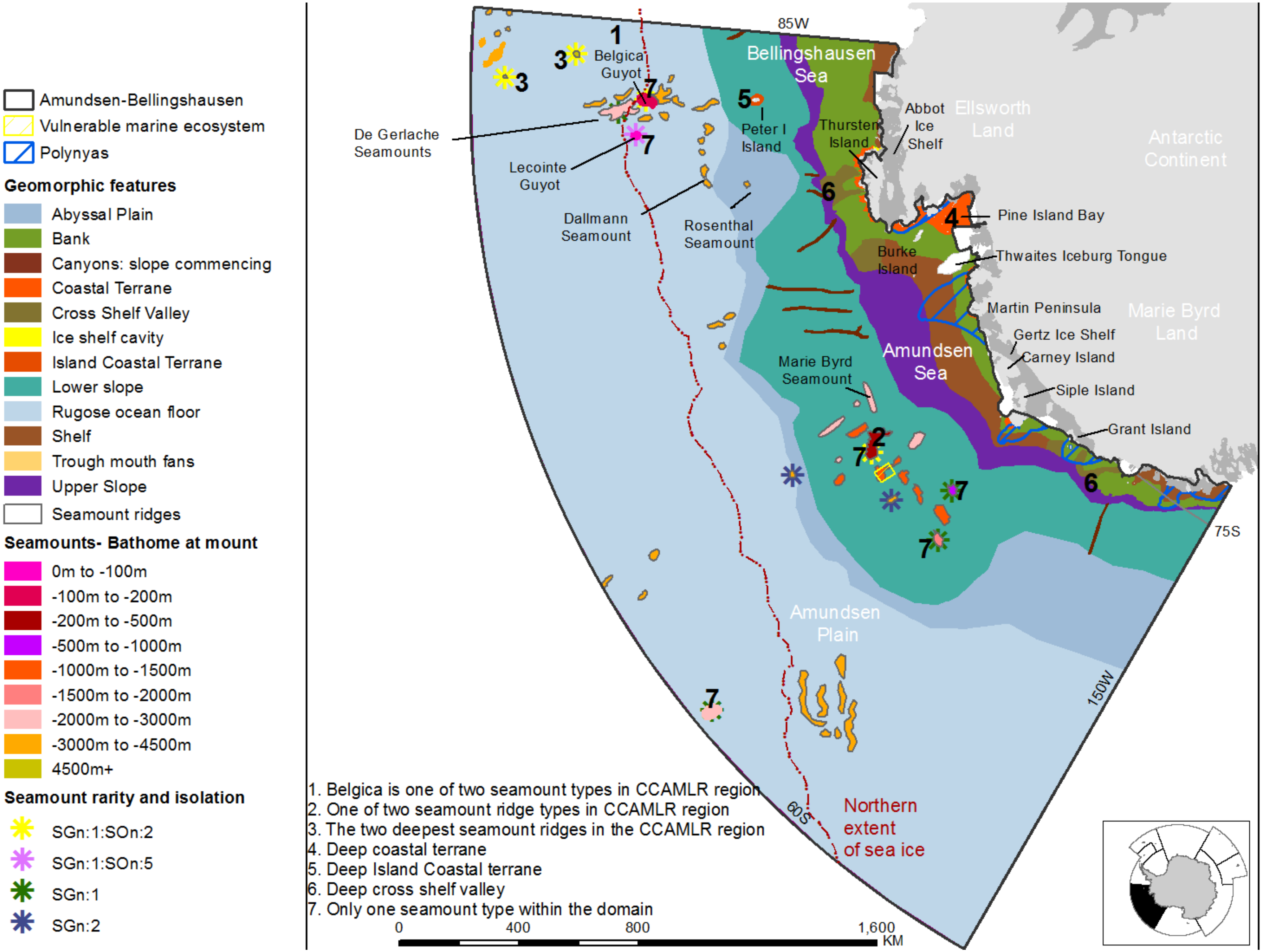

Figure 9: Benthic features of the Amundsen- Bellingshausen domain. See Figure 1 or description of seamount rarity and isolation code.

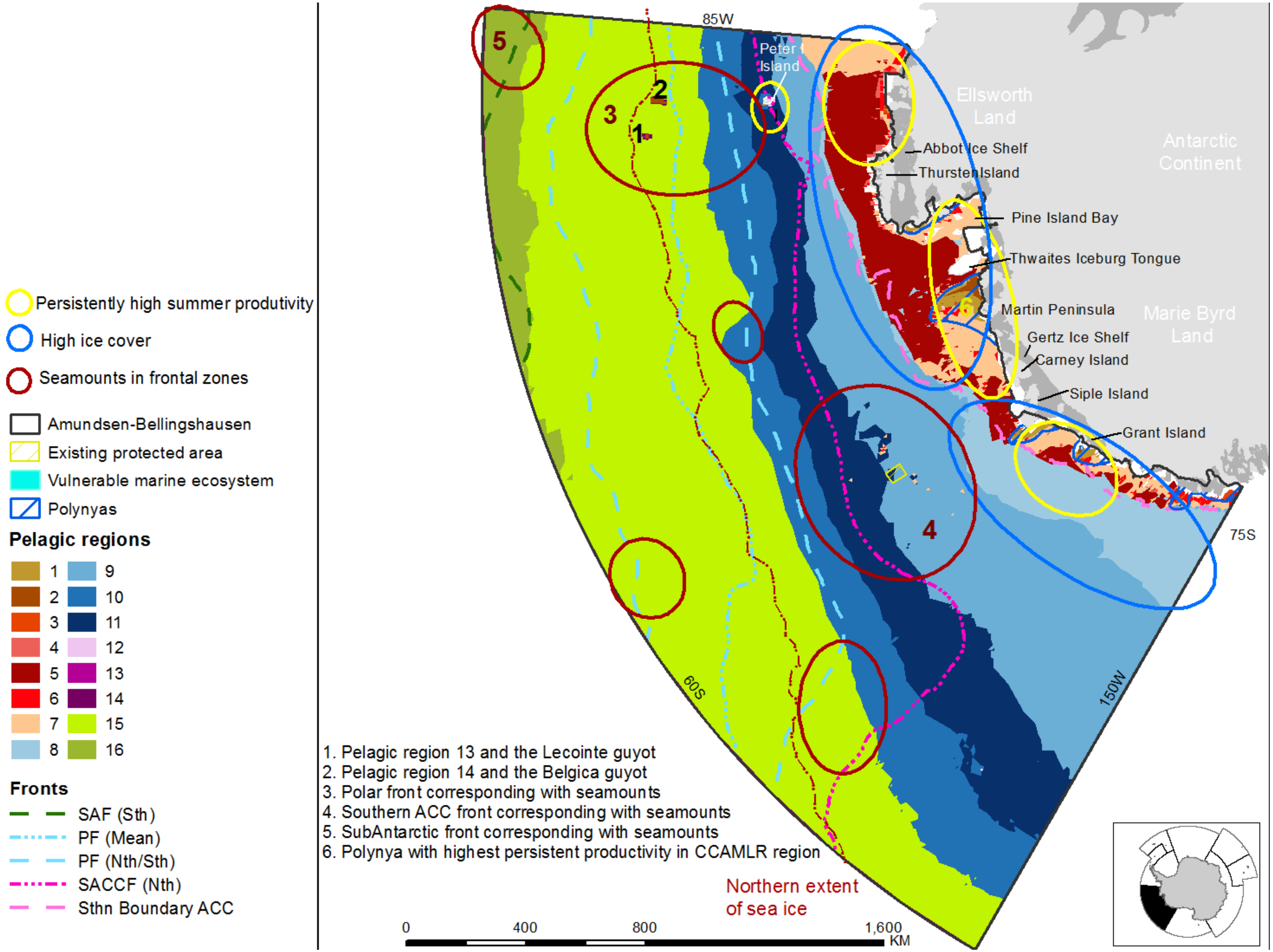

Figure 10: Pelagic features of the Amundsen- Bellingshausen domain

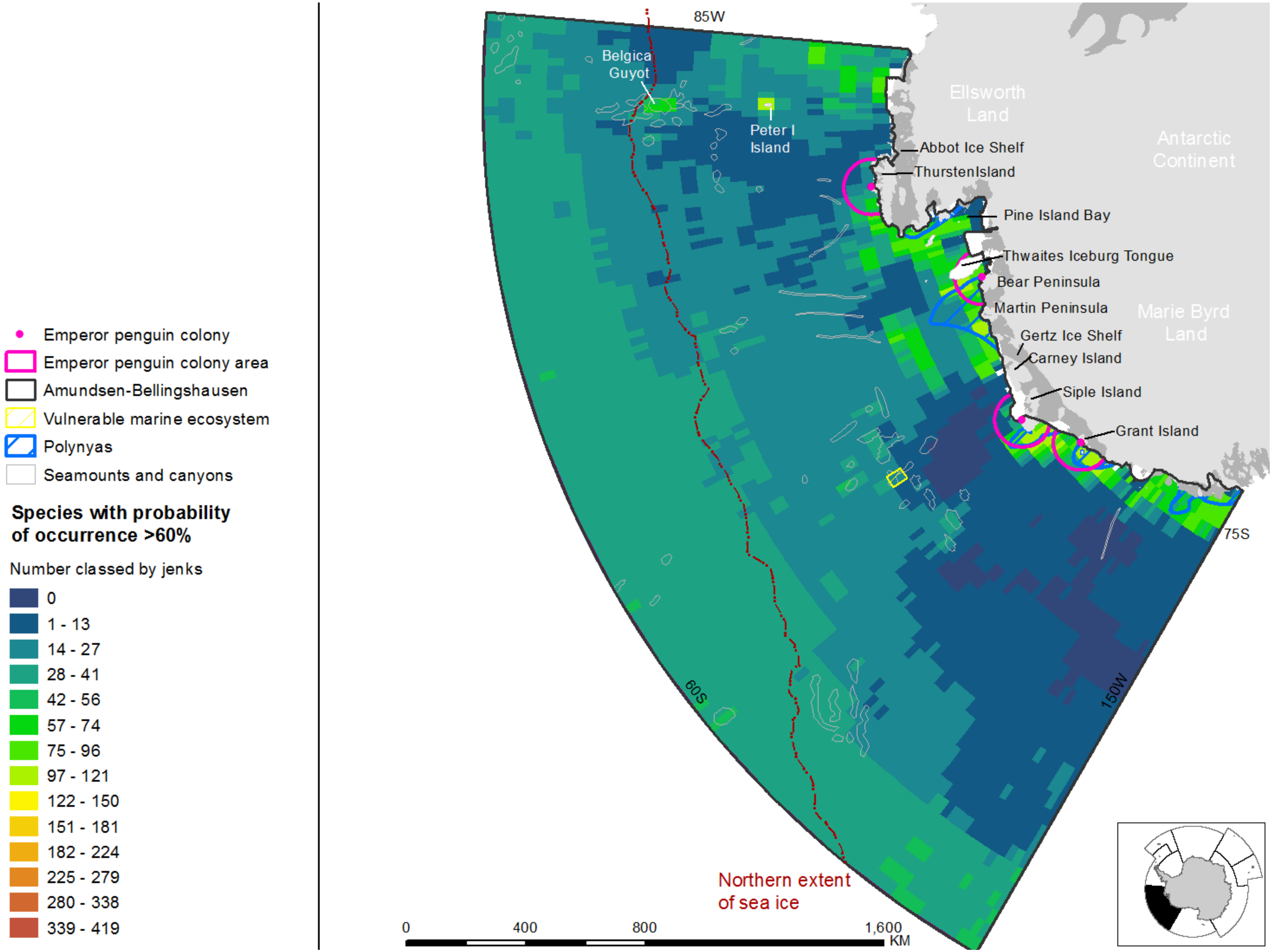

Figure 11: Species richness of the Amundsen- Bellingshausen domain

Data dossier for the AB-WS-BM MPA workshop, prepared by the Centre for Conservation Geography.

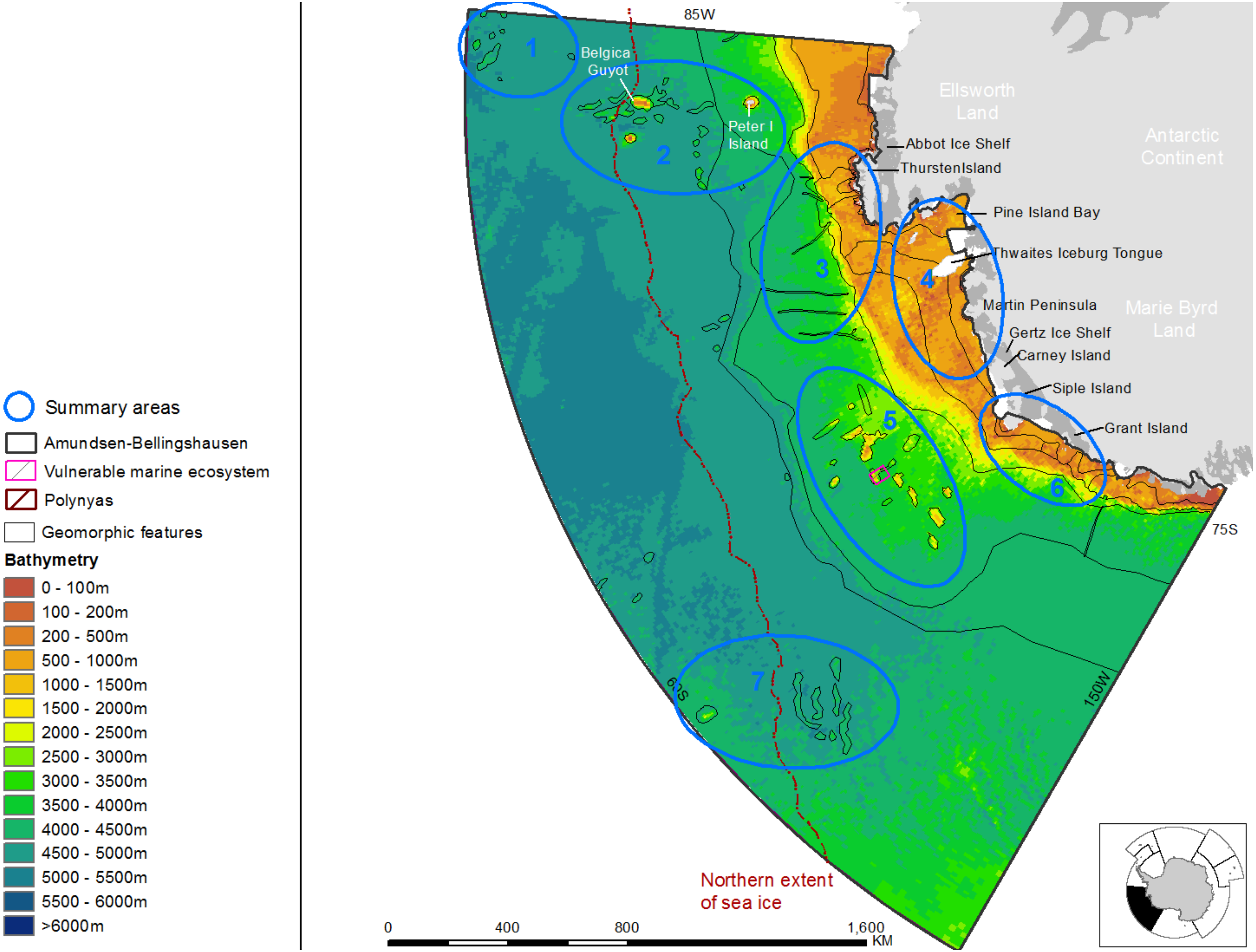

Figure 12: Summary of environmental features within the Amundsen- Bellingshausen domain

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