Proposed offshore Key Ecological Features and Biologically Important Areas of Australia's Indian Ocean Territories.

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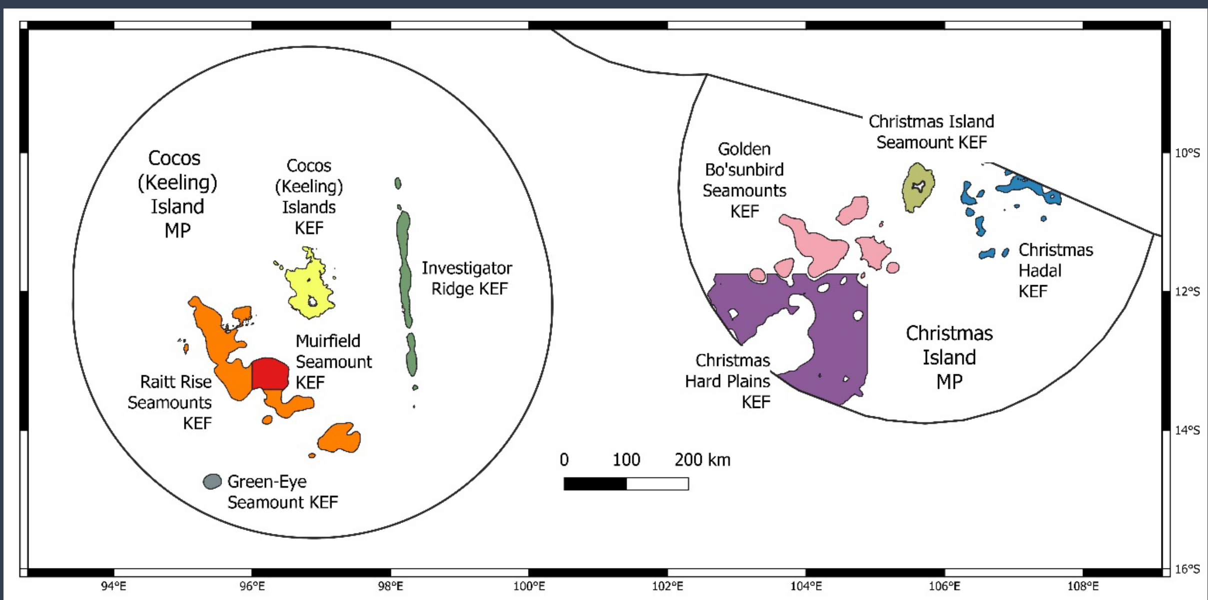

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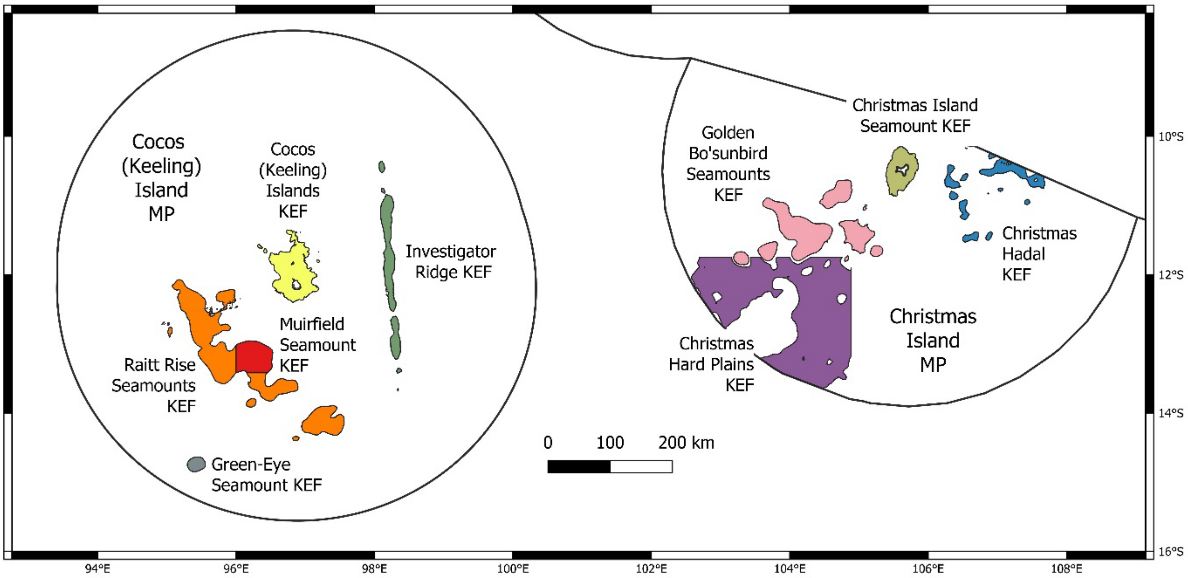
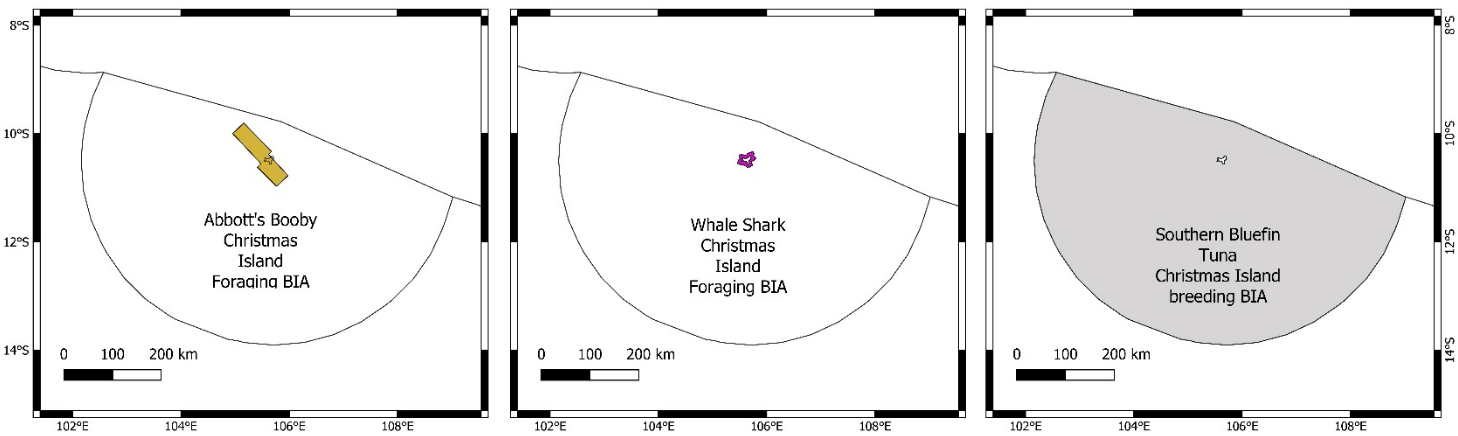


Proposed Key Ecological Features in Australia's Indian Ocean Territories.



Proposed Biologically Important Areas in Australia's Indian Ocean Territories.

Introduction

Prior to 2021, scientific knowledge of the marine biodiversity values of Cocos (Keeling) Islands and Christmas Island was largely restricted to inshore waters. From previous surveys and studies, we knew that the vast majority of the marine realm across the two territories is deep-sea, with seamounts and ridges, and abyssal and hadal plains. However, most areas had not been mapped with modern multibeam technology and only incidentally been surveyed by research vessels, which largely focused on geology or oceanography.

To gather more detailed knowledge, Museums Victoria led two RV *Investigator* voyages to the IOT to explore deep sea habitats—a 2021 voyage to Christmas Island and a 2022 voyage to Cocos (Keeling) Islands. In the context of establishing these waters as marine parks, Parks Australia supported these voyages and commissioned Museums Victoria to write this report to identify potential Key Ecological Features and Biologically Important Areas in the offshore waters of these islands.

Three versions of this report have been produced to assist Parks Australia with the IOT marine parks planning process:

1. A first version relied on information available prior to the RV *Investigator* voyages.
2. A second version incorporated new information from the RV *Investigator* voyage to Christmas Island in 2021.
3. This third and final version incorporates new information from both the 2021 and 2022 RV *Investigator* voyages to the IOT.

This report is complemented by the report *Assessment of the offshore marine natural values of Australia's Indian Ocean Territories*, also by Museums Victoria.

Key ecological features

Key ecological features (KEFs) are elements of the Commonwealth marine environment that, based on current scientific understanding, are considered to be of regional importance for either the region's biodiversity or ecosystem function and integrity.

56 KEFs have been identified across Australia's marine regions and are described in the Marine Bioregional Plans[1] for these regions. The criteria used to identify these 56 KEFs are the same criteria used in this report to identify potential KEFs in IOT offshore waters. Those criteria are:

- a species, group of species or community with a regionally important ecological role, where there is specific knowledge about why the species or species group is important to the ecology of the region, and the spatial and temporal occurrence of the species or species group is known
- a species, group of species or community that is nationally or regionally important for biodiversity, where there is specific knowledge about why the species or species group is regionally or nationally important for biodiversity, and the spatial and temporal occurrence of the species or species group is known
- an area or habitat that is nationally or regionally important for
    - enhanced or high biological productivity
    - aggregations of marine life

[1] Marine Bioregional Plans are available at: https://www.environment.gov.au/marine/marine-bioregional-plans.

  - biodiversity and endemism
- a unique seafloor feature with ecological properties of regional significance.

Biologically important areas

Biologically important areas (BIAs) are spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviour such as breeding, foraging, resting or migration.

BIAs have been identified for regionally significant marine species which are protected under the EPBC Act. These are species listed as threatened species (critically endangered, endangered, vulnerable, conservation dependent), migratory species, cetaceans or marine species. This report identifies potential BIAs for such species in offshore IOT waters with the information presented in accordance with the Commonwealth Government's BIA Protocol [2].

Methodology

There have been limited studies on the biodiversity values of IOT offshore areas. However, there are known occurrences and some observations of seabird, mammal, fish and turtle species and aggregations in pelagic waters, including of several threatened and/or migratory species. Furthermore, through the surveys and studies that have occurred, we know that the vast majority of the marine realm across the two territories is deep-sea, with seafloor consisting of seamounts and ridges, abyssal and hadal plains. Nevertheless, most areas have not been mapped with modern multibeam technology and only rarely been surveyed by research vessels, which have largely focused on the geology or oceanography.

Based on existing knowledge, major biogeographical characteristics of the IOT are:

- The region is biogeographically unique within the Australian marine domain due to its location in the tropical eastern Indian Ocean and the confluence of currents that has facilitated migration of marine taxa from both the east and north-west directions. In coastal waters around the islands, this has led to a unique assemblage of Pacific and Indian Ocean species including numerous hybrids. Other species have become self-recruiting leading to the evolution of endemic species.
- Oceanographic characteristics vary over the region. In particular, primary production declines from the relatively productive waters of the Indonesian continental margin to the oligotrophic waters of the central Indian Ocean. Spatial variation in primary productivity is a major driver of benthic community composition.
- The region includes numerous large seamounts and other underwater geomorphic features that are rare within the Australian jurisdiction. Seamounts are known to alter local oceanographic processes in varying ways depending on their depth and morphology.
- It is likely that each individual island, seamount and ridge will have a distinct community based on their unique migration and environmental history.

Consequently, the methodology used in this report to identify candidate KEFs was to focus on seafloor habitats that are likely to be important for biodiversity, endemism, and aggregations of

[2] The *Protocol for creating and updating maps of biologically important areas of regionally significant marine species* is available at: https://www.dcceew.gov.au/environment/marine/marine-species/bias

marine life based on this limited knowledge of IOT seafloors and more extensive knowledge of similar habitats elsewhere.

The proposed KEFs were assessed as being of national significance if the habitat was determined to be very rare within the Australian marine domain, and of regional significance if the habitat was extensive in the IOT but also likely to occur elsewhere.

The proposed KEF boundaries are based on bathymetry from the AusSeaBed (2020) dataset. The new multibeam sonar data from the Investigator voyages in 2021 and 2022 provide higher resolution bathymetry for many sections of the seafloor within the proposed KEFS. However, revision of the KEF boundaries requires this data to be integrated with existing data in a new AusSeaBed product which is likely to be completed and released in 2024.

In addition, three BIAs were identified for the few species for which sufficient data exists, including the foraging activities of Abbott’s Booby when nesting on Christmas Island, the foraging of whale sharks around Christmas Island during the Red land crab spawning season, and the spawning aggregation of Southern Bluefin tuna.

1. Proposed Christmas Island Seamount KEF

Maps and Images

Figure 1.1. Spatial extent of the proposed Christmas Island Seamount KEF. Bathymetric contours (30, 4000 m) derived from the AusSeaBed dataset (2021).

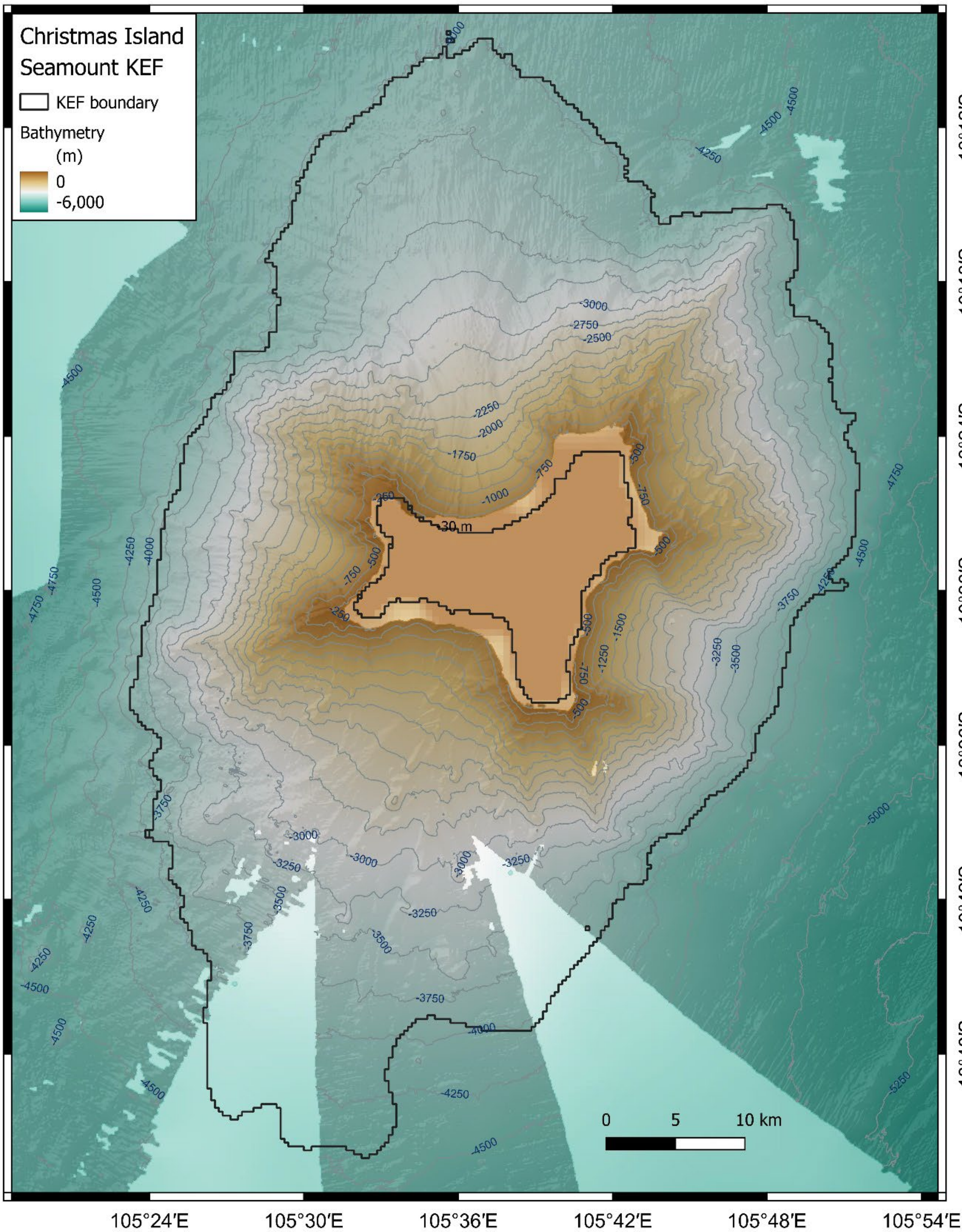


Figure 1.2. Topology of the proposed Christmas Seamount KEF. Darker bathymetry and contours are based on shipboard multibeam data, underlying (lighter) bathymetry is based on GEBCO 2022.

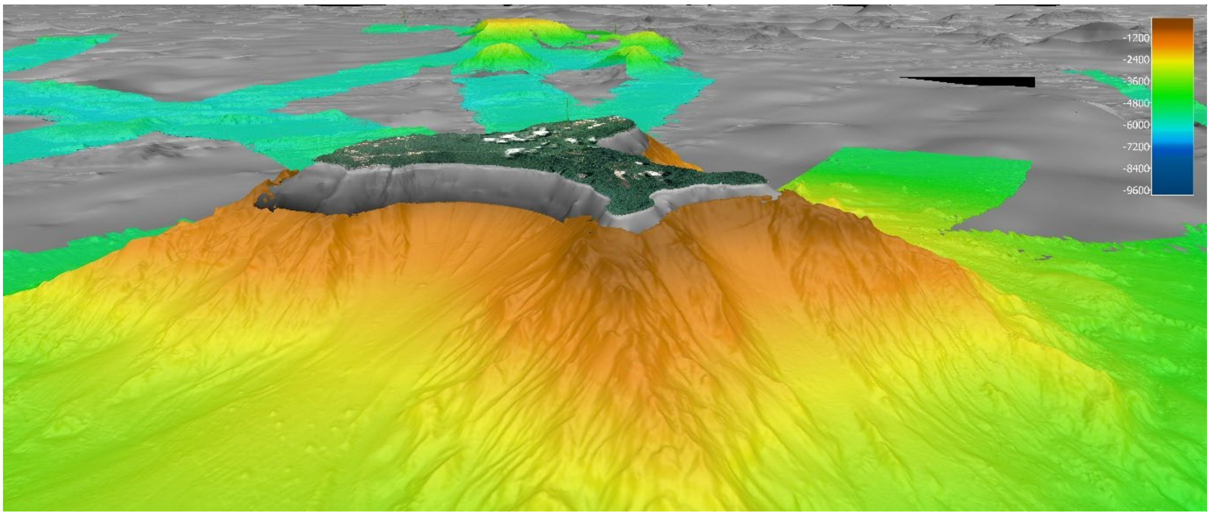


Figure 1.3. 3D representation of the Christmas Island Seamount from the east produced by CSIRO using QPS Fledermaus software and background datasets GEBCO 2022 (grey) and arial photography from the Christmas Island Geographic Information System (CIGIS (green-white).

Profile

Values

The mesophotic (30-200 m) upper bathyal (200-1000 m) depth zones on the Christmas Island seamount are unique within the Christmas Island Territory and Exclusive Economic Zone. The mid bathyal (1000-2000 m) depth zone is also very rare within this region (<1750 km^2) [2] and the lower bathyal (2000-2500 m) depth zone is also very limited. Similar to the shallow water community, the faunal composition on the seamount flanks is likely to be unique within the Australian marine domain due to the unusual biogeography of the area.

National and/or regional importance

The Christmas Island seamount is of national importance for biodiversity and endemism.

Location

The seamount underlying Christmas Island lies between 105.4 to 105.9˚E, 10.2 to 10.8˚S.

Description

Christmas Island sits atop a massive volcanic seamount that originated in the late Cretaceous period (87.5 to 75.2 Ma, [4]). The island may have subsided beneath the sea surface during the Paleocene (65 to 55 Ma) but there was a second stage of volcanism in the Eocene (43 to 37 Ma) which outcrops on the island today [4]. The seamount was submerged during the Eocene to Miocene (43 to 17 Ma) when limestones from shallow water and bathyal communities were formed on the summit. Subsequently, the island has been uplifted on the "fore-bulge" of the Australian plate as it has been subducted into the Sunda Trench. It was therefore again above sea-level by the Late Miocene (between 5.66 and 4.49 Ma) [5]. Since that time it has hosted massive seabird colonies which produced the superphosphate which was mined until recently [2]. There was also a third stage of volcanism during the Pliocene (4.5 to 4.2 Ma) which produced dyking, tuffs and vents (''petit-spot'' volcanism) in the Murray Hill region of the Island [4, 6].

The habitat deeper than 30 m is under-sampled and the fauna is largely unknown. Species of demersal fish recorded from 60-300 m around Christmas Island make up 7% of the fish fauna [7, 8]. This is likely to be an underestimate as only hook-and-line gear has been used to detect these fish [8]. However, the near vertical slope of these habitats around the islands limits the amount of suitable habitat and hence population size [7]. The life history characteristics of these species make them vulnerable to overfishing and maintaining a local population will be largely dependent on self-recruitment [9].

The biogeography of the area is complex. It is expected that biological community composition of the mesophotic and upper bathyal (30-1000 m) would follow the pattern in shallow water (0-30 m) [8, 10] and be a mixture of species that have migrated from both the Western Pacific/Eastern Indonesia (via the Indonesian ThroughFlow) and the Indian Ocean (via the Java Current) [11]. At mid-bathyal (1000-2000 m) depths, water masses are a mixture of Antarctic Intermediate Water from the south, Indonesian Intermediate Water from the east and Indian Deep Water from the north [2, 12, 13]. Deeper water masses are likely to originate from the south [14].

The Christmas Island seamount community is likely to differ from those at similar depths around Cocos (Keeling) Islands due to differences in the proximity of other landmasses (especially Indonesia), in net primary productivity of the oceans, and migration history, and will likely result in unique biological assemblages on each of these features.

The sublittoral habitat (30-200 m) is likely to be a biological important area for pelagic fish, seabirds, and marine mammal species.

2. Proposed Cocos (Keeling) Seamount KEF

Maps and Images

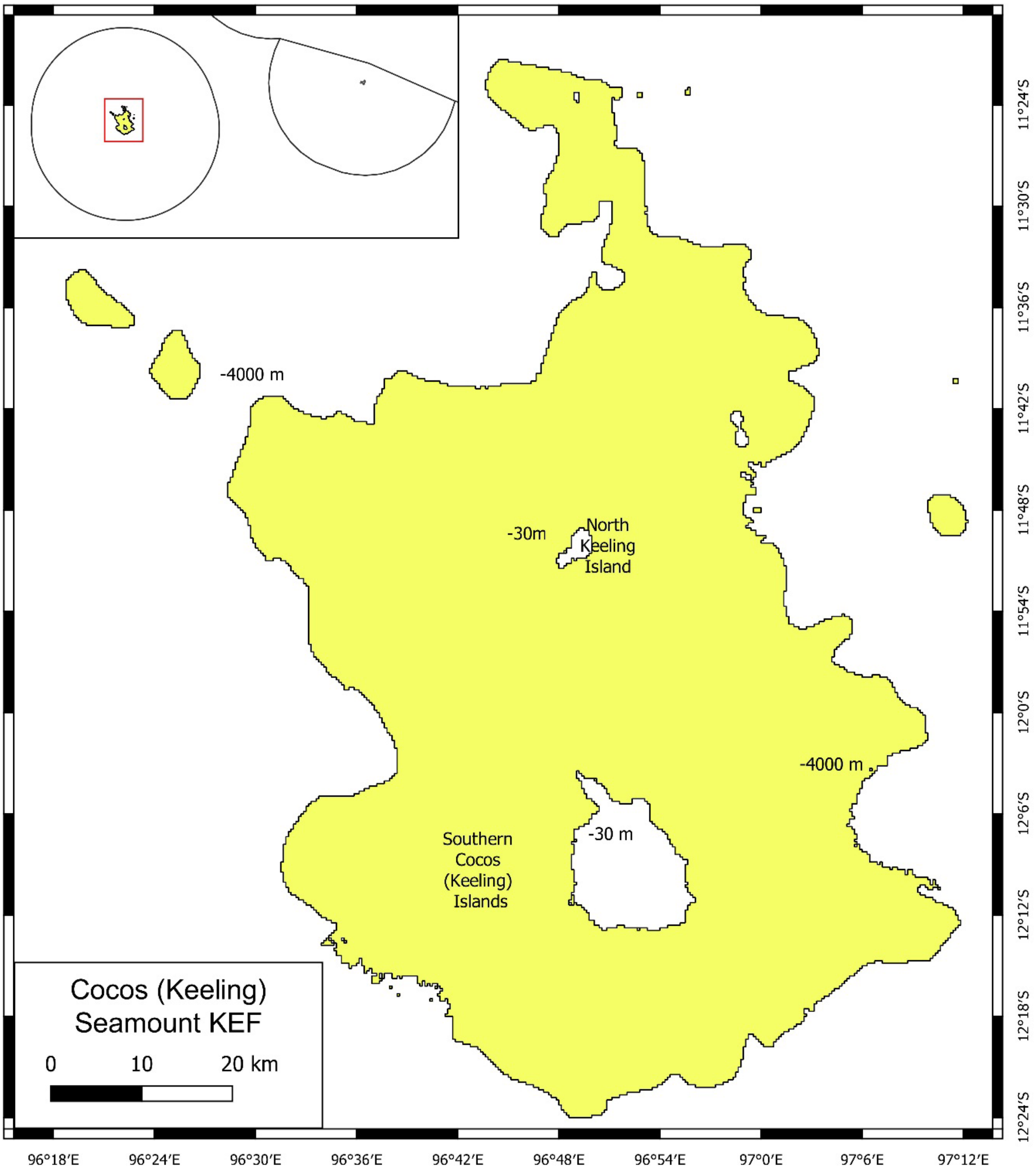


Figure 2.1. Extent of the proposed Cocos (Keeling) Seamount KEF. Bathymetric contours (30, 4000 m) derived from the AusSeaBed dataset (2021).

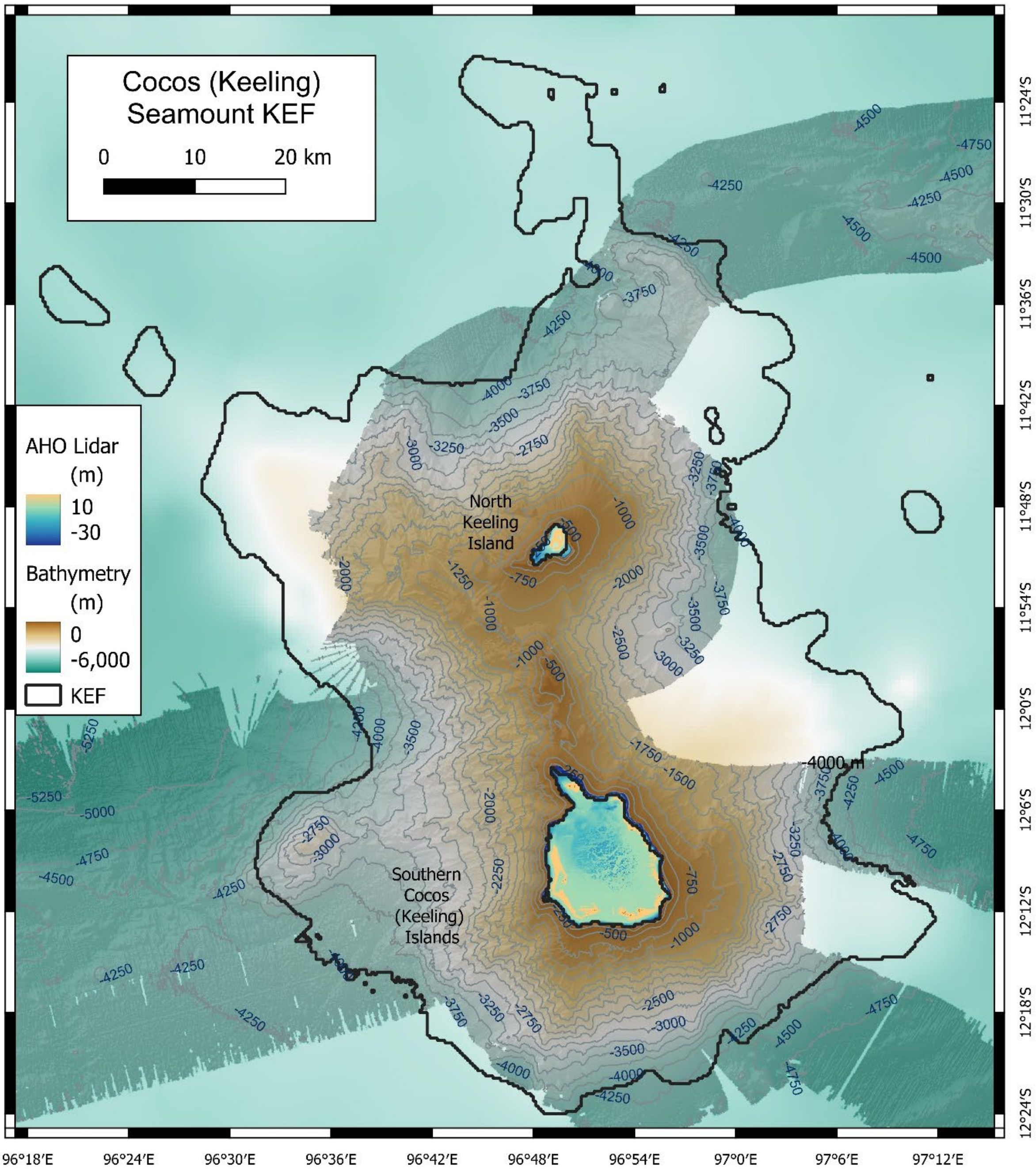


Figure 2.2. Topology of the proposed Cocos (Keeling) Seamount KEF. Darker bathymetry and contours are based on shipboard multibeam data, underlying (lighter) bathymetry is based on GEBCO 2022.

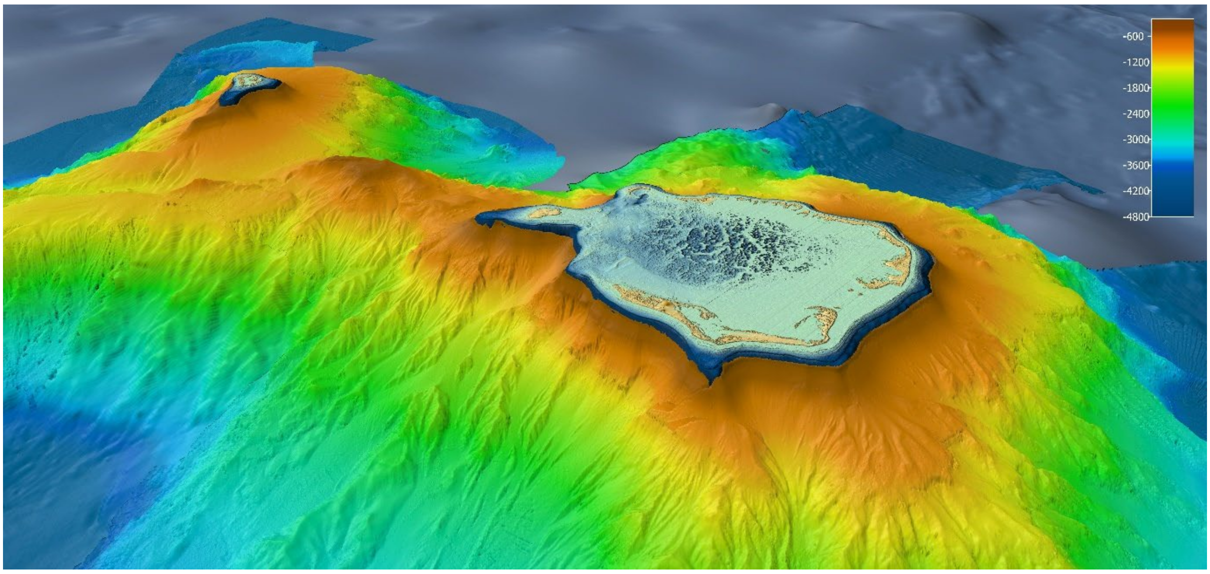


Figure 2.3. 3D representation of the Cocos (Keeling) Islands Seamount produced by CSIRO using QPS Fledermaus software and background datasets GEBCO 2022 (grey) and AHO (LADS) Bathymetry (blue-orange).

Profile

Values

The mesophotic (30-200 m) upper bathyal (200-1000 m) depth zones on the Cocos (Keeling) seamount are very rare within the Cocos (Keeling) Islands Territory and Exclusive Economic Zone, otherwise occurring only on the Muirfield and 'Green Eye' seamounts. The mid bathyal (1000-2000 m) depth zone is also very rare within this region (<2041 km^2) [2] and the lower bathyal (2000-2500 m) depth zone is also very limited. Similar to the shallow water community, the faunal composition on the seamount flanks is likely to be unique within the Australian marine domain due to the unusual biogeography of the area.

National and/or regional importance

The Cocos (Keeling) Islands seamount is of national importance for biodiversity and endemism.

Location

The seamount underlying the Cocos (Keeling) Islands lies between 96.5 to 97.2˚E, 11.5 to 12.4˚S.

Description

The main South Keeling Island group has five main islands arranged in a circular atoll: West, Horsburgh, Direction, Home and South islands, as well as several other smaller islands. North Keeling is a single C-shaped atoll. North and South Keeling are linked by a submarine ridge summiting at approximately 350 m water depth (Fig. 2.2). The Cocos (Keeling) Islands sit on top of a huge seamount with a base diameter of ~70 km. The volcanic core of the seamount is 41.5–23.3 Ma [4]. It is capped by 1500 m of limestone. On the islands, there is porous Pleistocene limestone (130-111 ka) [15] at depth of 8–13 m that is overlain by biogenic mud and sand deposits [16]. A mantle plume at latitude 17˚S [17] has potentially reduced the subsidence rate of the seamount, allowing continuing limestone formation to keep the island at sea-level. The atolls appear to be in an advanced stage of erosion and the hard-rock sampling in this area have not shown any signs of recent volcanism [3].

The fauna below 30 m depth is under-sampled and largely unknown. Species of demersal fish recorded from 60-300 m around Cocos (Keeling) Islands make up 5% of the island fish fauna [8]. This is likely to be an underestimate as only hook-and-line gear has been used to detect these fish [8]. The life history characteristics of these species make them vulnerable to overfishing and maintaining a local population may be largely dependent on self-recruitment [9].

The upper seamount habitat (30-1000 m) is likely to be a biological important area for pelagic fish, seabirds, and marine mammal species. Equally, eDNA of deep water fish species have been detected in shallow waters [18].

The biogeography of the seamount is complex. The predominant current is the westward flowing Southern Equatorial Current (SEC) that includes both Indonesian ThroughFlow water (ITW, 0-400 m) and Indonesian Intermediate Water (IIW, 500-1100 m) [12, 13]. During summer, the monsoon winds drives the surface Java Current from the NW, before it retroflexes and gets entrained by the SEC [11]. Consequently, it is expected that biological community composition would follow the pattern in shallow water (0-30 m) [8, 10] and be a mixture of species that have migrated from both the Western Pacific/Eastern Indonesia (via the Indonesian ThroughFlow) and the Indian Ocean (via the Java Current). At mid-bathyal (1000-2000 m) depths, water masses are a mixture of Antarctic Intermediate Water from the south, Indonesian Intermediate Water from the east and Indian Deep Water from the north [2, 12, 13]. Deeper water masses are likely to originate from the south [14].

The Cocos (Keeling) seamount community is likely to differ from those at similar depths around Christmas Island and on the Muirfield seamount due to differences in the proximity of other landmasses (especially Indonesia), net primary productivity of the seawater, environmental history and migration history, and will likely result in unique biological assemblages on each of these features. Moreover, the upper 500 m of benthic habitat on Muirfield differ in being on a seamount summit rather than the seamount flank habitat on Cocos (Keeling).

3. Proposed Muirfield Seamount KEF

Maps and Images

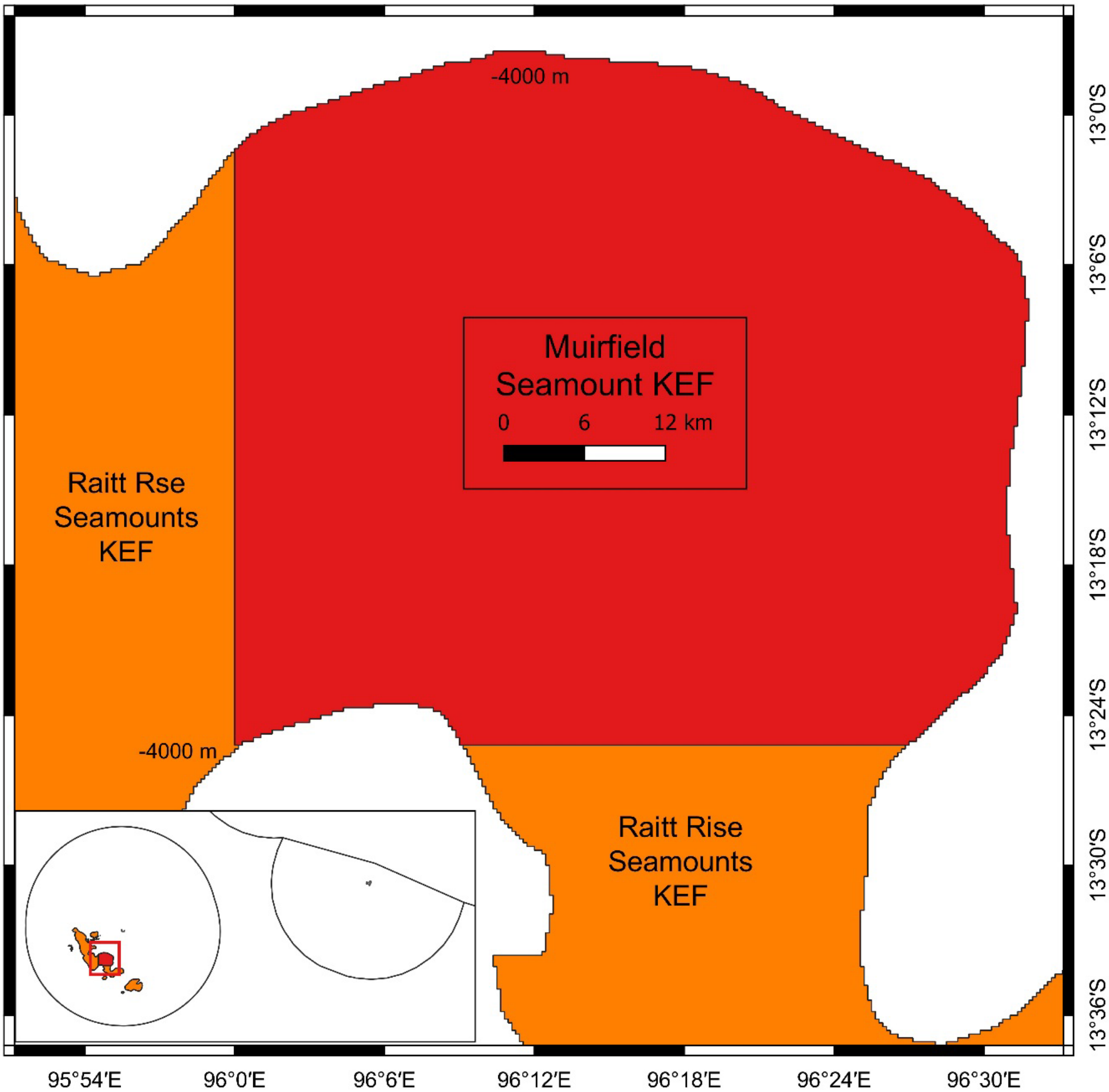


Figure 3.1. Spatial extent of proposed Muirfield Seamount KEF. Bathymetry (4000 m) is derived from the AusSeaBed dataset (2021).

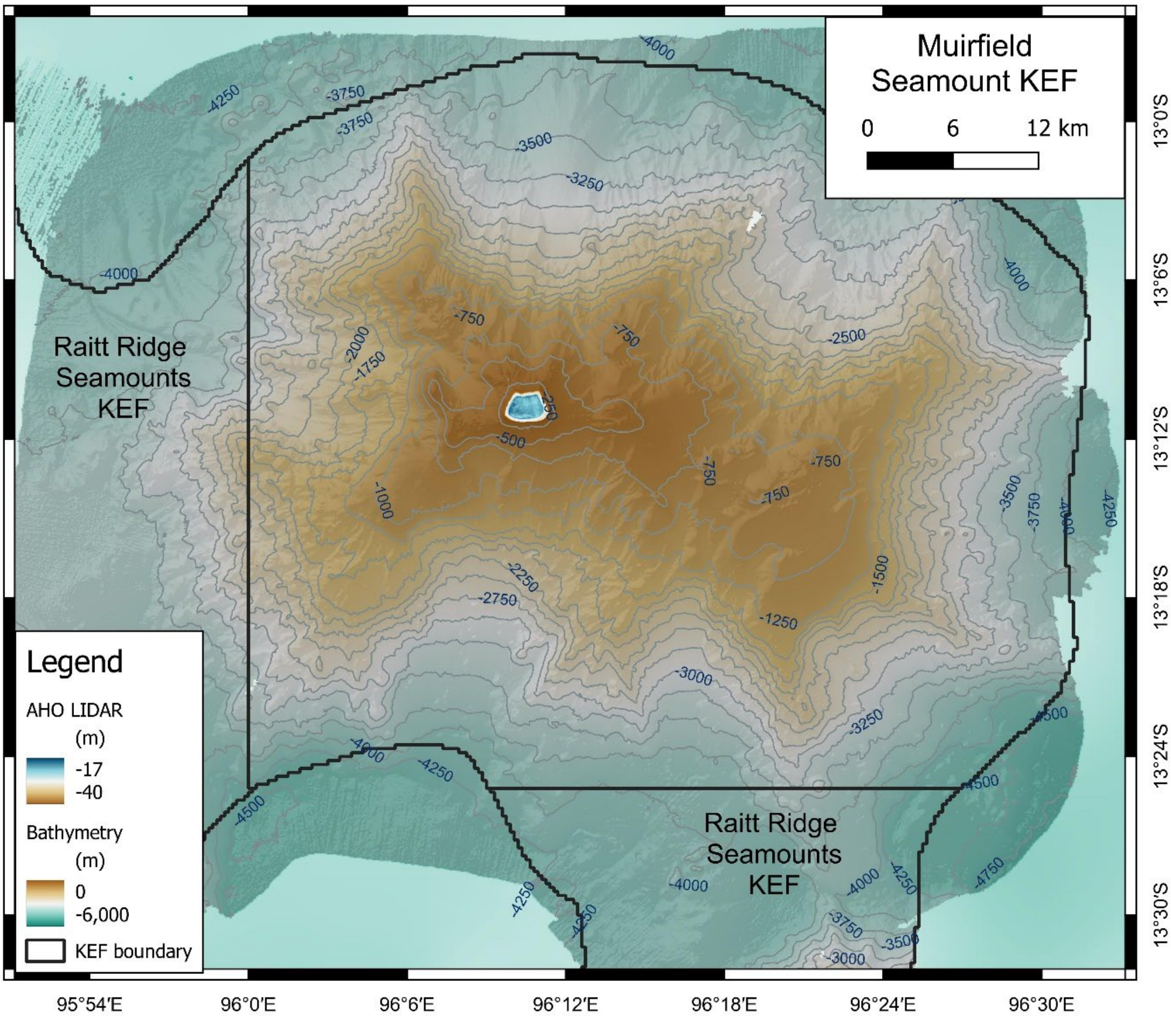


Figure 3.2. Topology of the proposed Muirfield Seamount KEF. Bathymetry and contours derived from RV Investigator survey IN2022_V08 and an AHO LADS LIDAR survey (2012).

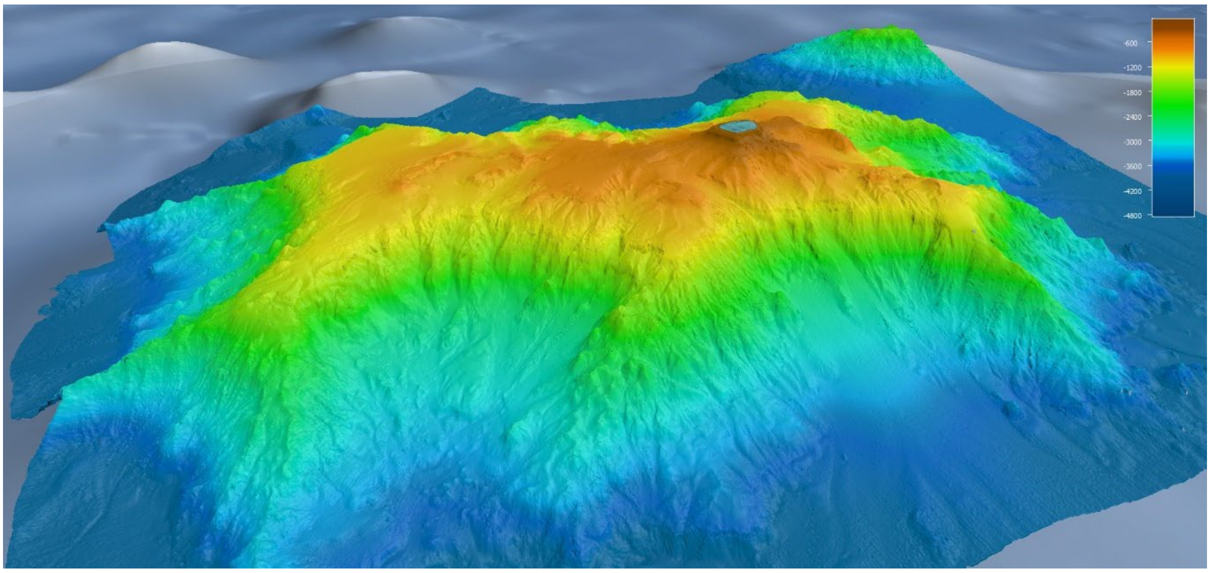


Figure 3.3. 3D representation of the Muirfield Seamount produced by CSIRO using QPS Fledermaus software and background datasets GEBCO 2022 (grey) and AHO (LADS) Bathymetry (blue).

Profile

Values

Muirfield is the shallowest seamount in Australia's Indian Ocean Territories, with its summit lying approximately 16 m below sea-level. It is the only seamount, and one of only three features in the territories, that have seafloor habitat between 30 and 400 m depth, the other two being around the Islands of Christmas and Cocos (Keeling). It is one of the tallest seamounts in Australian waters, rising more than 4000 m from the abyssal plain.

The biological community is likely to be of international significance due to its height and location. Large shallow-water seamounts are rare in the eastern Indian Ocean, the nearest being over 1900 km to the South-East, located south of the Ninety-East Ridge. The biogeography of the seamount communities is likely to be complex, with shallow (0-1100 m) water masses arriving from the East and North-West and deeper water from the South. The isolated communities on Muirfield are likely to be different from that around Cocos (Keeling) and Christmas Islands due to separate migration and environmental histories.

National and/or regional importance

Muirfield seamount is of national importance for biodiversity and endemism.

Location

Muirfield Seamount is approximately 130 km SW of Cocos (Keeling) Islands in the Australian Exclusive Economic Zone. The approximate location and extent of this feature down to the start of the abyssal plain (4000 m) is between 96.00 and 96.50˚E, 13.00 to 13.42˚S (Fig. 3.1).

Description

The Muirfield seamount is named after a British commercial vessel that struck the summit in 1973 sustaining damage to the hull [19]. Lidar data obtained by the Australian Hydrographic Office has recorded depths as shallow as 17 m (Fig. 3.2). The Investigator voyage IN2022_V08 mapped the bathymetry of the entire seamount (Fig. 3.2).

Muirfield is approximately 46.7 to 40.2 Ma in age [6]. It does not have a guyot-type plateau but instead rises to a small cylindrical peak that appears to be a drowned atoll, with the rim of this feature being slightly elevated from the centre. The shallow nature of the seamount could be due to a topographic rise produced by the presence of a seismically imaged plume near the Cocos (Keeling) Islands [4]. Williams et al [19] hypothesised that the visible presence of volcanic rock underneath a thin layer of coral on the summit is indicative of Muirfield being a relatively young seamount, however there is no evidence that Muirfield is volcanically active.

The Franklin expedition recorded sparse reef building corals above 25 m on the western summit and a band of gorgonian corals at 70 m [19]. Otherwise, benthic habitats consisted of patches of coarse sand, volcanic debris, and bare rock, the latter supporting sparse encrusting invertebrates and sea urchins [19]. A strong downward current produces asymmetrical sand ripples at 500-800 m. Sand habitat near the seamount summit shows evidence of wave scour [19].

The predominant current is the westward flowing Southern Equatorial Current (SEC) that includes both Indonesian ThroughFlow water (ITW, 0-400 m) and Indonesian Intermediate Water (IIW, 500-

1100 m) [12, 13]. During summer, the monsoon winds drives the surface Java Current from the NW, before it retroflexes and gets entrained by the SEC [11]. Consequently, it is expected that biological community composition for upper habitats (16-1100 m) would follow the pattern shown by shallow (0-30 m) water communities of Christmas and Cocos (Keeling) Islands [8, 10] and be a mixture of species that have migrated from both the Western Pacific/Eastern Indonesia (via the Indonesian ThroughFlow) and the Indian Ocean (via the Java Current). However, the biogeographic and environmental history of Cocos and Christmas islands have led to distinct biological communities [9], and the communities of Muirfield are also likely to be distinct.

Biological communities at lower depths are also likely to be a complex mixture of faunas based on the water masses present. Mid-bathyal (1100-2000 m) water masses in this region are an interacting mixture of southern (Antarctic Intermediate Water), northern (Central Indian Water) and eastern (Indonesian Intermediate Water) flows [2]. The main water mass at lower bathyal depths (1800-4000 m) is Indian Deep Water, which is an extension of North Atlantic Deep Water mixed with upwelled Antarctic Bottom Water [14]. Antarctic Bottom Water flows slowly from the south across the abyssal seafloor (<4000 m) [14].

The biological community is likely to be of international significance due to its height and location. Large shallow (summit <200 m) seamounts are rare in the eastern Indian Ocean, the nearest being over 1900 km to the South-East, located south of the Ninety-East Ridge.

4. Proposed Golden Bo-sunbird Seamounts KEF

Maps and Images

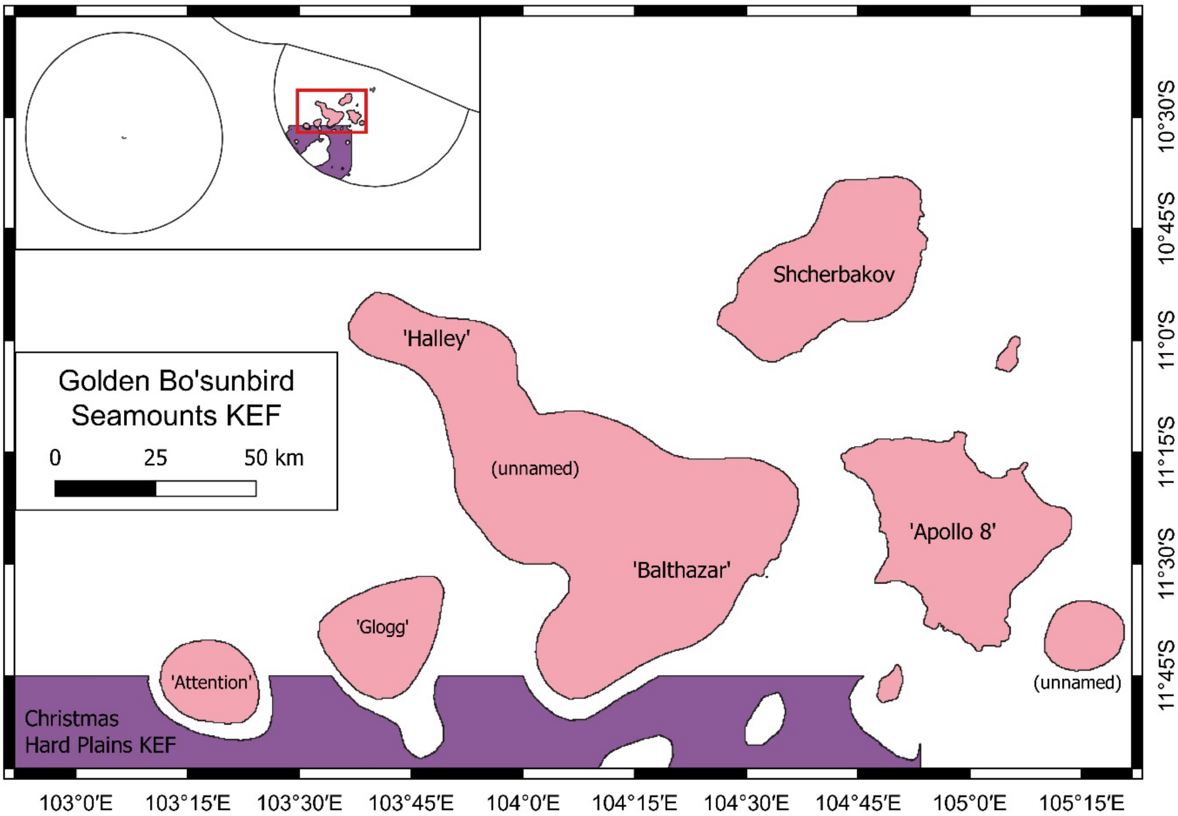


Figure 4.1. Spatial extent of the proposed Golden Bo'sunbird Seamounts KEF. Bathymetric contours (4000 m) derived from the AusSeaBed dataset (2021).

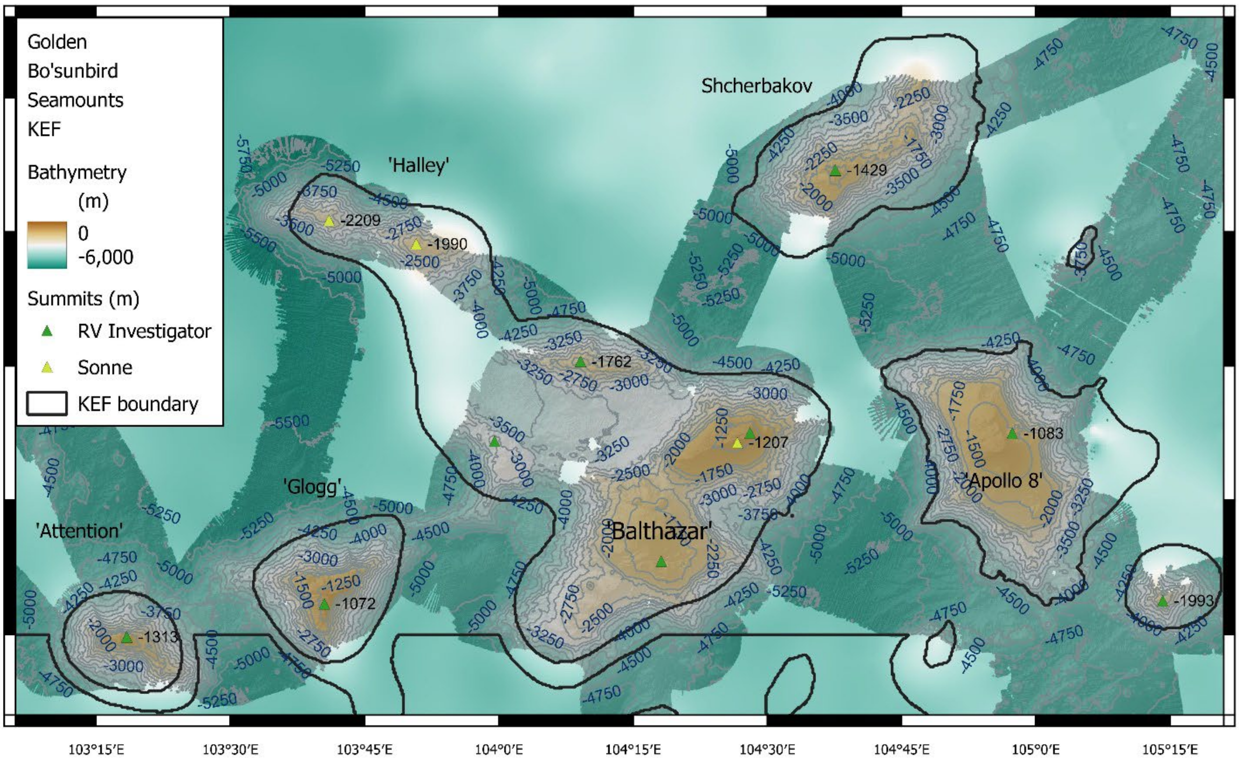


Figure 4.2. Topology of the proposed Golden Bo'sunbird Seamounts KEF from multibeam bathymetry (darker colours) with GEBCO 2022 bathymetry as background (lighter colours). Seamount summit depths from Investigator and Sonne multibeam datasets.

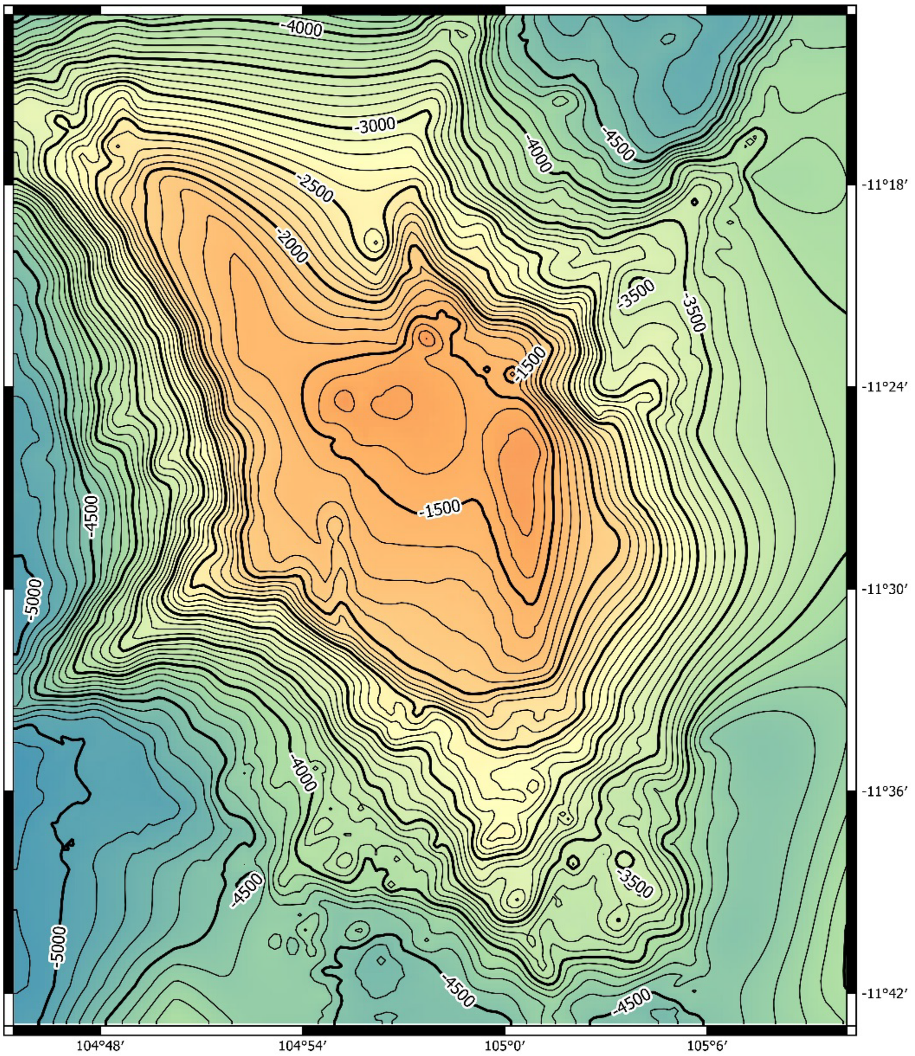


Figure 4.3. Estimated bathymetric contours around 'Apollo 8' Seamount from AusSeaBed showing a broad convex summit (1300-2000 m) and steep flanks.

Profile

Values

Mid-bathyal (1000-2000 m) benthic/demersal habitat on seamount summits contain rare eastern Indian Ocean benthic habitat at these depths. Preliminary surveys on the Shcherbakov and 'Balthazar' seamounts indicate that this habitat supports diverse cold-water coral and sponge communities – which are recognised elsewhere as vulnerable marine ecosystems by international fishery managers (see http://www.fao.org/3/i5952e/i5952e.pdf).

The biological community is likely to be unique within the Australian marine domain due to its complex biogeography. Mid-bathyal water masses in this region are an interacting mixture of southern (Antarctic Intermediate Water), northern (Central Indian Water) and eastern (Indonesian Intermediate Water) flows. Each seamount within the Golden Bo'sunbird cluster possibly supports a distinct community based on its migration and environmental history.

National and/or regional importance

The Golden Bo'sunbird seamount cluster is of national importance for biodiversity and endemism.

Location

The Golden Bo'sunbird seamount cluster is located SW of Christmas Island between 103.1 to 105.35˚E and 11.9 to 10.6˚S.

Description

A cluster of seven seamounts that summit between 1000 and 2000 m are located SW of Christmas Island. These include the Shcherbakov seamount (often misspelt as Sherbakov or Scherbakov) which was discovered and named by a Russian expedition in 1961, and is officially named in international gazetteers (e.g. GEBCO, Marine Regions). Another five seamounts were unofficially named by the Sonne SO199 expedition, including ‘Apollo 8’, ‘Balthazar’, ‘Glogg’, ‘Attention’, and ‘Halley’. A smaller seventh seamount to the NW of ‘Balthazar’ is unnamed. These are collectively referred to here as the Golden Bo’sunbird seamount cluster, although this is an expansion from the geographic extent shown in the GEBCO Gazetteer entry (https://www.ngdc.noaa.gov/gazetteer/), which excludes Shcherbakov and ‘Halley’. This cluster name (after the local name for the endemic Christmas Island subspecies of the White-tailed tropic bird) was proposed in 1994 before modern maps of the area were available. Recent bathymetric data do not support a geomorphological division between southern (‘Apollo 8’, ‘Balthazar’, ‘Glogg’, ‘Attention’) and northern (Shcherbakov, ‘Halley’ and unnamed) seamounts in this area.

These seamounts are shallower than most of the others that occur in Australia’s Indian Ocean Territories. At least some of them are being lifted by a bulge in the underlying seafloor as it gets subducted into the Java Trench, similar to Christmas Island [4].

Shcherbakov is estimated to be 87.6 to 86.0 Ma old [6] and last rose above seal-level 80 to 76 Ma [4]. The seamount rises relatively steeply from 5,000 m to less than 1,500 m over a distance of approximately 10 km at its southern flank while it takes almost 60 km for the same drop in elevation at the NE side [3]. The plateau top has a relatively flat topography and orientated ENE-WSW, however, it is uncertain whether the plateau formed through wave erosion [3]. Limestones at 2000-2200 m have a shallow reef origin, laid down during the Eocene to Oligocene, and now overlain with a manganese crust (Bezrukov 1973 cited in [20]).

‘Apollo 8’ (named after the first manned moon mission) is a guyot-type seamount with a western flank that rises from 5,000 to at least 2,000 m where a flat top region appears to have developed. The seamount base is estimated to be 81-85 Ma in age [6] and the last age of exposure of ‘Apollo 8’ above sea-level is estimated to be 21-28 Ma [4]. The only limestones retrieved from this seamount summit have been of pelagic origin of Quaternary age [21].

‘Balthazar’ Seamount complex consists of two large SW-NE orientated dome-shaped features that rises from 6000 to less than 1500 m on the SE feature and 1200 m on the NW one. The seamount is capped by limestones of Maastrichian (shallow water origin) to Pliocene (pelagic origin) in age [21].

The base of ‘Glögg’ is estimated to be 64-65 Ma [6] and the last age of exposure to be 40-43 Ma [4]. ‘Glögg’ has an triangle shaped base with an approximately east-west orientation [3]. ‘Attention’ rises from 5,000 m to less than 2,500 m and has a roughly ridge shape with a long axis of ~40 km in a WNW-ESE orientation [3]. A small oval shaped plateau (8 x 3 km) with an irregular surface topography is developed along its top. The bathymetry does not provide unequivocal evidence for emergence of this volcano above sea level [4]. The summit limestones originated in the Eocene from a shallow water environment and Paleocene to Eocene from a pelagic origin [21].

‘Halley’ is a large WNW-ESE orientated oval shaped seamount with both western and eastern summits (at 2000-2200 m) that are connected by small ridge at 4500 m. Their summits are relatively flat and contain cones of probable volcanic origin along the plateau edges [3].

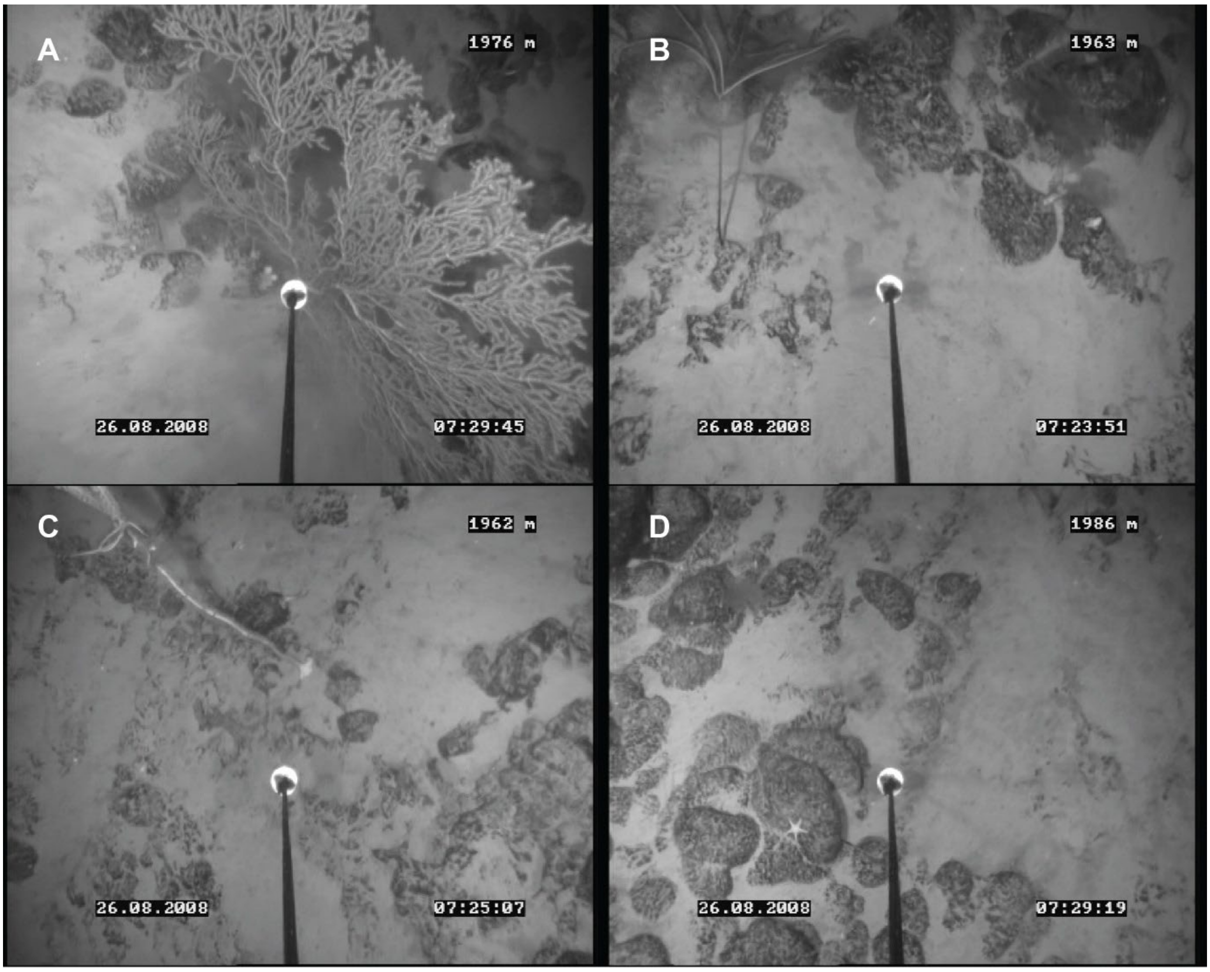


Figure 4.4. Video stills of a small volcanic cone on the NE flank of 'Balthazar' seamount in 1900-2000 m depth taken by the Sonne SO199 expedition (courtesy of Carsten Lüter, Berlin Museum of Natural History). A) Gorgonian coral, B) stalked crinoid, C) coral with epizoic brittle-star, D) seastar.

Rocky substrates between 1000 and 2000 m are known to be covered in a manganese crust [20] that can alter benthic community composition [22, 23]. Rock substrata on the flanks of some seamounts in the Golden Bo'sunbird chain have been recorded as supporting coral, sponge and crinoid dominated communities (Fig. 4.5). Similar communities elsewhere in the world's oceans have been designated as Vulnerable Marine Ecosystems (VMEs) to be avoided by the demersal trawlers. Such communities have been imaged on the seamounts Shcherbakov and 'Balthazar' [3], but are also likely to occur on the other seamounts in this cluster. At Shcherbakov, the Sonne expedition observed the widespread swimming holothurian *Enypniastes eximia* at ~1800 m depth [3].

The cluster's summits at depths of 1000-2000 m will be influenced by currents that flow from the south as well as the north and east [2], and potentially have a unique biogeographic mix of tropical and subtropical Indian Ocean species. Seamounts also potentially play an important role in surrounding pelagic ecosystems. They frequently deflect currents over and around them, and assist the mixing of water masses and vertical transport of nutrients [24].

These seamounts are located in a relatively productive region of the IOT close to the Indonesian continental margin. The richness and abundance of seamount communities are dependent on resources descending from productive surface waters, in the form of carcases, faeces, organic detritus, and vertically migrating plankton. The community composition of the Golden Bo'sunbird chain can be expected to differ from those in less productive areas, such as the Cocos Island EEZ.

The dynamics of the demersal fish populations at this seamount cluster are unknown, but similar seamounts elsewhere act as important spawning sites.

5. Proposed Raitt Rise seamounts KEF

Maps and Images

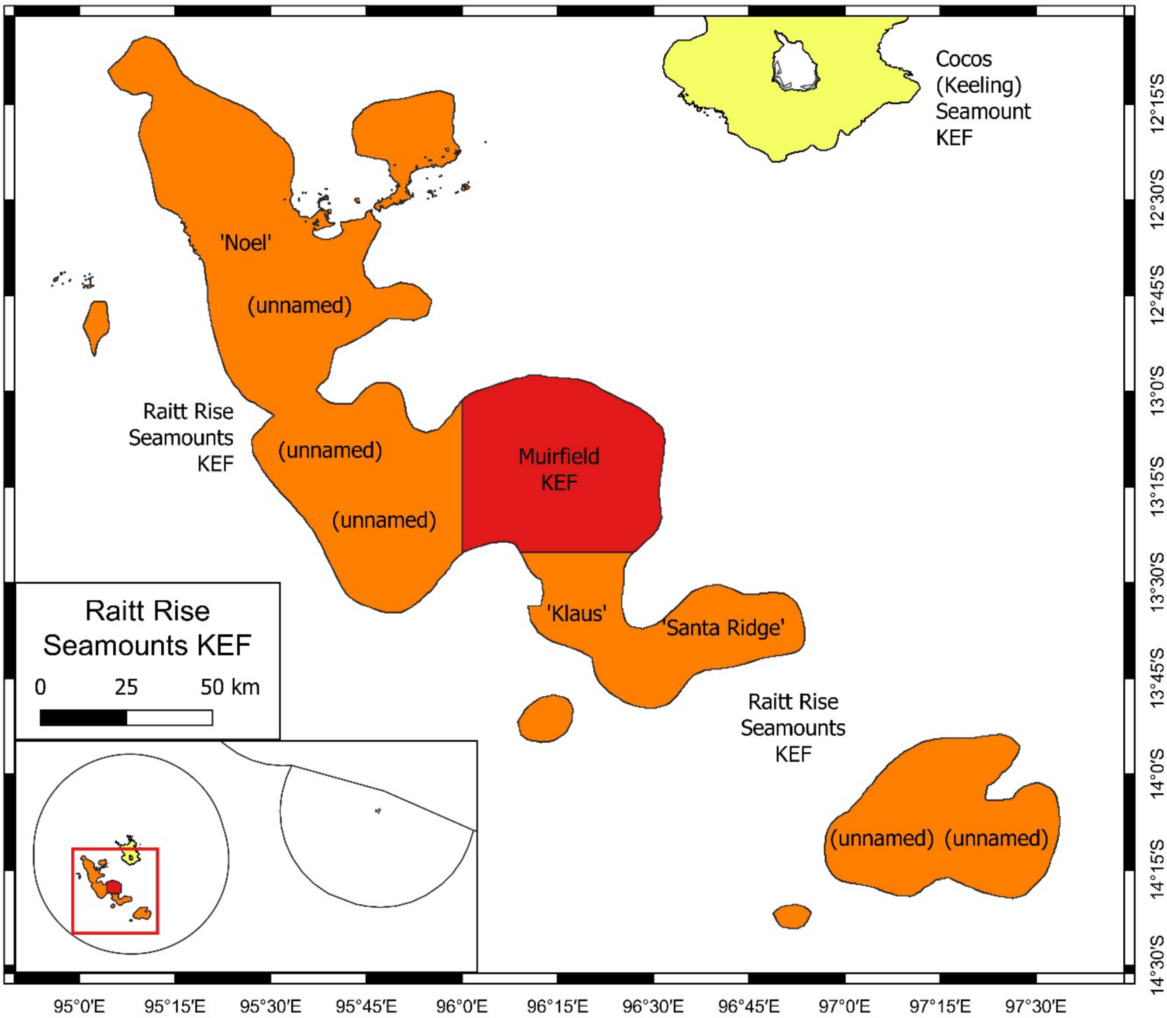


Figure 5.1. Spatial extent of the proposed Raitt Rise Seamounts KEF. Depth contour (4000 m) derived from the AusSeaBed dataset (2021).

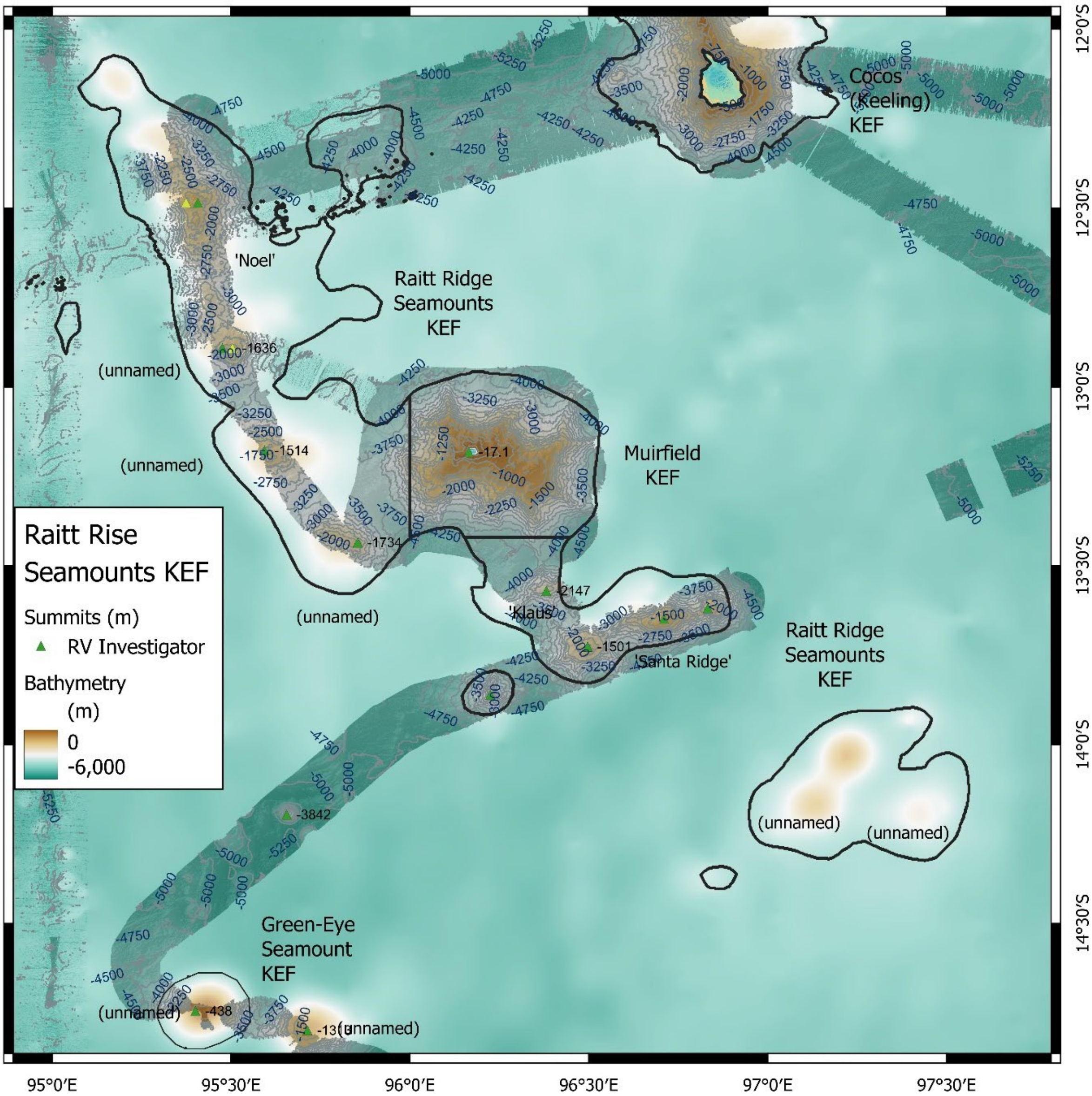


Figure 5.2. Topology of the proposed Raitt Rise Seamounts KEF and surrounding areas derived from multibeam (darker colours) and GEBCO 2022 bathymetry (lighter). Seamount summit depths from available multibeam coverage are also indicated.

Profile

Values

Mid-bathyal (1000-2000 m) benthic/demersal habitat on seamount summits form only a small percentage of the Indian Ocean EEZs [2]. The biological communities are likely to be distinct from other seamount clusters in this region (e.g. the Golden Bo'sunbird Seamount cluster) due to the presence of different water masses and the reduced net primary productivity of surface waters that occurs to the SW of the Cocos (Keeling) Islands.

National and/or regional importance

The Raitt Rise seamount chain is of regional importance for biodiversity and endemism.

Location

The Raitt Rise seamount chain is located in an arc to the SW and south of the Cocos (Keeling) Islands between 95.045 to 97.73˚E and 12.07 to 14.65˚S.

Description

The Raitt Rise was discovered by the U.S. research vessels "Argo" and "Horizon" in 1962 and named in 1993 after a famous ocean seismologist. Satellite gravity data suggest that there is at least 10 seamounts in a NW to SE series that lie to the SW of the Cocos (Keeling) Islands. One of these is very shallow (Muirfield, summiting at 16m) and has been described as a separate KEF above.

Only a few of the remaining 9 seamounts have a name or other associated data. The seamount 'Noel' was informally named by the Sonne 2009 expedition. It is orientated in a NNW-SSE direction with a guyot-type summit [4] indicative of having been flattened by wave energy at the sea surface during its formation. It also has numerous small volcanic cones along its flanks and ridge crest indicating a later phase of volcanism [3]. The seamount base is estimated to be 47 Ma [6] and the estimated the last age of exposure to be 28-31 Ma [4]. 'Klaus' is a small Seamount that lies just to the north of the 60 km long ESE-WSW orientated 'Santa' Ridge complex (see below). Nothing is known about several other peaks along the Rise that have not been mapped as yet.

The seamount summits at depths of 1000-2000 m will be influenced by currents that flow from the south as well as the north and east [2], and potentially have a unique biogeographic mix of tropical and subtropical Indian Ocean species.

The richness and abundance of seamount communities are dependent on resources descending from productive surface waters, in the form of carcases, faeces, organic detritus, and vertically migrating plankton. Annual net primary productivity (NPP) varies in a gradient from a high to the NE of the Christmas Is EEZ (nearest to the Indonesian continental margin) to a low to the SW of Cocos (Keeling). It can be expected that the seamount communities on the Raitt Rise will differ from those associated with more productive waters along the Golden Bo'sunbird seamount chain.

The dynamics of the demersal fish populations on Raitt Rise are unknown, but similar seamounts elsewhere can act as important spawning sites.

6. Proposed Investigator Ridge KEF

Maps and Images

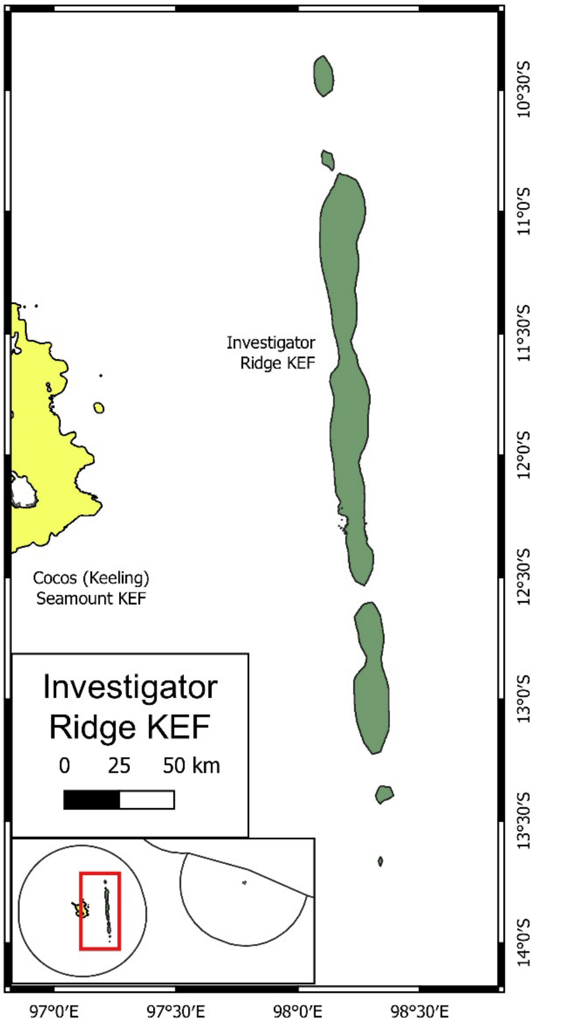


Figure 6.1. Spatial extent of the proposed Investigator Ridge KEF. Depth contour (4000 m) derived from the AusSeaBed dataset (2021).

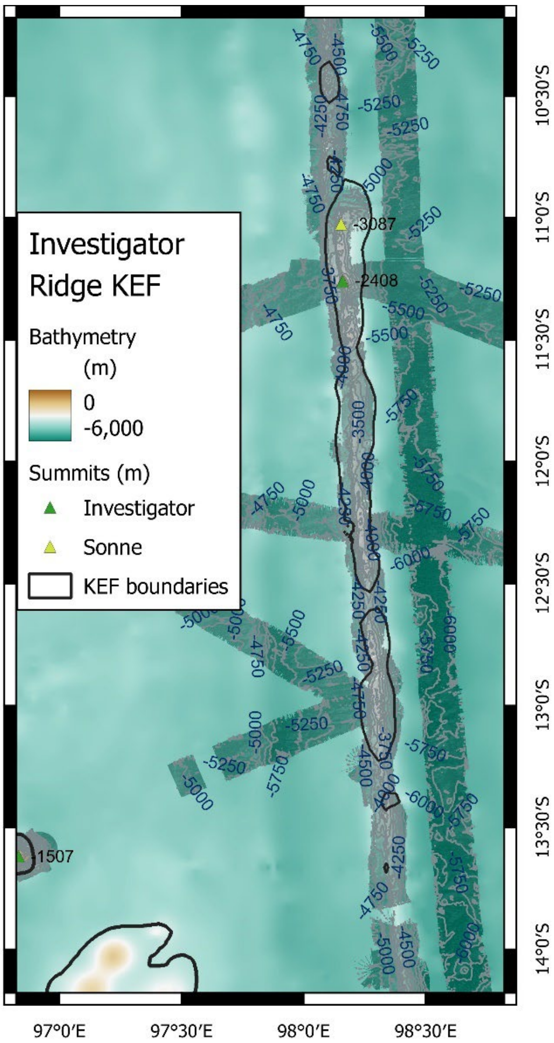


Figure 6.2. Topology of the proposed Investigator Ridge KEF derived from multibeam (darker colours) and GEBCO 2022 dataset (ligher). Ridge peaks from available multibeam coverage are also indicated.

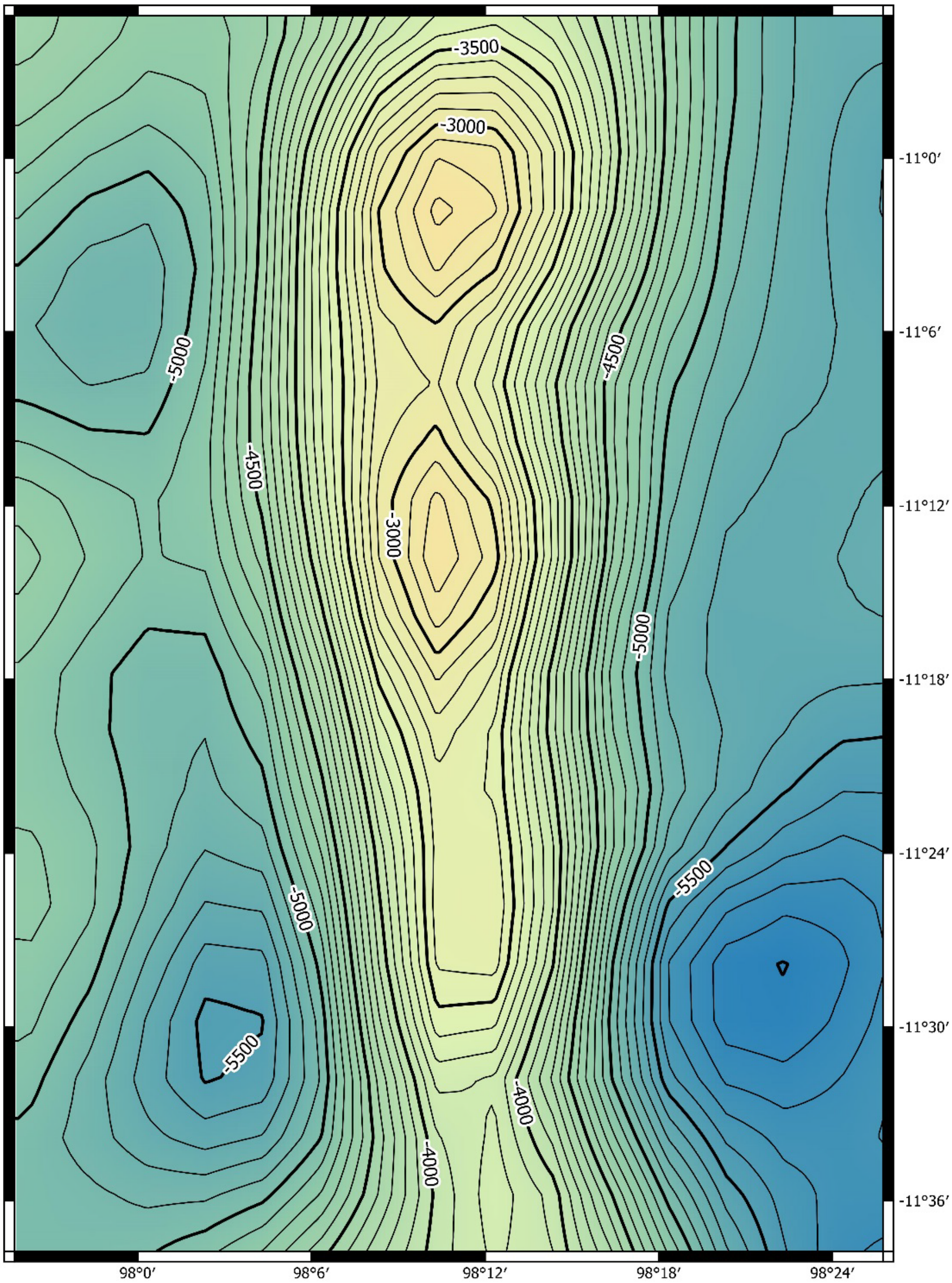


Figure 6.3. Estimated bathymetric contours around the shallowest section of the Investigator Ridge in Australian waters showing the steep flanks and two elongate peaks at 2700 m.

Profile

Values

The flanks and summits along the Investigator Ridge are likely to support large areas of rocky substrata that is otherwise rare in the Indian Ocean Territories between 2,500 and 4,000 m. This habitat would support a specialised epifauna that is adapted to living on bare rock surfaces.

National and/or regional importance

The central Investigator Ridge is of regional importance for biodiversity and endemism.

Location

A shallow section of the Investigator Ridge (summiting at 2,408 m) occurs to the east of Cocos (Keeling) Islands between 97.9.1 to 98.6˚E and 9.9 to 13.8˚S.

Description

The Investigator Ridge is a ~1,800 km long N-S orientated fault zone in the ocean crust of the Wharton Basin which is assumed to have formed prior to the plate tectonic reorganization of the circum-Indian area at 90 to 100 Ma. Geological measurements indicate that the younger oceanic crust to the west of the Ridge is offset by ~900 km from the older crust to the east. There is a steep west-facing scarp along most of the fracture zone, which suggests recent reactivation of a developing new plate boundary between the eastern (Australian) and the western (Indian) parts of the Indo-Australian Plate. Due to the collision of India with Asia, the western part of the Indo- Australian Plate (roughly west of the Ninety-east Ridge, a part of the Kerguelen hotspot track) cannot move northwards anymore. On the other hand, due to northward verging subduction beneath Indonesia, the eastern half of the plate with Australia continues to move northwards. The difference in movement between the two halves of the plate occurs in a diffuse zone east of the Ninety-east Ridge producing north-south aligned fracture zones in the ocean crust that have been/are being reactivated as strike-slip faults [3].

Most of the Investigator Ridge was mapped using multi-beam acoustics by the Sonne SO199 expedition [3] although no backscatter information was retained (Werner, pers. comm.). Only a ~720 km section in the centre of the Ridge is in Australian waters in the Cocos (Keeling) EEZ. The central section of this has several elongated peaks that are shallower than 3,000 m deep, the shallowest being 2,408 m at 11.26°S (Fig. 6.2). The total area of habitat between 2,000 m and 3,000 m along the Ridge in Australian waters is only 79 km^2 [2]. The Investigator Ridge forms 16% of ridge habitat across all Australian waters, both in the IOT and elsewhere [2].

The steep sides of the Ridge suggest that the seafloor is likely to be exposed rock. The likelihood of rocky substrata is increased on the western-side by relatively recent re-activation of the fault line, and on the eastern side by the likelihood of strong bottom currents that may run northward along the base of the ridge due to the Coriolis Effect. Strong earthquakes recorded from the area [3] may also regularly remove sediment from steep slopes. Seafloors between 3,000 m and 4,000 m comprise a relatively small proportion (4.81 %) of the Indian Ocean Territories and are mostly around seamounts and along the Ridge [2]. Given the ancient age of most IOT seamounts, most of the area at these depths is likely to be covered in soft sediment, and rocky seafloor is likely to be relatively rare except for along the steep sides and summits of the Ridge.

A specialised epifauna is likely to exist on exposed rock. The RV Sonne managed to take video of a diverse fauna of octocorals on the summit of the ridge [3]. The shallower peaks (< -3000 m) on the Ridge would function as elongate seamounts and support a similar fauna. Evidence from the Australian margin indicate that animals occurring at 3,000 m to 4,000 m are likely to be different from those that occur in shallower water [25], although many individual species will have relatively wide distributions at these depths [26, 27]. Many rocks from the southern end of the Ridge are covered with a thick (1-3 cm) manganese crust [3]. The presence of manganese crusts is known to alter the composition of the epifauna in the central Pacific Ocean [22, 23].

The Investigator Ridge has been proposed as a general barrier to dispersal [2]. However, most of the ridge crests irregularly in 3,500 to 4,500 m of water, so at most it would hinder only the local dispersal of the abyssal fauna.

This feature was discovered and explored by the U.S. research vessels "Argo" and "Horizon", of the Scripps Institution of Oceanography (SIO), during the International Indian Ocean Expedition (IIOE) 1960-1965. It was named after the Indian Research Commission vessel "Investigator", which explored the Bay of Bengal and northeast Indian Ocean in the 1880s to 1920s.

7. Proposed Christmas Hard Plains KEF

Maps and Images

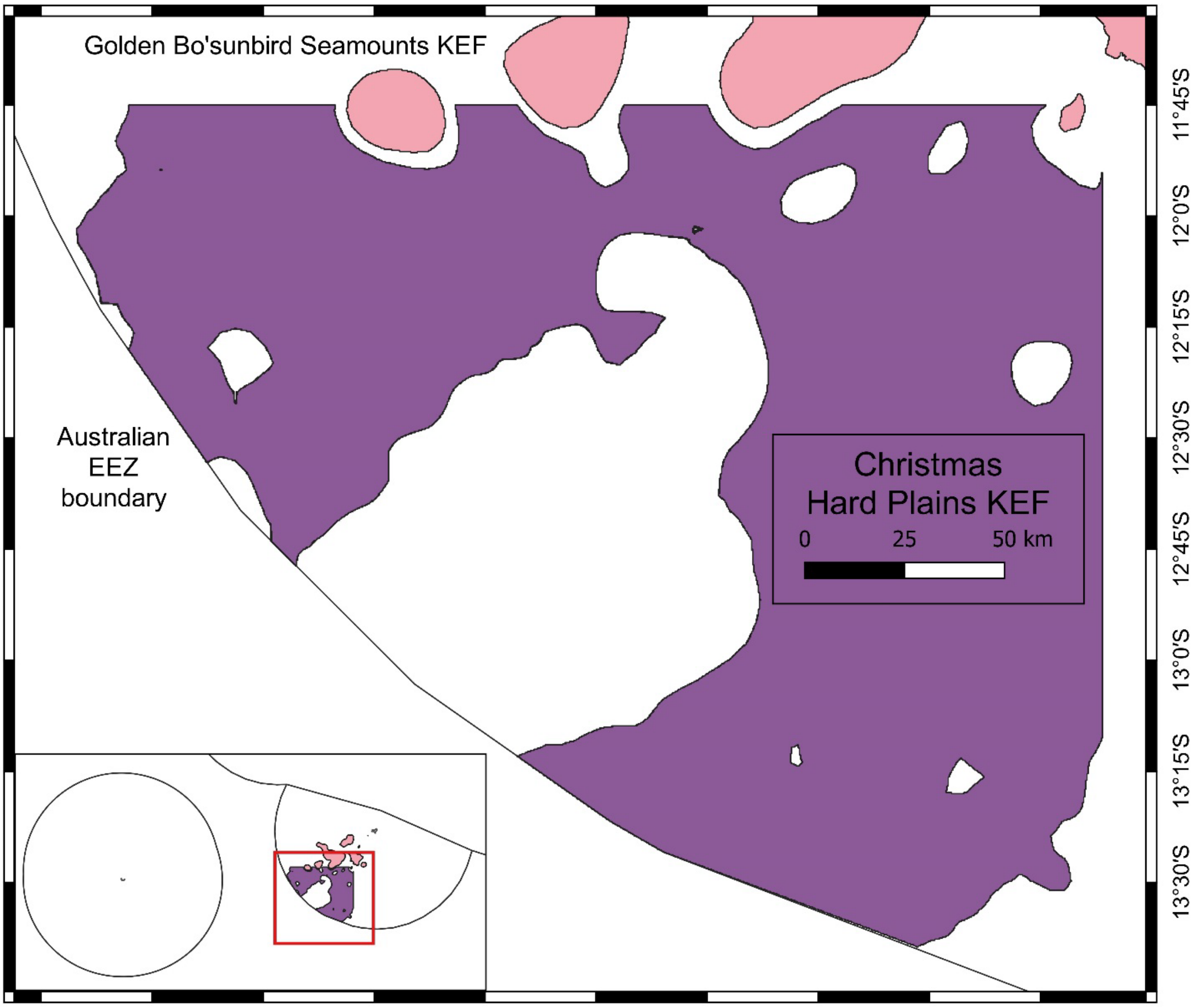


Figure 7.1. Spatial extent of the proposed Christmas Hard Plains KEF. Depth contours (4700, 5900 m) derived from the AusSeaBed dataset (2021).

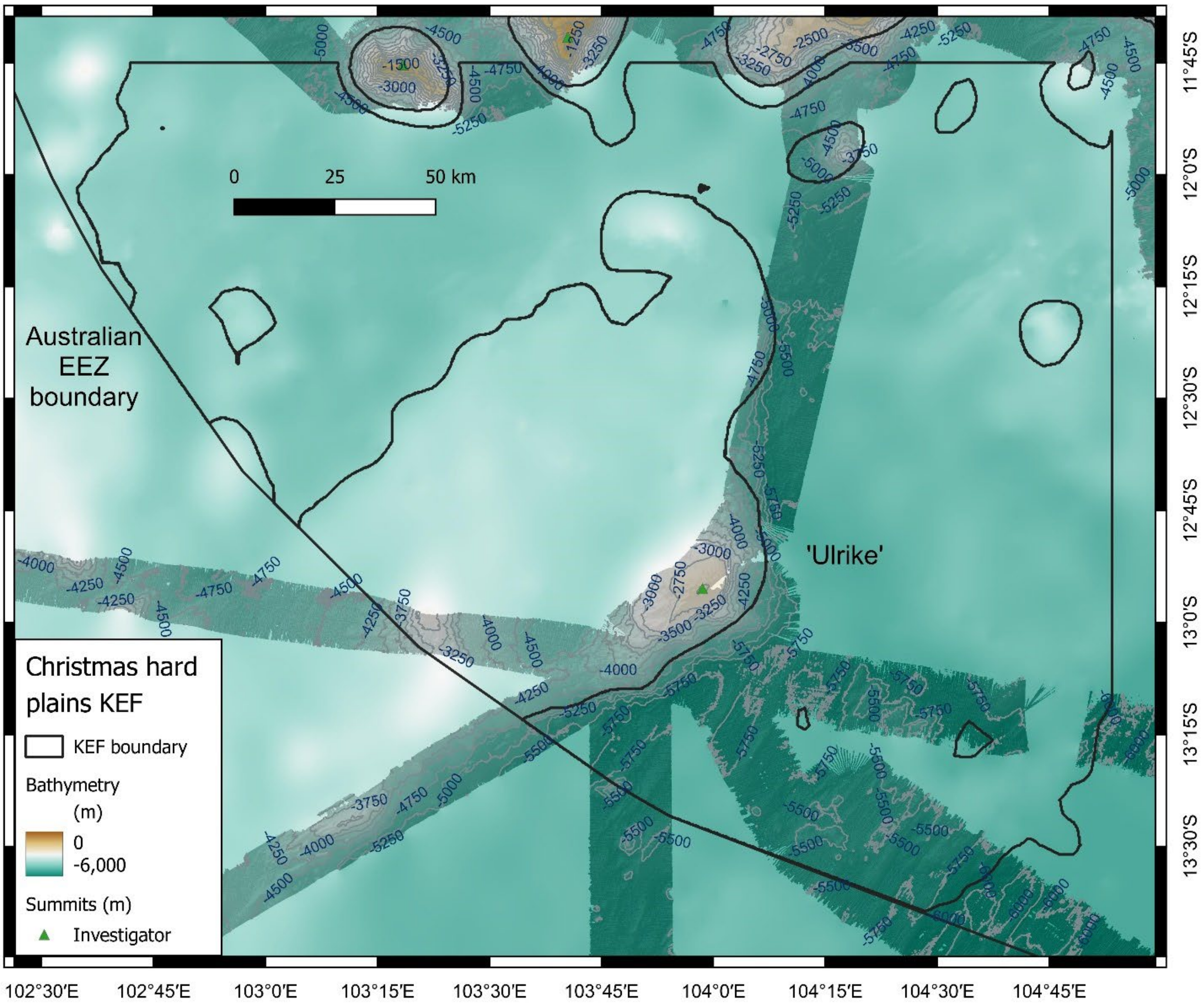


Figure 7.2. Topology of the region around the proposed Christmas hard plains KEF derived from the multibeam (darker colours) and GEBCO 2022 datasets (lighter). Seamount peaks above 3500 m from AusSeaBed and available multibeam coverage are also indicated.

Profile

Values

Manganese nodules are a scarce rocky substrate on the mostly sedimentary abyssal plain and support a distinctive specialised fauna. Within the Indian Ocean Territories, the area known to have the densest concentration of nodules lies to the SW of Christmas Island between 4,780 and 5,888 m.

National and/or regional importance

The proposed Christmas Island hard plains KEF is of regional importance for biodiversity and endemism.

Location

The dense quantities of manganese nodules have been reported from SW of Christmas Island between 103.0 to 104.2˚E and 12.65 to 11.75˚S (Fig. 7.1).

Description

Manganese nodules are known to occur on the surface of siliceous clays (4780-5888 m) to the south-west of Christmas Island in areas between seamounts [20]. The nodules occur on siliceous sediments as they form beneath the lysocline (3,800 m deep) in water that dissolves particles of calcareous origin. Ash from Indonesian volcanos may inhibit their formation further north [20]. Nodules form very slowly on the seafloor from a number of geochemical processes. Nodules influence the composition of the benthos as they provide hard substratum on a mainly sedimentary seafloor. The density of nodules will also affect community composition and biomass [28].

Only a small part of the Indian Ocean Territories has been surveyed for manganese nodules [20] and future studies may find that dense deposits also occur in other areas. Manganese nodules have also been recorded from the SW of Western Australia [20] and in the Tasman Sea [29].

The water mass on the abyssal seafloor is the cold, well-oxygenated Antarctic Bottom Water that originates off Antarctica [14].

The proposed KEF's spatial extent also includes the 'Ulrike' seamount, named by the SO199 expedition [3]. This seamount has the appearance of a tilted crustal block, rising from 5,800 m to a sloped plateau between 2,000 and 2,600 m deep [3]. It is feasible that 'Ulrike' has formed from either an uplifted crustal block or from secondary volcanism associated with the fault zone to the southwest [3]. A rock from the SW flank of the seamount was aged at 75.9 Ma [6]. The limestones from the summit contain shallow water Cretaceous fossils [21], suggesting that the seamount was emergent at one time.

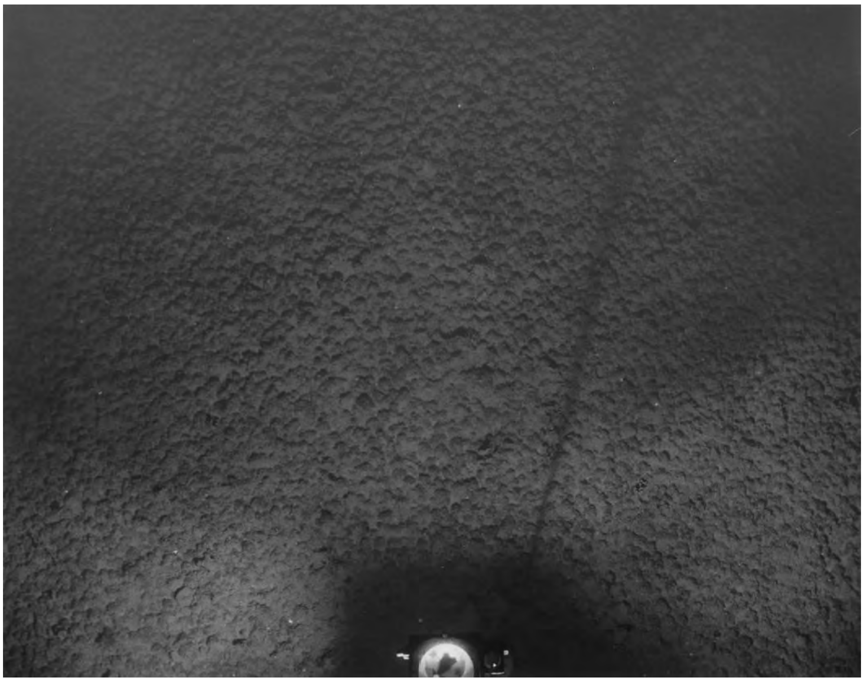


Figure 7.3. Photograph of manganese nodules from Vema station VM33-005 to the south of Christmas Island. The photo is recorded to be from 2,982 m [2], however, seafloors at the recorded location are much deeper (5,633 m).

8. Proposed Christmas Hadal KEF

Maps and Images

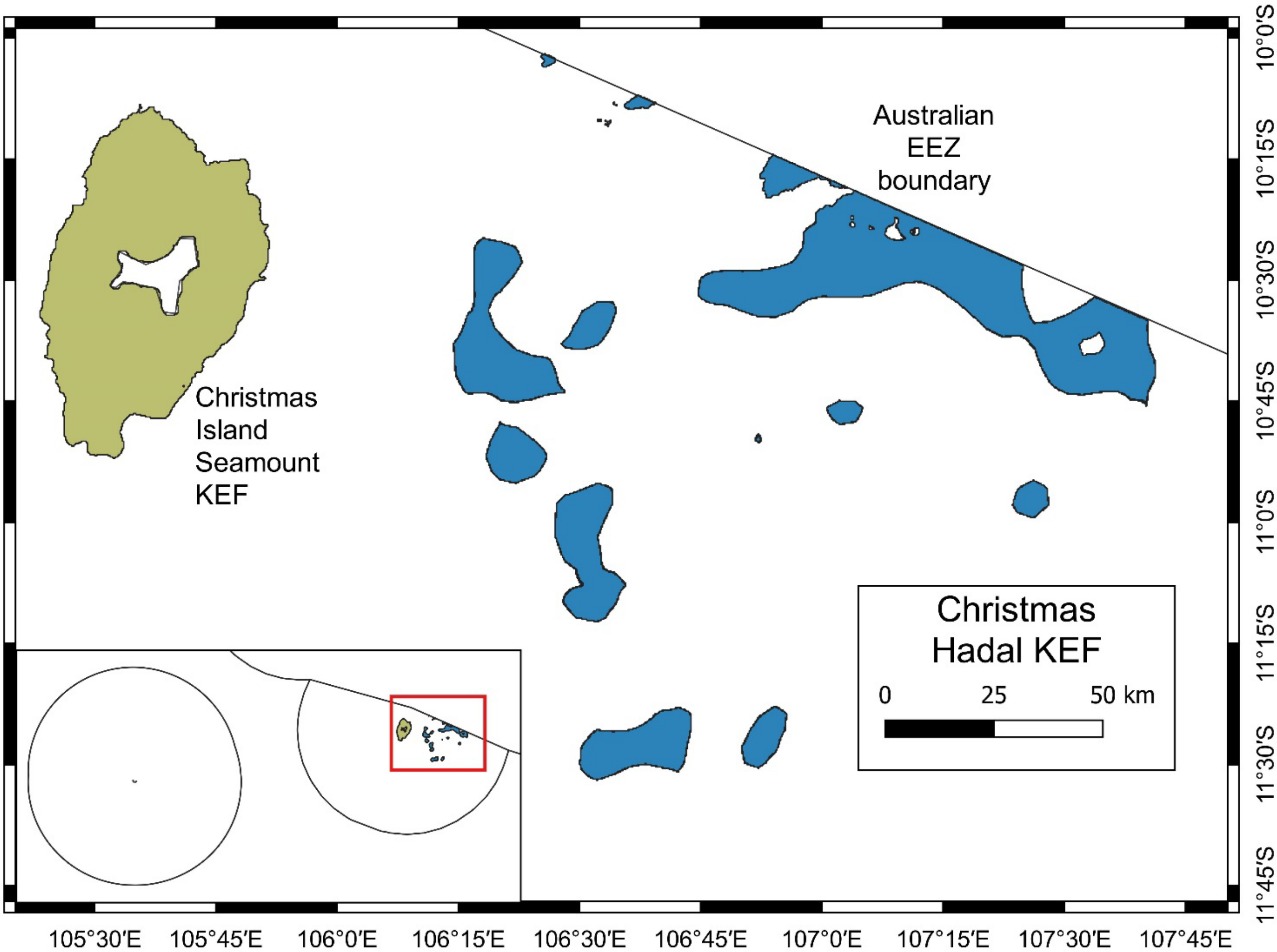


Figure 8.1. Spatial extent of the proposed Christmas Hadal KEF. Depth contour (6000 m) derived from the AusSeaBed dataset (2021).

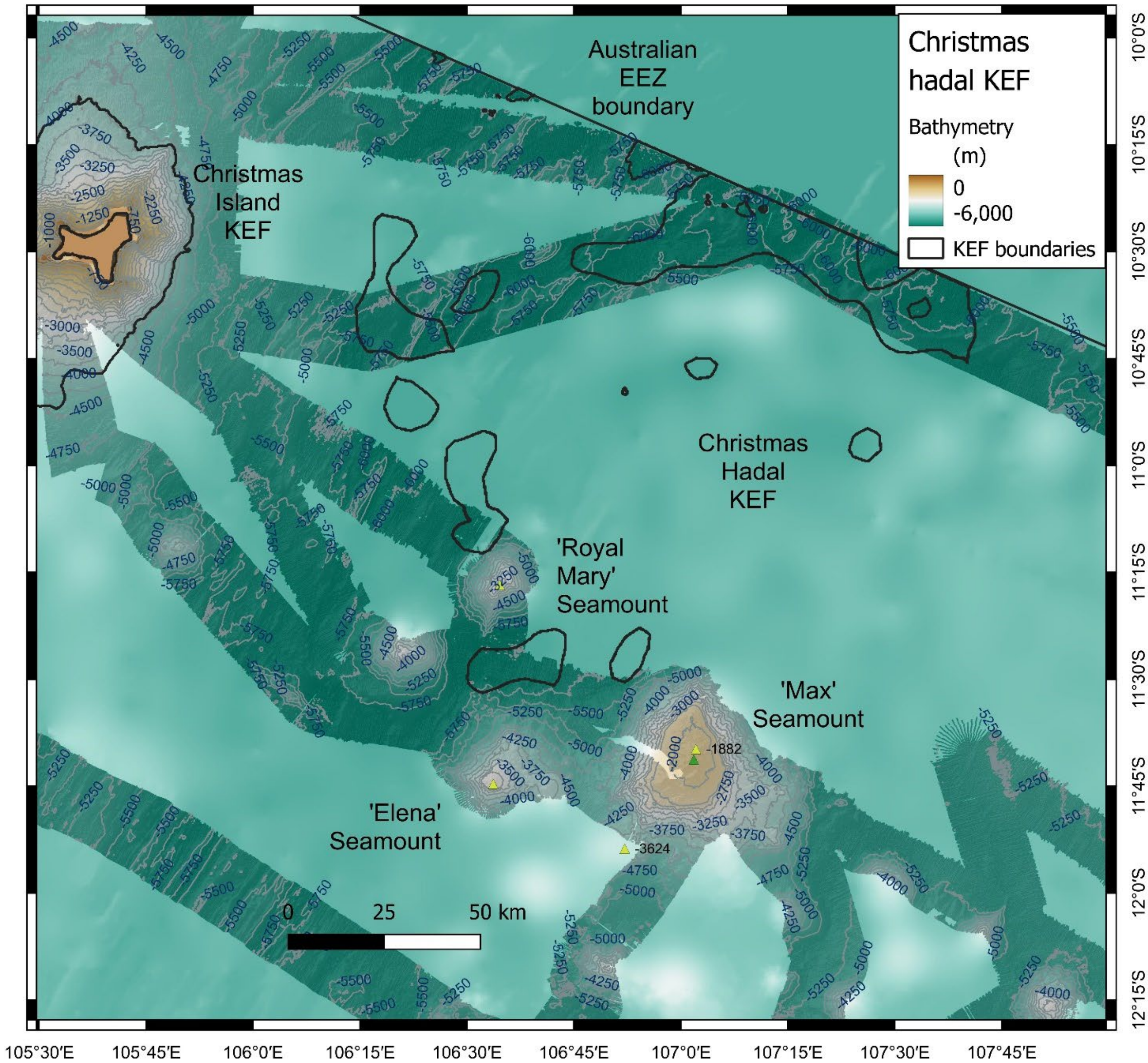


Figure 8.2. Topology of the region around the proposed Christmas hadal KEF derived from multibeam (darker colours) and GEBCO 2022 dataset (lighter).

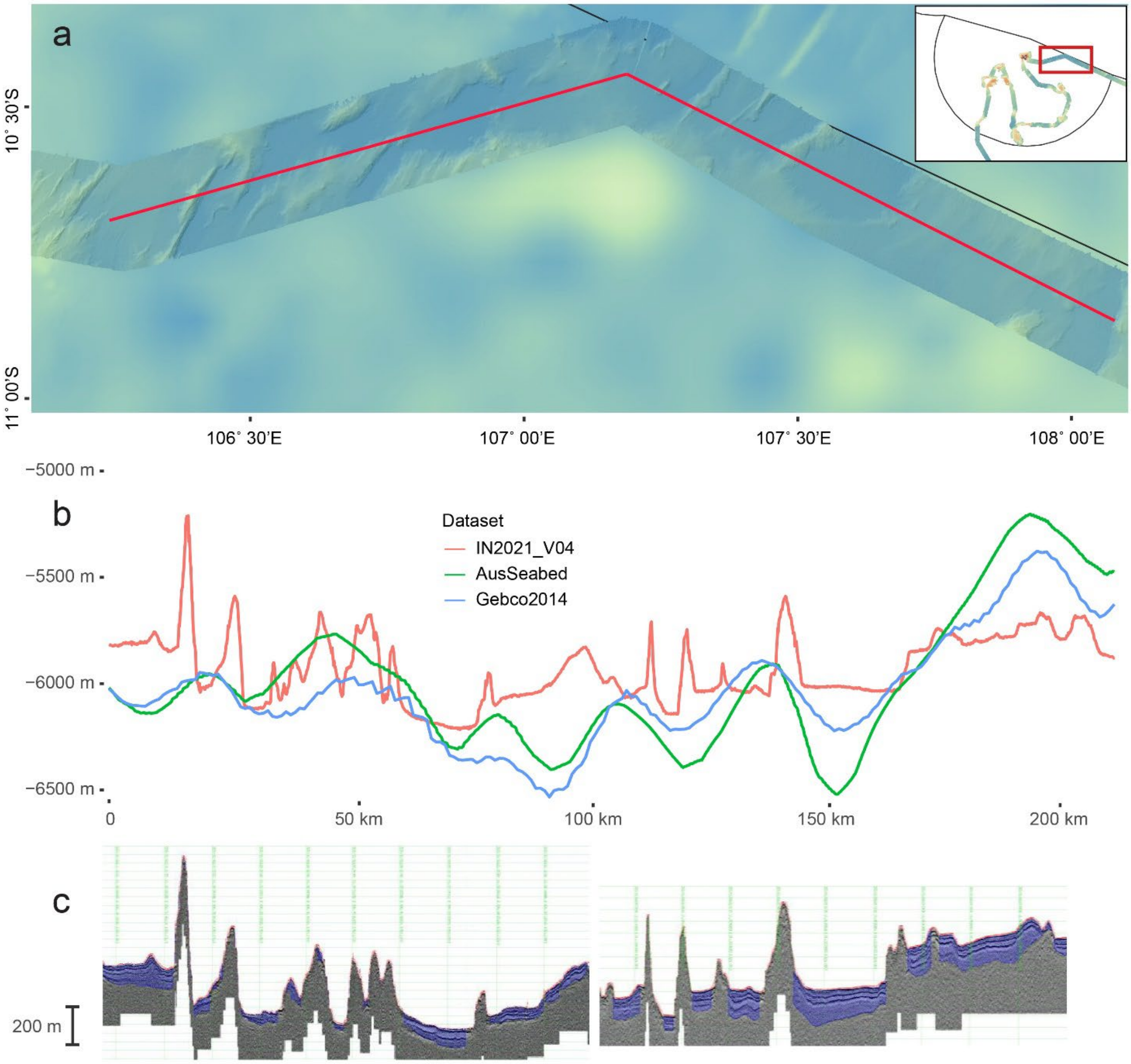


Figure 8.3. Transect of the IN2021_V04 voyage across the abyssal-hadal plain east of Christmas Island. (a) Multibeam bathymetry. (b) Profile of multibeam bathymetry (along red track in (a)) showing the considerable difference between the predicted seafloor bathymetry from satellite gravity measurements of the GEBCO 2014 and AusSeaBed datasets and the IN2021_V04 multibeam data. (c) Sub-bottom profiles showing the varying depth of the sedimentary layer (purple) on the plain and the abyssal hills (GSM/CSIRO).

Profile

Values

The hadal (below 6,000 m) plains and seafloor holes to the east of Christmas Island are some of the deepest seafloors in the Australian EEZ. The total amount of seafloor below 6,000 m across the Indian Ocean Territories at these depths forms 93.2% of this habitat in the Australian EEZ. A specialist fauna is known to occur at hadal depths.

National and/or regional importance

The proposed Christmas Island hadal KEF is of national importance for biodiversity and endemism.

Location

The deepest seafloors in the Indian Ocean Territories lie to the east of Christmas Island adjacent to Indonesia's Sunda Trench between 105.72 to 107.8˚E and 10.02 to 12.16˚S (Fig. 8.1).

Description

The Australian marine domain has relatively few areas below 6000 m. The plains and troughs at these depths in the Indian Ocean territories total 12,834 km^2 in area and represent 93.2% of this depth zone across the Australian EEZ [2]. The deepest point is estimated to be 6,542 m (AusSeaBed 2020 bathymetric dataset) or 6,490 m (GEBCO 2019). The plains within this KEF (Fig. 8.2) represent some of the deepest seafloors across the entire Australian marine domain. Examination of the GEBCO (2019) and AusSeaBed (2020) indicate that only a few holes in the Leeuwin fracture zone [30] (in the South-West Australian Marine Park) and the Hjort Trench (south of Macquarie Island) appear to be deeper.

The seafloor bathymetry in this region is largely known from only satellite gravity measurements (Fig. 8.2), which are known to be inaccurate for troughs and holes [31]. Only a few transects of this area have been mapped using modern multibeam technology, including a transect to the east of Christmas Island on the IN2021_V04 expedition in June 2021 (Fig. 8.3). This new data indicates that the hadal areas are more likely to be a seafloor plain that lies below 6000 m that is intersected by abyssal hills and ridges, rather than an abyssal plain dotted with hadal troughs and holes. More mapping is required before the extent of the hadal areas can be accurately determined.

Oceanic depths below 6000 m are referred to as the hadal zone and animals require special adaptations to survive the extreme pressures, cold and lack of organic matter [32]. Animals or protists with calcareous skeletons living beneath the lysocline must also evolve adaptions to survive carbonate dissolution. The lysocline (or calcite saturation horizon) in this region lies around 3,800 m [33] where the sediment changes from being principally of calcareous origin above the lysocline to being of siliceous origin below.

The hadal environments in this KEF differ from other hadal troughs and holes to the south of Christmas Island EEZ or SE of the Cocos (Keeling) EEZ in being situated below an area of higher net primary productivity (being closer to the Indonesian continental margin). This KEF is likely to share species that inhabit the deep Sunda Trench in the Indonesian EEZ.

9. Proposed Green-eye Seamount KEF

Maps and Images

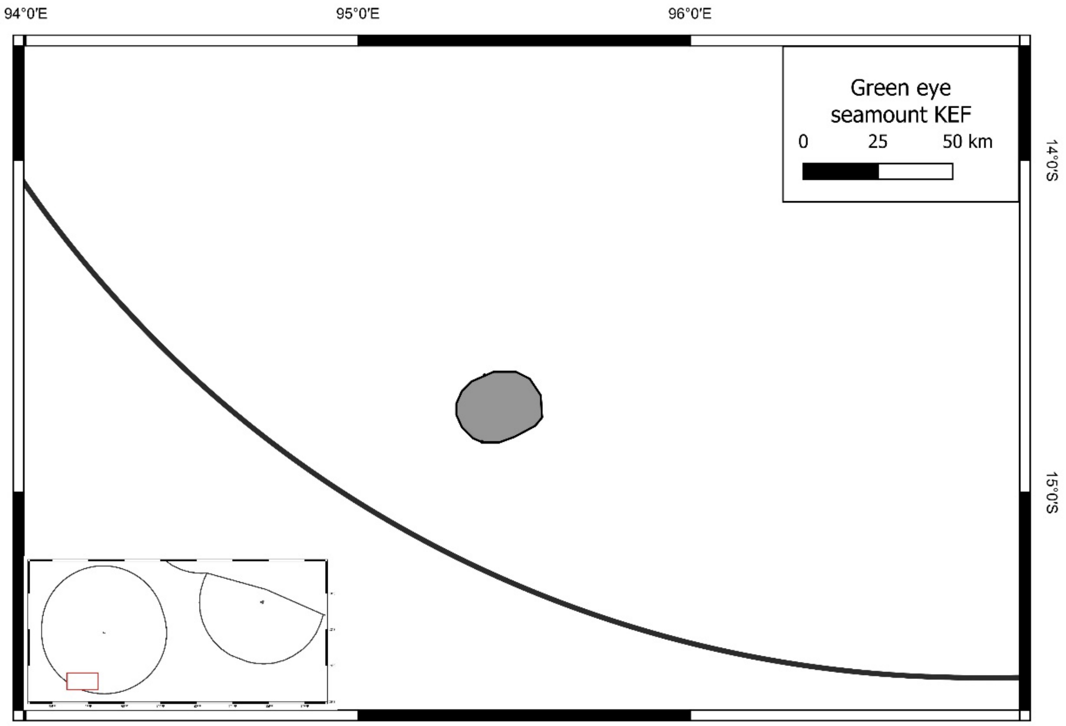


Figure 9.1. Spatial extent of the proposed Green-eye Seamount KEF. Depth contour (4250 m) derived from the GEBCO (2022) dataset.

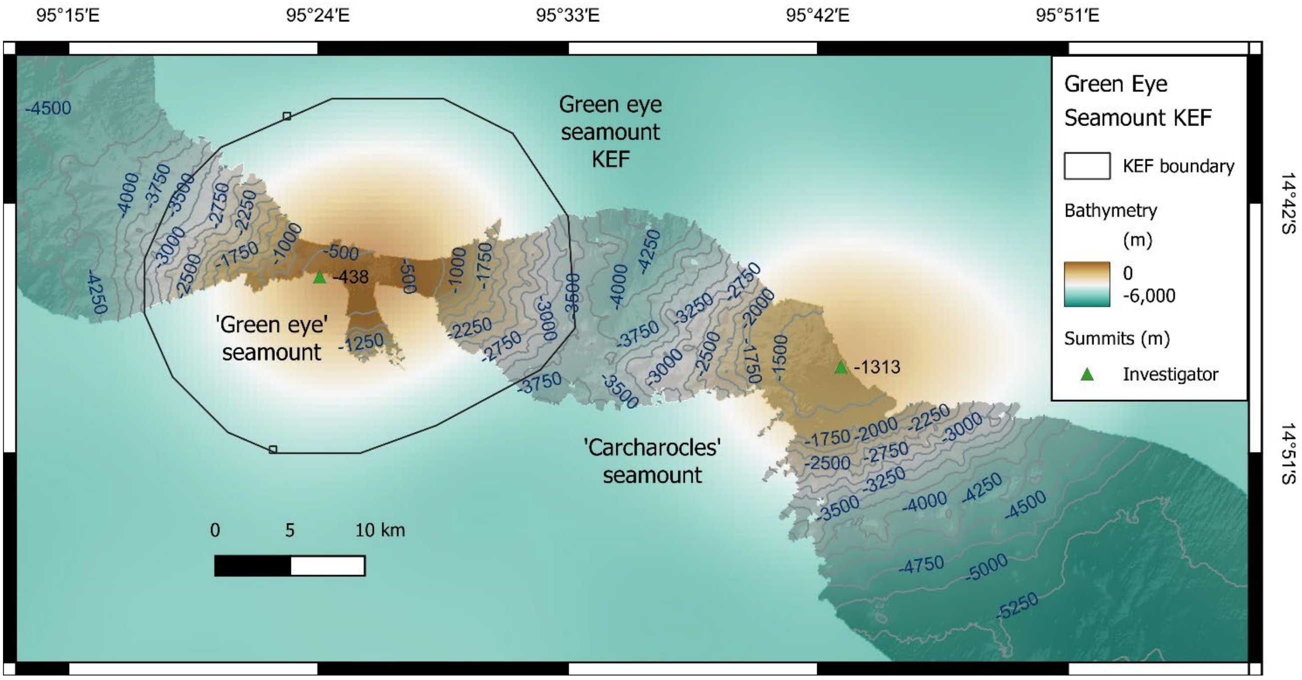


Figure 9.2. Topology of the region around the proposed Green-eye Seamount KEF derived from multibeam (darker colours) and GEBCO 2022 datasets (lighter). Peaks from available multibeam coverage are also indicated.

Profile

Values

'Green-eye' is the only seamount in Australia's Indian Ocean Territories that summits (438 m) in upper bathyal depths (200-1100 m). Preliminary data indicates a dense demersal and pelagic fish fauna occurring around the summit, including an undescribed species of Green-eye (after which this seamount is informally named).

National and/or regional importance

The proposed Green-eye Seamount KEF is of national importance for biodiversity and endemism.

Location

'Green-eye' is the most south-westerly of all seamounts in the Indian Ocean Territories, lying close to the EEZ boundary between 95.3 to 95.6˚E and 14.65 to 14.83˚S (Fig. 8.1).

Description

'Green-eye' seamount was previously known mainly from satellite gravity measurements and visits by the occasional commercial fishing vessel. It is here informally named after an undescribed species of Green-eye fish that has only been recorded from this seamount and Muirfield (Dr M. Gomon, Museums Victoria, *pers. comm*.). It appears to be a conical structure with a large, flattened summit at 450-500 m depth of around 7 km diameter. The highest point to be measured to date is 438 m below sea-level.

Echo sounders on the RV *Investigator* IN2022_V08 voyage indicated a dense demersal assemblage around the summit rim, and an exploratory beam trawl across the summit collected numerous demersal fish.

Although, little is known about this feature, and multibeam mapping hasn't yet been completed, it appears to have a rich diverse summit fauna. It is the only seamount in the region that summits at upper bathyal depths (200-1100 m) and as such is likely to support an internationally significant benthic and demersal fauna.

10. Proposed Abbott's Booby Christmas Island foraging BIA

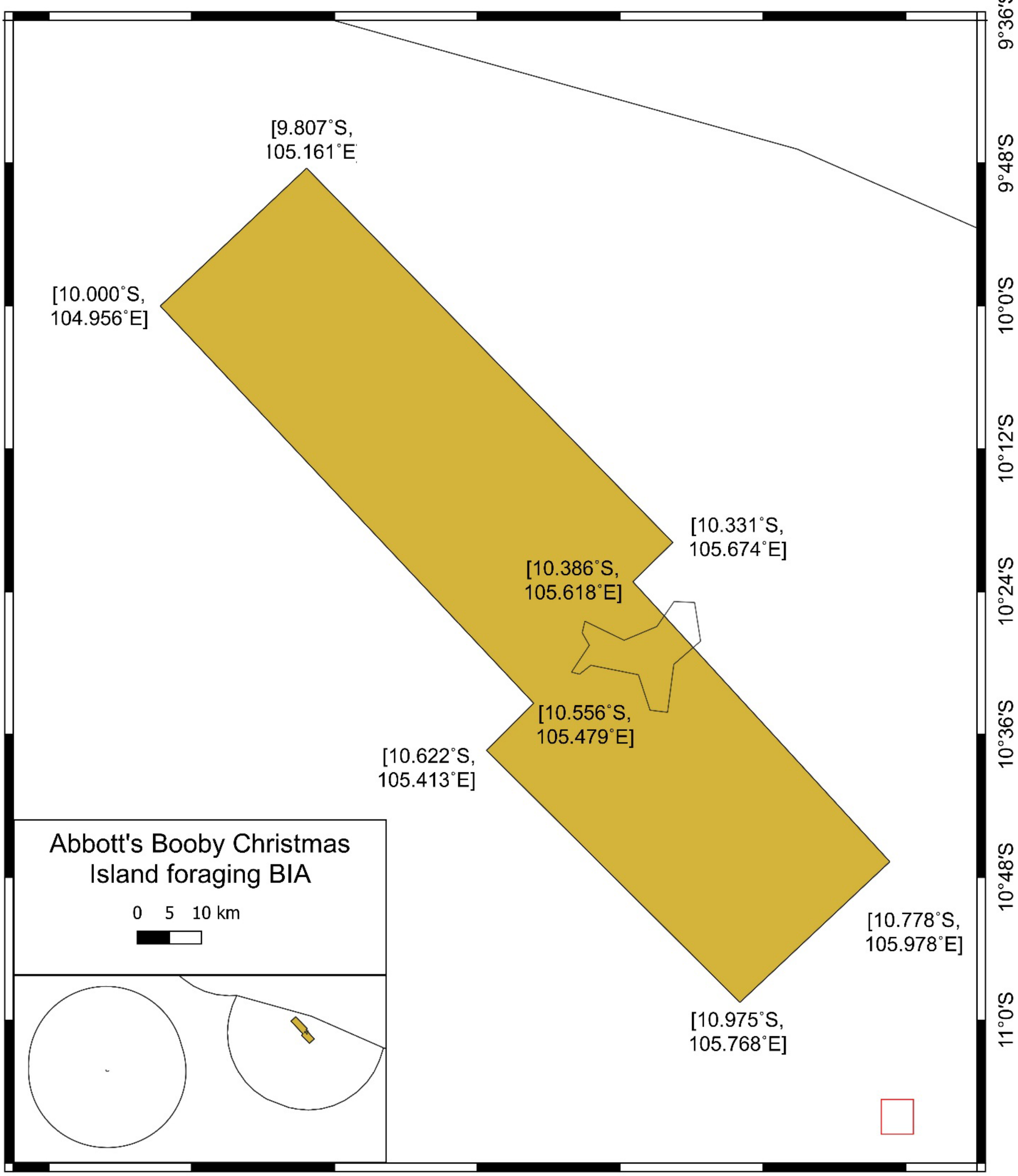


Figure 10.1. Proposed foraging BIA for nesting Abbotts Booby based on the analysis of Hennicke & Weimerskirch 2014 [1] (see Fig. 10.5).

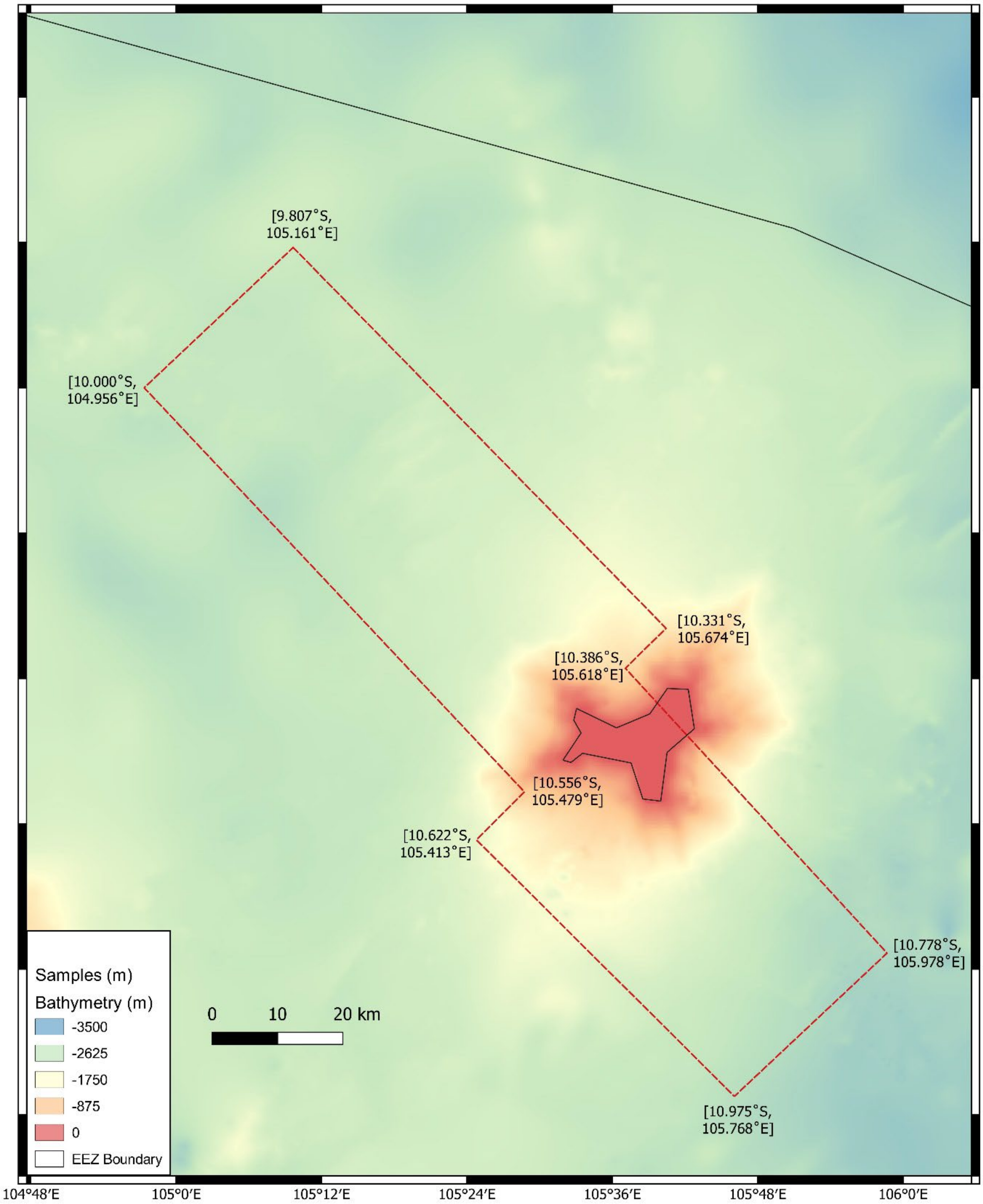


Figure 10.2. Seafloor topology of the proposed foraging BIA for nesting Abbotts Booby.

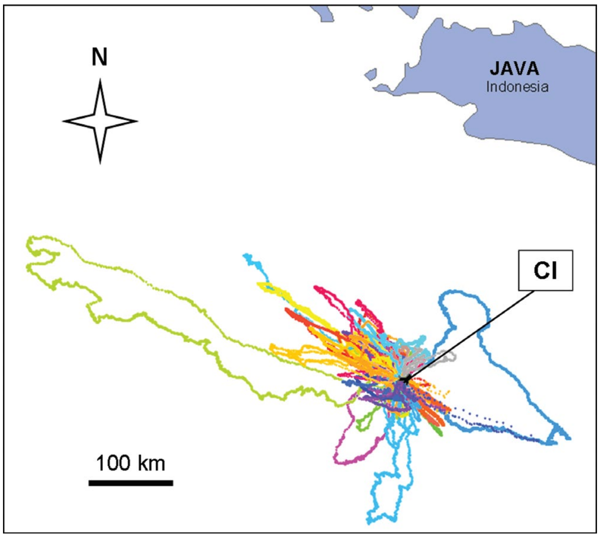


Figure 10.3. Foraging movements of Abbott's Boobies during early chick-rearing recorded with GPS-loggers from 2004–2010. Each colour represents a different individual. Copied from Hennicke & Weimerskirch 2014 [1].

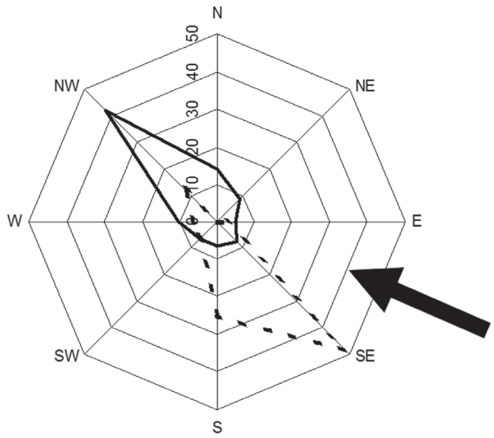


Figure 10.4. Directions of foraging trips of Abbott's Boobies from the two sub-colonies (ECT = dotted line; NWP = solid line) during early chick-rearing from 2004–2010. The arrow indicates the main wind direction during the study period, numbers show relative frequencies (%).Copied from Hennicke & Weimerskirch 2014 [1].

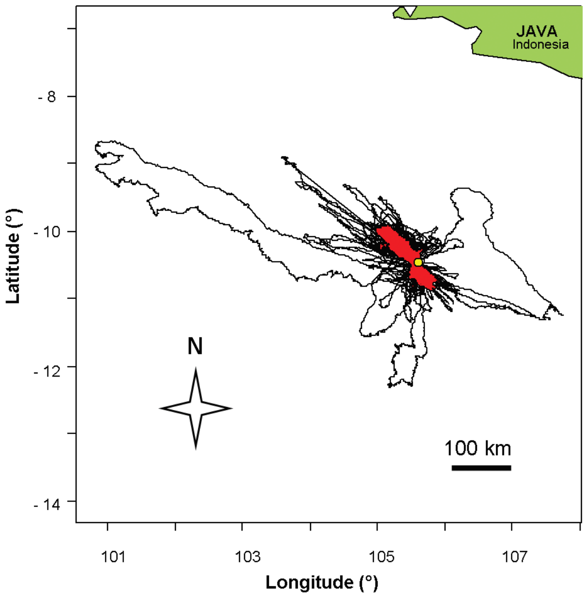


Figure 10.5. Marine Important Bird Area (red) for Abbott's Boobies during early chick-rearing according to the methodology of BirdLife International. Paths of foraging trips are shown as black lines (see also Fig. 10.3), Christmas Island is depicted as yellow dot. Copied from Hennicke & Weimerskirch 2014 [1].

Species group

Seabirds

Genus

Papasula

Species

Papasula abbotti

Common Name

Abbott's Booby

Location

Christmas Island

Breeding

On Christmas Island most nests are situated in tall forest in the central and western areas of the plateau. Some nests are also found in forest along the upper terrace along the north coast. Nest sites are largely restricted to areas above 150m [34].

Foraging

The main recorded foraging area for brooding members of this species is to the NW and SE of Christmas Island, orientated to the direction of the prevailing wind [1]. Most foraging trips remain within 60 km, however, birds occasionally range as far as 550 km [1].

Migration

From Christmas Island, mature birds range into Indonesia and occasionally as far as Guam or northern Australia. This species formerly bred on islands in the western Indian Ocean [34].

Aggregation

Aggregation- known

Other

Occurrence

Known to occur

Use Level

High

Eco Reason

Foraging to feed young chicks

Season

Late August until early October, when Abbott’s Boobies rear young chicks

Source Category

Satellite tracking data

Source Description

Hennicke, J.C. and H. Weimerskirch, Foraging movements of Abbott’s Boobies during early chick-rearing and implications for a marine Important Bird Area in Christmas Island waters. Raffles Bulletin of Zoology, 2014. Supplement 30: p. 60-64.

PROGRAM

BIA created for the IOT marine parks project

EPBC Threatened Status

Endangered

EPBC Listed Migratory

Listed migratory (Bonn)

11. Proposed Whale Shark Christmas Island foraging BIA

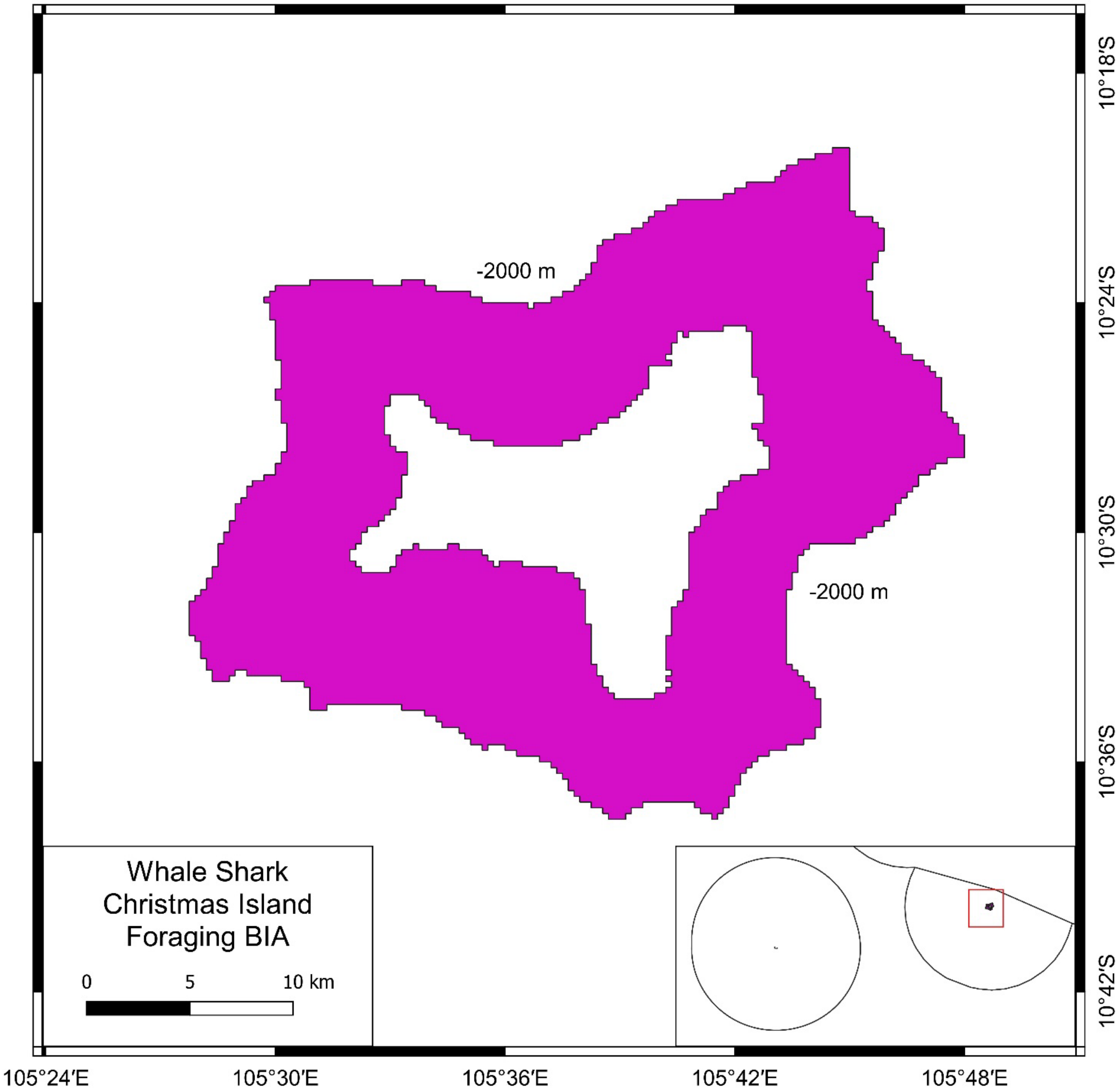


Figure 11.1. Proposed foraging BIA for Whale Sharks (0-2000 m depth) around Christmas Island.

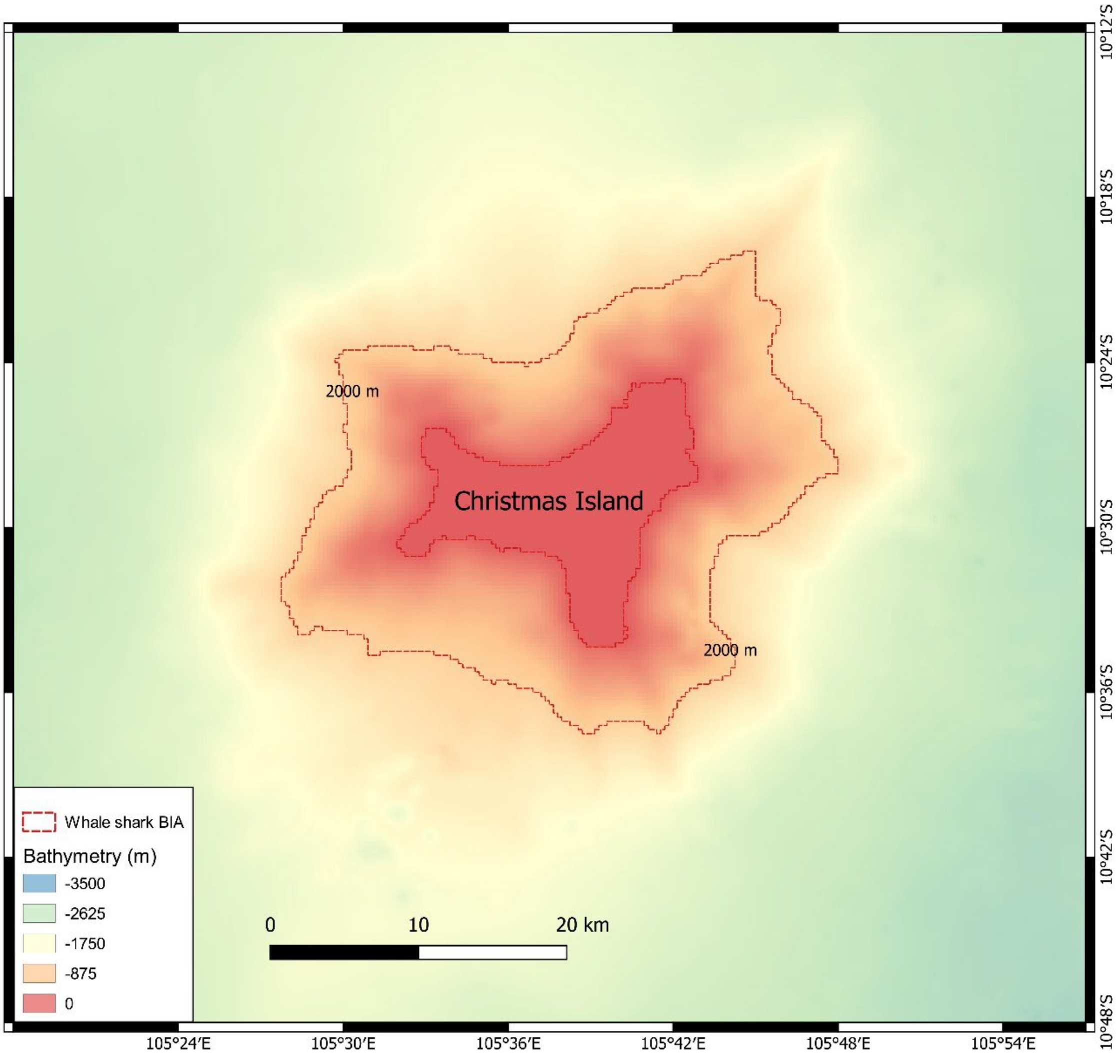


Figure 11.2. Seafloor topology of proposed foraging BIA for Whale Sharks (0-2000 m depth) around Christmas Island.

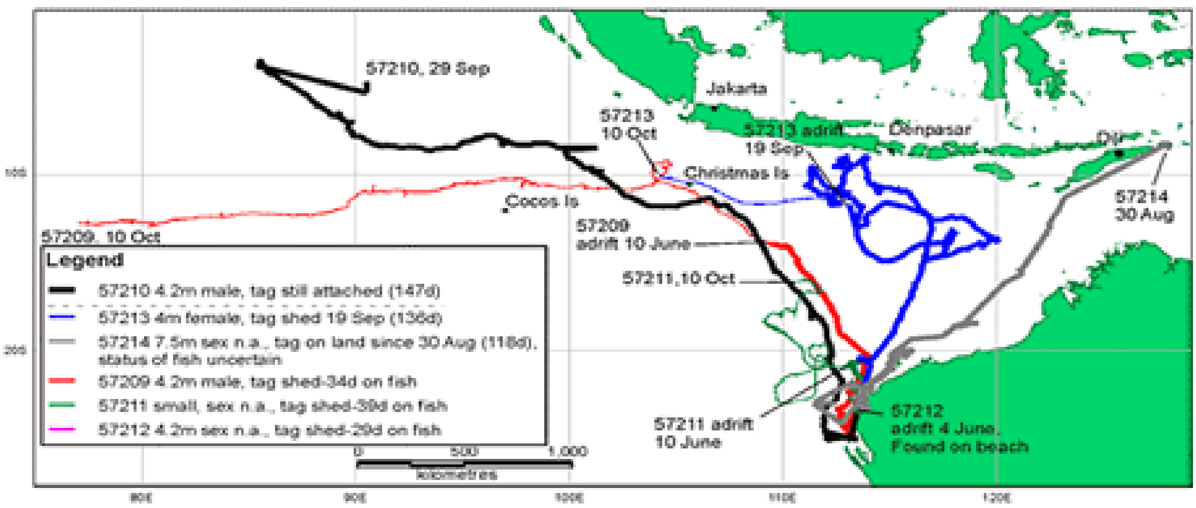


Figure 11.3. Migration routes of tagged Whale Sharks from NW Australia into the Indian Ocean. Image copied from Brewer et al. [2].

Species group

Sharks

Genus

Rhincodon

Species

Rhincodon typus

Common Name

Whale Shark

Location

Waters around Christmas Island to 2 km deep.

Breeding

Little is known about the breeding behaviour of Whale Sharks or where it occurs. Breeding has been observed rarely, including off St Helena and Ningaloo. Embryos hatch from eggs within the female, and there is some evidence that females can store sperm and fertilise embryos when required [35].

Foraging

Whale sharks forage in water up to 2 km depth and then return to warmer shallow waters to thermo-regulate [36]. The large larval production from spawning red crabs (*Gecarcoidea natalis*) at Christmas Island, attracts whale sharks to the area, although they may feed on other invertebrates spawn or zooplankton as well [37, 38]. The feeding aggregation includes rarely seen juvenile animals (1-3 m in length) [37].

Migration

Whale sharks are widespread between 30°N and 35°S and frequently migrate over large distances, including some of the largest distances ever recorded for a migrating animal. They aggregate in relatively few areas, generally associated with enhanced zooplankton production driven by oceanic upwellings or larval production [36].

Aggregation

Aggregation- known

Other

Occurrence

Known to occur

Use Level

High

Season

December to March, with some records from November and April [37].

Source Category

Visual evidence [37], DNA evidence for the consumption of red crab larvae by whale sharks [38].

Source Description

Brewer, D. T., A. Potter, T. D. Skewes, V. Lyne, J. Andersen, C. Davies, T. Taranto, A. D. Heap, N. E. Murphy, W. A. Rochester, M. Fuller and A. Donovan (2009). Conservation values in Commonwealth waters of the Christmas and Cocos (Keeling) Island remote Australian Territories. Report to Department of Environment and Water Resources. Cleveland, CSIRO: 216 pp.

Copping, J. P., B. D. Stewart, C. J. McClean, J. Hancock and R. Rees (2018). "Does bathymetry drive coastal whale shark (Rhincodon typus) aggregations?" PeerJ 6: e4904.

Hobbs, J. P. A., T. Hamanaka, M. C. A., J. J. Gilligan and N. J. (2009). "Seasonal aggregation of juvenile whale sharks (Rhincodon typus) at Christmas Island, Indian Ocean." Coral Reefs 28: 577.

Meekan, M. G., S. N. Jarman, C. McLean and M. B. Schultz (2009). "DNA evidence of whale sharks (Rhincodon typus) feeding on red crab (Gecarcoidea natalis) larvae at Christmas Island, Australia." Marine and Freshwater Research 60(6): 607-609.

Schmidt, J. V., C. C. Chen, S. I. Sheikh, M. G. Meekan, B. M. Norman and S. J. Joung (2010). "Paternity analysis in a litter of whale shark embryos." Endangered Species Research 12: 117-124.

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EPBC Threatened Status

Vulnerable

EPBC Listed Migratory

Listed migratory (Bonn)

12. Proposed Southern Bluefin Tuna Christmas Island breeding BIA

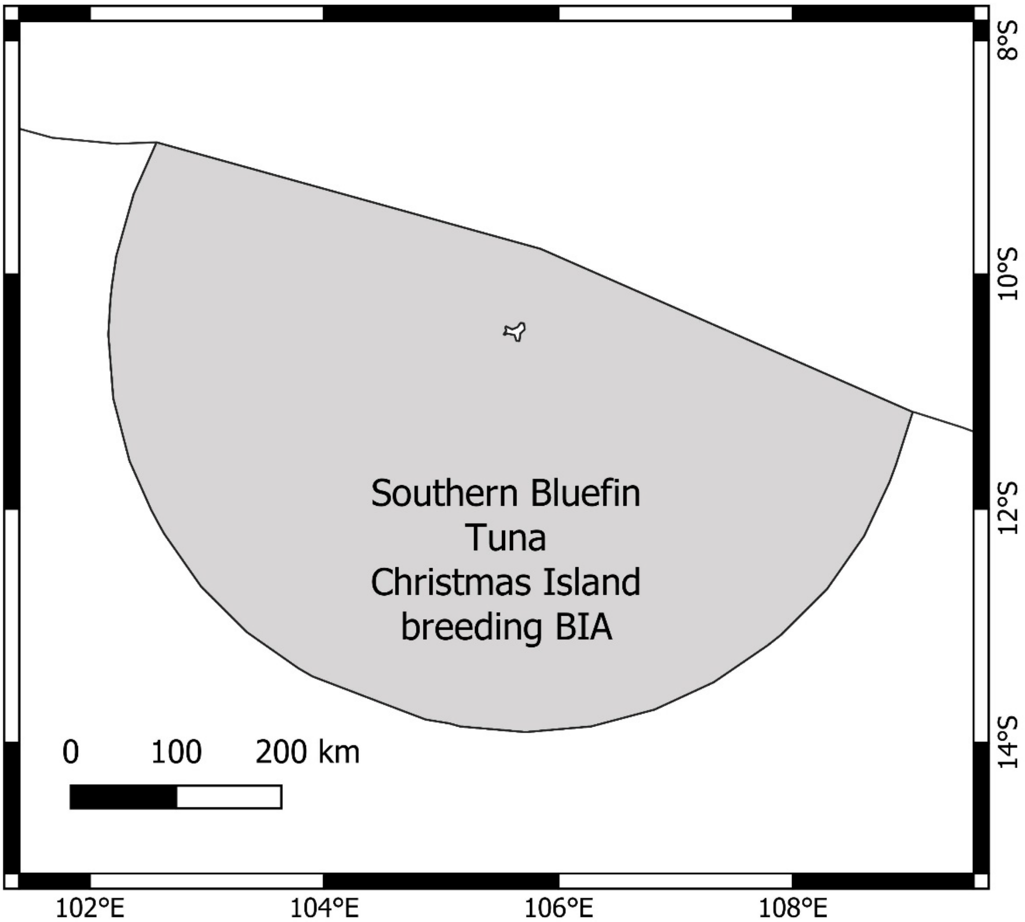

Figure. 12.1. Extent of the proposed Southern Bluefin Tuna Christmas Island breeding BIA (=EEZ boundaries).

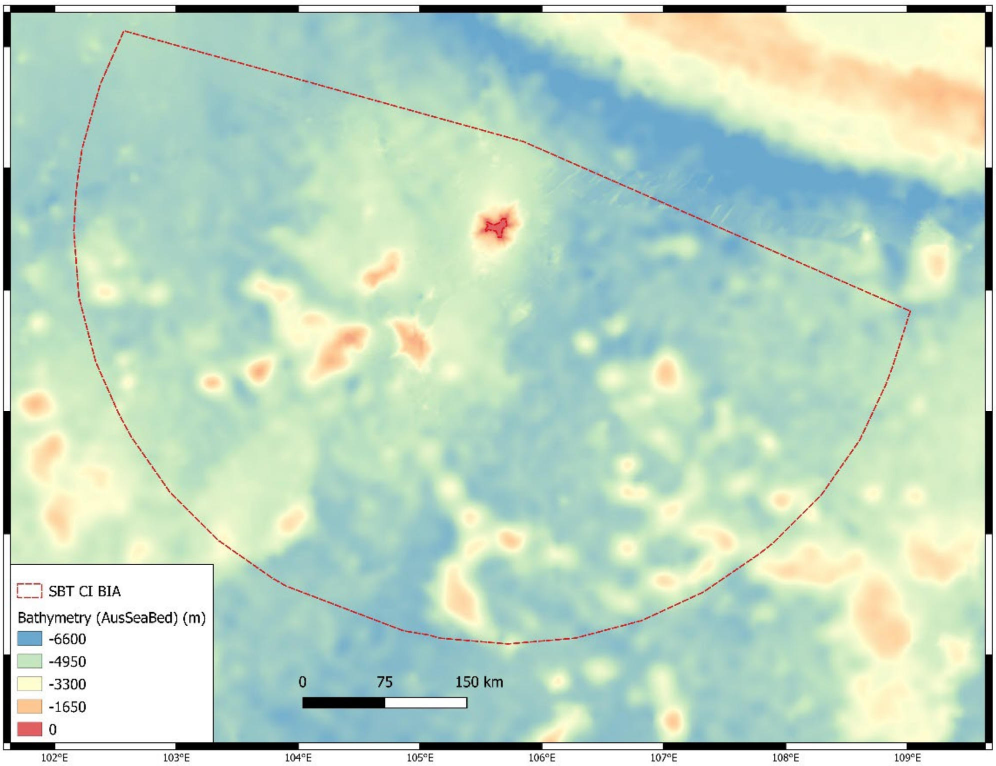

Figure 12.2. Topology of the proposed Southern Bluefin Tuna Christmas Island breeding BIA (=EEZ boundaries).

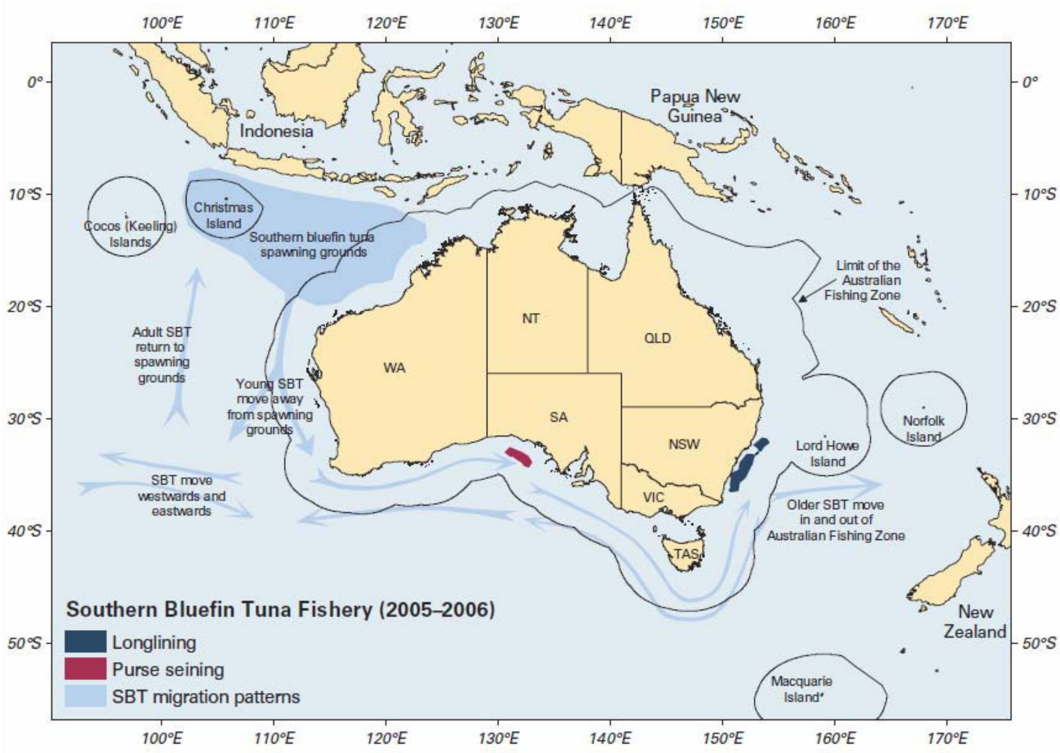

Figure 12.3. Extent of the Southern Bluefin Tuna breeding grounds and subsequent migration routes (BRS Status report 2007, copied from Brewer et al. [2]).

Species group

Other

Genus

Thunnus

Species

Thunnus maccoyii

Common Name

Southern Bluefin Tuna

Location

The Christmas Island Exclusive Economic Zone

Breeding

Breeding for the entire species occurs in one spawning ground in the eastern Indian Ocean between Christmas Island and the NW Australian coast (Fig. 12.3) [39]. This includes the entire Christmas Island EEZ. Other areas in the spawning area, either in international waters, or the EEZ off NW Australia, are not included in this BIA.

Migration

Southern Bluefin Tuna migrates down the coast of Western Australia until it reaches temperate/subantarctic latitudes and then they either turn east across Southern Australia to the Tasman Sea [40] or west across the Indian Ocean [39]. Adult fish also have been found in the SW Pacific and SE Atlantic Oceans [39]. Adults typically prefer cooler water, but larger animals migrate to the warm-water spawning ground to breed. This is probably due to the temperature requirements of larval fish [41]. Spawning adults frequently dive to 150 m depth to thermoregulate [40].

Aggregation

Aggregation- known

Occurrence

Known to occur

Use Level

High

Season

Spawning is between September and April, with peaks in October and February [40]; individual fish probably stay in the spawning area for one month or so [42].

Source Category

Confirmed sightings

Source Description

Chambers, M. S., L. A. Sidhu, B. O'Neill and N. Sibanda (2017). "Evidence of separate subgroups of juvenile southern bluefin tuna." Ecology and Evolution 7(22): 9818-9844.

Evans, K., T. A. Patterson, H. Reid and S. J. Harley (2012). "Reproductive Schedules in Southern Bluefin Tuna: Are Current Assumptions Appropriate?" PLOS ONE 7(4): e34550.

Farley, J. H., T. L. O. Davis, M. V. Bravington, R. Andamari and C. R. Davies (2015). "Spawning Dynamics and Size Related Trends in Reproductive Parameters of Southern Bluefin Tuna, Thunnus maccoyii." PLOS ONE 10(5): e0125744.

Hobday, A., K. Evans, J. P. Eveson, J. Farley, J. Hartog, M. Basson and T. Patterson (2015). Distribution and Migration—Southern Bluefin Tuna (Thunnus maccoyii). Biology and Ecology of Bluefin Tuna. T. Kitagawa and S. Kimura, CRC Press: 189-210.

Patterson, H., A. Williams, B. Hennecke and D. Mobsby (2019). Chapter 23. Southern Bluefin Tuna Fishery. Fishery status reports 2019. H. Patterson, A. Williams, J. Woodhams and R. Curtotti. Canberra, Australian Bureau of Agricultural and Resource Economics and Sciences: 384-394.

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EPBC Threatened Status

Conservation dependent.

Southern Bluefin Tuna is also assessed as overfished. The spawning stock of Southern Bluefin Tuna is at a very low level (9-13 % unfished biomass) [43] and in 2010 the species was listed as conservation dependent under the EPBC act. The Convention for the Conservation of Southern Bluefin Tuna aims to build up spawning fish stocks to 20% of its unfished biomass by 2035.

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