4 DESCRIPTION OF THE EXISTING ENVIRONMENT

4.1 Overview

Pilot Energy acknowledges the Traditional Owners of the lands and seas connected to the survey area and recognises their enduring cultural authority and connection to Country. We respect that all living beings, places, and natural features may hold cultural significance, and that totemic species, sacred sites, and Dreaming tracks form part of the cultural and spiritual fabric of Traditional Owners' lives. Accordingly, all species, habitats and places described in this chapter are recognised as potentially carrying cultural values in addition to their ecological roles. This acknowledgement reflects Pilot Energy's commitment to respectful engagement and ensures that new or previously unrecorded cultural values identified during consultation are given due consideration.

This section describes the environmental and socio-economic values and sensitivities within the existing environment of the Operational Area and wider environment that may be affected (EMBA) by the proposed activity (see Figure 4-1). The EMBA is a conservative approximation of the furthest extent that could be affected in any credible impact scenario. In this case, the EMBA represents an unplanned release of marine gas oil (MGO). The EMBA was derived from oil spill modelling for a 6-hour surface release of 320 m^3 at the south-east point of the OA. It is important to note that the EMBA covers a much larger area than the area that is likely to be affected during any one single spill event. The modelling was run for a variety of weather and metocean conditions (100 simulations in total). Other nearby sensitivities that were considered potentially relevant to the EP are also described in this section. The information contained in this section has been used to inform the assessment of impacts and risks in Section 7 and Section 8. For further detail on the modelling refer to Section 8.6.

4.1.1 Regional context –South-west Marine Region

The OA is in the South-west Marine Region (SWMR), described in 2008 by the former Department of the Environment, Water, Heritage and the Arts (DEWHA) (now the Department of Agriculture, Fisheries and Forestry; DAFF) during the introduction of Integrated Marine and Coastal Regionalisation of Australia (IMCRA) bioregional planning. Under these plans, the Australian marine environment was categorised into six broad marine bioregions (Figure 4-2). The Marine Bioregional Plans describe the marine environment and conservation values of each marine region, as well as set out broad biodiversity objectives, identify regional priorities and outline strategies and actions to address these priorities (DSEWPC 2012a).

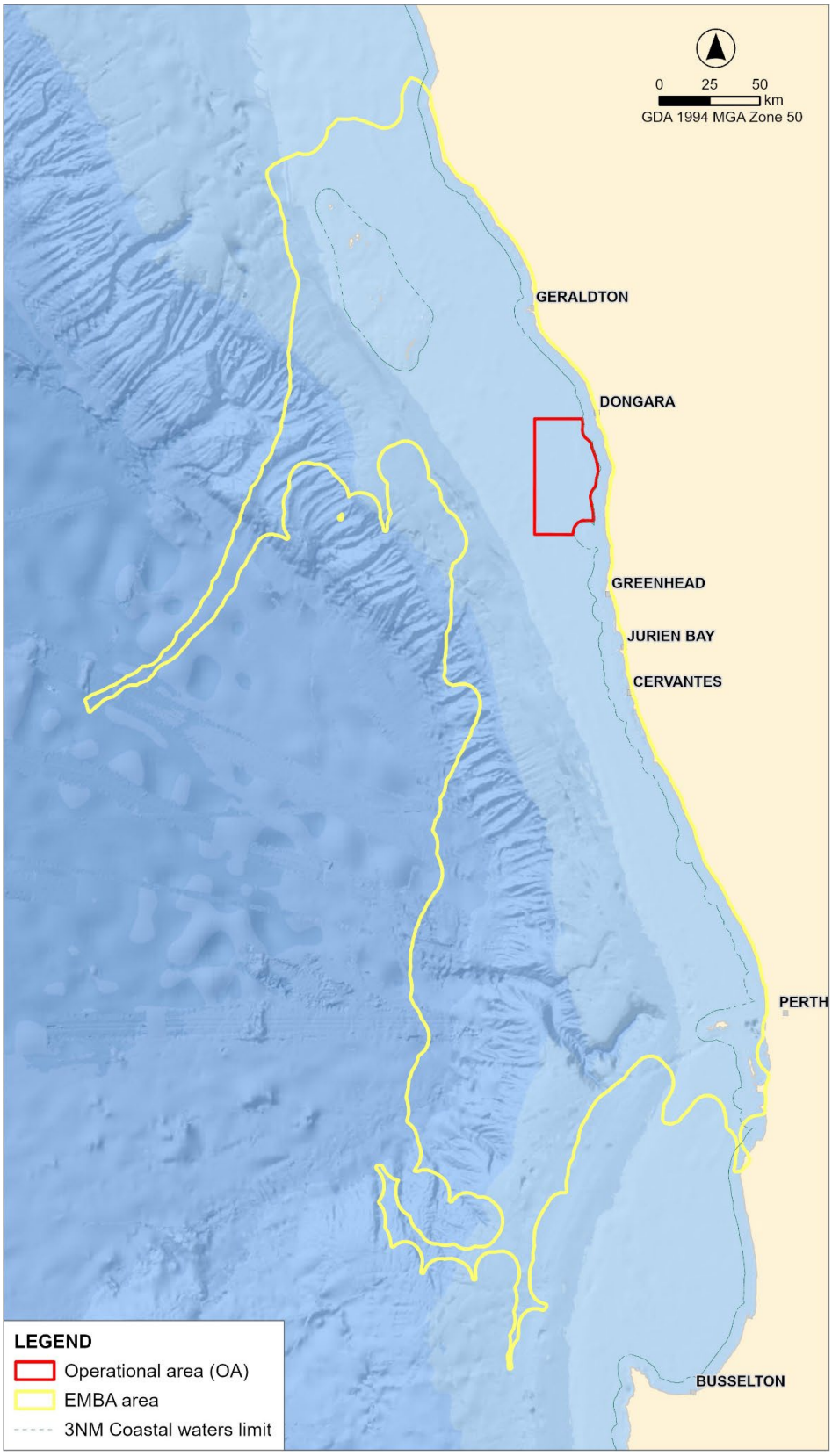


Figure 4-1: Operational area and EMBA for the Eureka 3D MSS

The SWMR comprises Commonwealth waters from the eastern end of Kangaroo Island, South Australia (SA) to Shark Bay, WA. The SWMR spans approximately 1.3 million square kilometres (km^2) and is characterised by the following aspects (DSEWPC 2012a; DEWR 2007):

- Contains subtropical to temperate waters, with complex oceanographic patterns primarily driven by the Leeuwin Current and its interactions with other currents
- Narrow continental shelf on the west coast and a wide continental shelf in the Great Australian Bight
- Exposure of the continental shelf to high wave energy throughout the region
- Islands and reefs in both subtropical (e.g. Houtman Abrolhos Islands) and temperate waters (e.g. Recherche Archipelago)
- Low levels of nutrients and biomass in the ocean and most of the coastal waters
- Diverse marine communities composed of species of temperate origin, which mix with tropical and subtropical species
- Containing globally significant levels of biodiversity and endemism
- Containing threatened and migratory species listed under the EPBC Act, including cetaceans, pinnipeds, marine reptiles, seabirds, seahorses and pipefish, and sharks
- Containing biologically important areas (BIAs), in which EPBC Act listed species carry out critical life functions, such as reproduction, feeding, migration or resting
- Low levels of terrigenous inputs, particularly in the southern part of the region, contributing to low levels of productivity.

Within the SWMR, marine habitats are further categorised into seven provincial bioregions. The OA is located within the Southwest Shelf Transition (SWST), and the EMBA overlaps with part of the Central Western Province (CWP), Southwest Transition (SWT), and the Southwest Shelf Province (SWSP) (Figure 4-3) These four provincial bioregions are described below.

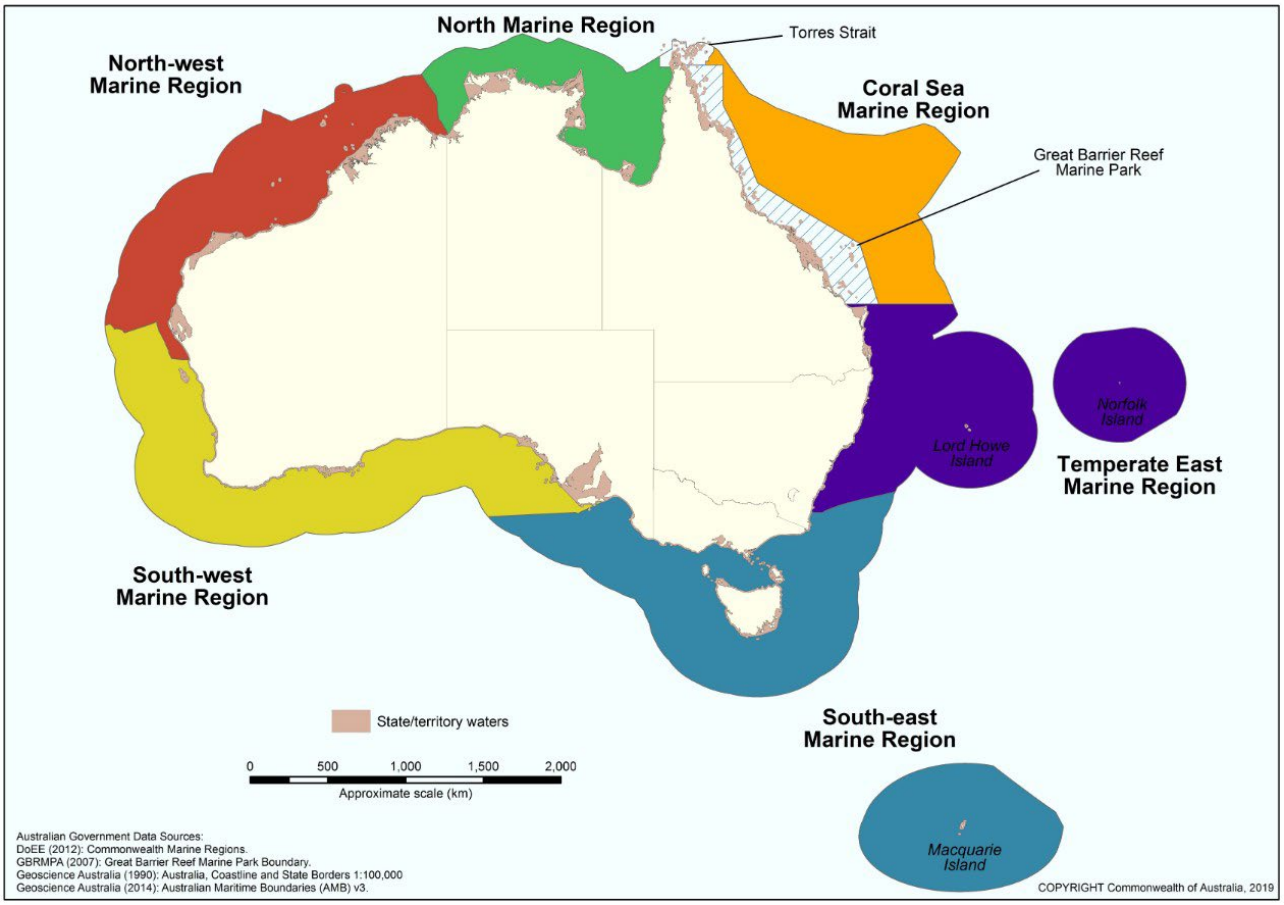


Figure 4-2: Marine bioregions of Australia (Source: DCCEEW 2019a)

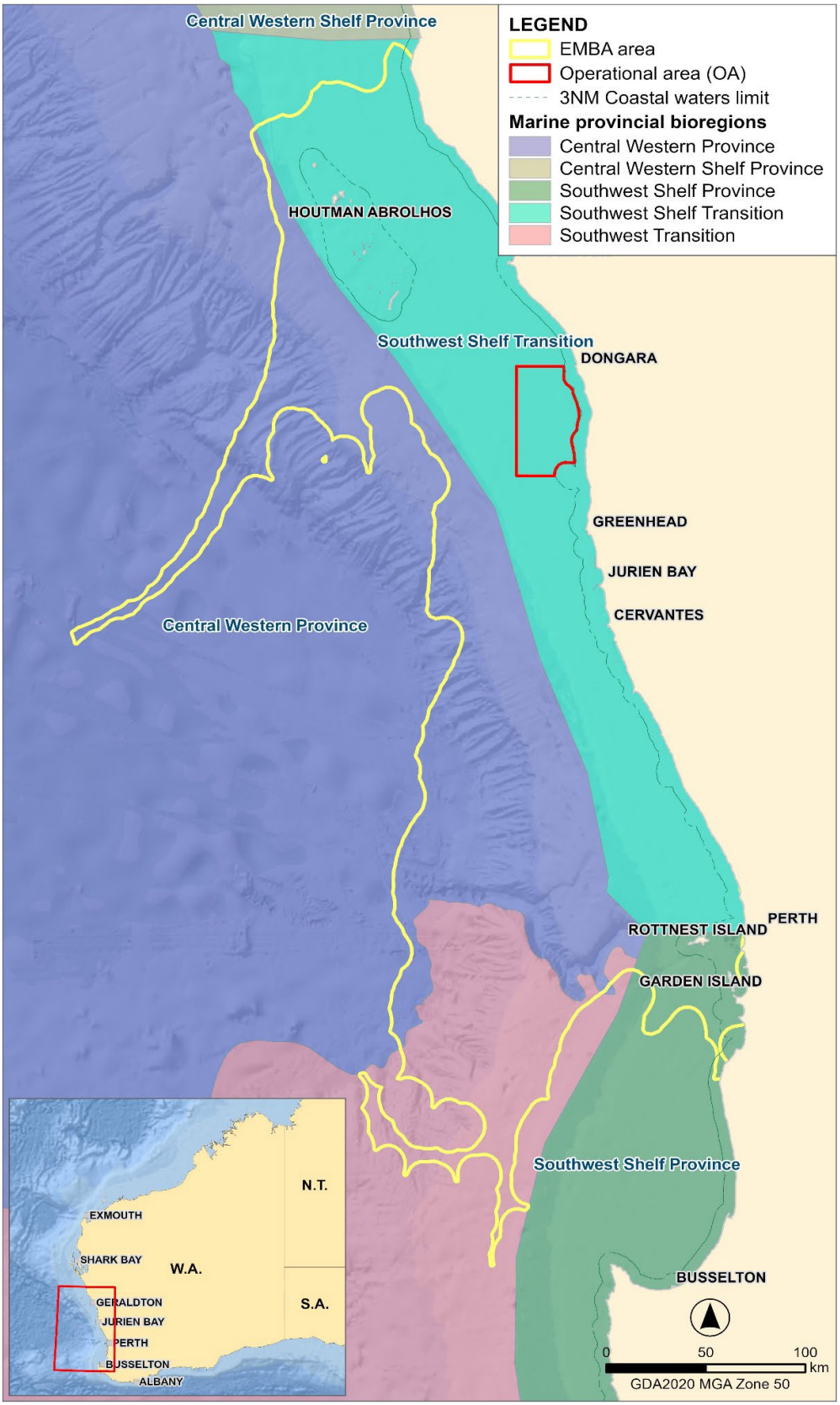


Figure 4-3: Provincial bioregions (IMCRA v4.0) (source: North-West Atlas/DCCEEW 2023)

4.1.1.1 Southwest Shelf transition

The OA is located within the Southwest Shelf Transition (SWST), which covers approximately 33,000 km^2 in nearshore areas of the continental shelf between Perth and Kalbarri (Figure 4-3). The narrow continental shelf ranges from approximately 40 to 80 km in width, with a depth of 10–200 m and is physically complex, containing narrow ridges, depressions, and smooth plains (DEWHA 2008b). Important topographical features on the shelf include the Abrolhos Islands, Beagle Islands, Rottnest Island, Garden Island, Cockburn Sound, and the inshore lagoons that run parallel to the coastline (DEWR 2007). The SWST is influenced by the Leeuwin Current (LC) as it pushes sub-tropical water southward along the western edge of the bioregion. The area is a complex transition zone, representing the northern limit of warm temperate species, and the southern limit of sub-tropical and tropical species. For example, the Houtman Abrolhos Islands off Geraldton are renowned for their coral reefs and unique mix of temperate and tropical species (DEWHA 2008b). The region is commercially important to both the petroleum and commercial fishing industries, as well as Defence.

4.1.1.2 Central Western Province

The EMBA overlaps with part of the Central Western Province (CWP), which covers approximately 27,000 km^2 extending offshore from the SWST to the limit of the Australian Exclusive Economic Zone (EEZ) (Figure 4-3). The CWP is characterised by a narrow continental slope, canyons, and the most extensive area (~52,000 km^2) of continental rise in all of Australia's marine regions (DEWHA 2008b). Large eddies approximately 200–300 m in diameter is a significant feature in the bioregion. Eddies detach from the LC and spin anticlockwise, transporting shallow water plankton communities offshore to deeper waters, which can enhance productivity in surface waters (DEWHA 2008b). The CWP contains the Perth Canyon, the largest submarine canyon in Australia, which marks a distinct change in the distribution of marine organisms and the southern boundary for many tropical and sub-tropical species (DEWHA 2008b). Demersal fish communities on the continental slope have relatively high biodiversity and include at least 31 endemic species (DEHWA 2008b). The region is commercially important for fishing, shipping, and defence training.

4.1.1.3 Southwest Transition

The EMBA overlaps with part of the Southwest Transition (SWT), which covers approximately 110,000 km^2 extending from the Southwest Shelf Province (SWSP) out to the Australian EEZ (Figure 4-3). The SWT is centred on the Naturaliste Plateau, a 90,000 km^2 submerged continental fragment that rises from water depths of >5000 m to 2000 m and is surrounded by deep ocean floor. This bioregion represents a significantly different environment from the surrounding seabed and adjacent provinces (DEWHA 2008b). Depths in the bioregion range from 48 m to ~6000 m and contain all biome types, resulting in a great diversity of epifauna (DEWHA 2008b). The region is commercially important for fishing, shipping, and defence training.

4.1.1.4 Southwest Shelf Province

The EMBA overlaps with part of the Southwest Shelf Province (SWSP), which covers approximately 61,000 km^2 extending offshore to the SWT (Figure 4-3). It includes the coastal waters and continental shelf of south-west WA. The continental shelf is narrow, with small offshore inlets, high-energy swells, and rocky headlands (DEWHA 2008b). The SWSP contains the second deepest seabed habitat in all IMCRA shelf bioregions and is the only bioregion to contain three classes of geomorphic units (DEWHA 2008b). The SWSP is strongly influenced by the LC, which runs southward along the entirety of the bioregion. This bioregion hosts a large rage of temperate species, with some tropical influence, and large seagrass meadows (DEWHA 2008b). The region is commercially important for fishing, shipping, and Defence training.

4.2 Physical environment

4.2.1 Climate

4.2.1.1 Seasonal patterns

The climate of the SWMR is dry subtropical, exhibiting a short and hot summer season from December to March and a cooler winter season between May and September (BoM 2022a). The region is characterised by winter dominant rainfall and windy conditions experienced year-round, which strengthen in the summer months.

The region is also influenced by the El Niño Southern Oscillation (ENSO), an irregular periodic variation in winds and sea surface temperatures over the tropical Pacific Ocean that is associated with climate anomalies in the tropics and subtropics (McClatchie et al. 2006).

4.2.1.2 Air temperature and rainfall

The region experiences a Mediterranean climate, characterised by distinct seasonal patterns of hot, dry summers (November to February) and mild, wet winters (May to August; BoM 2022a). The highest air temperatures in the region occur in January and February, while the lowest temperatures occur in July and August. Rainfall typically occurs during the winter wet season, with the highest rainfall recorded in June and July. Rainfall during the summer period is typically low.

Air temperatures measured at Geraldton airport (approximately 55 km north of the OA) from 2011–2022 are summarised in Table 4-1 and indicate a maximum mean monthly air temperature of 33.0 °C in January, with an annual mean of 27.0 °C. The minimum mean monthly air temperature is 9.0 °C in August, with an annual mean of 13.8 °C (BoM 2022a). Rainfall measured in Geraldton town (approximately 55 km north of the OA) from 1877 to 2022 shows maximum and minimum mean monthly precipitation of 109.8 mm in June and 3.6 mm in December, with a mean total annual precipitation of 445.3 mm (BoM 2022a).

Table 4-1: Mean daily maximum and minimum air temperatures for each month (2011–2022) and mean monthly precipitation (1877–2022) recorded at Geraldton

Month	Mean daily maximum (\°C)*	Mean daily minimum (°C)*	Mean monthly precipitation (mm)†
January	33	19.2	6.1
February	32.8	19.6	9
March	31.9	18.5	13.6
April	28.8	15.6	23.6
May	25.1	12.3	66.7
June	22	10.3	109.8
July	20.6	9.5	88.3
August	21.1	9	64.5
September	23.3	9.2	29.8
October	25.7	11.6	17.7
November	28.4	14.4	8.1
December	31.4	17	3.6

* Recorded at Geraldton airport (source: BoM 2022a) †Recorded at Geraldton town

4.2.1.3 Wind

Anticyclonic high-pressure systems, as well as periodic tropic and extratropical cyclones and seasonal sea breezes characterise the wind patterns off the WA coast. The seasonal movement of high-pressure systems from ~38°S in summer (generating mainly offshore winds) to ~30°S in winter (producing mainly onshore winds) creates a progressive phase-shift in the seasonal wind pattern (Gentilli 1971; 1972; Pattiaratchi & Woo 2009). Around the OA winds vary seasonally, with generally strong and persistent southerlies during the summer months and weaker, more variable winds in winter (Figure 4-4). The wind roses indicate predominantly southerly winds between February and March, with average wind speeds of 7.5 m/s and peak speeds of 18.5 m/s.

In addition to seasonal wind trends, there is a consistent sea breeze system characterised by offshore winds from an easterly direction in the morning, switching to obliquely onshore winds from a south-south-west direction in the afternoon. The cycle is often defined by an abrupt increase in wind speed and shift in wind direction (Masselink & Pattiaratchi 2001).

Winds in the region are also highly influenced by meteorological processes, such as the passage of cold fronts during winter and storms in the southern Indian Ocean. Dissipating tropical cyclones may track down from the northwest coast infrequently during late summer and can have significant impacts on the coastline, causing extreme winds, storms surge, and storm waves (Eliot & Pattiaratchi 2010).

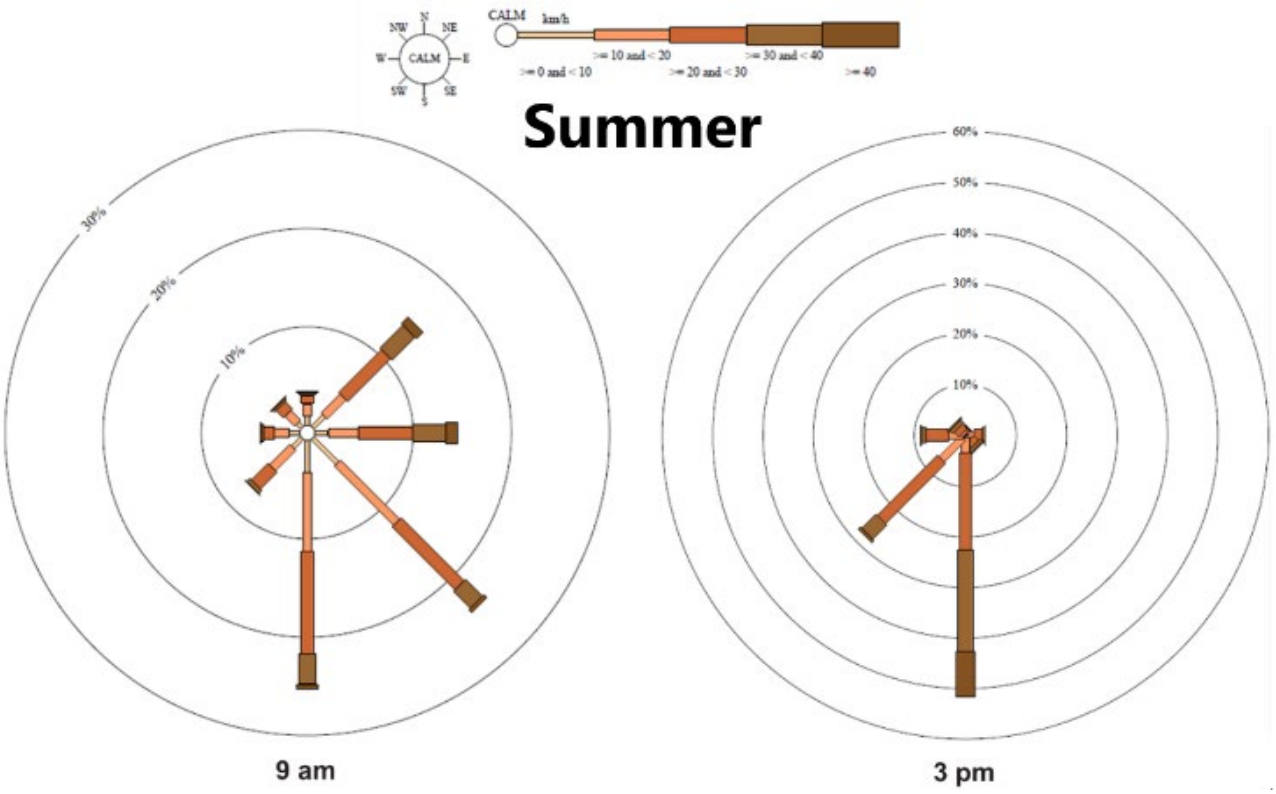


Figure 4-4: Wind roses for Geraldton, showing direction (%) vs wind speeds (km/h) at 9.00 am and 3.00 pm in summer 1941–2014 (source: BoM 2022b)

4.2.2 Oceanography

4.2.2.1 Tides

The SWST has a mixed, primarily diurnal, and partly semi-diurnal tidal regime. Tides off the WA coast generally increase in magnitude from south to north, with seasonal variation in tidal range as the annual cycle of diurnal tides peaks near the solstices in June and December (BoM 2023a; Eliot 2018).

Tides recorded at Port Denison (6 km north-west of the OA) are mainly diurnal and microtidal, with an average tidal range of approximately <1 m (BoM 2023a). Similarly, Geraldton (approximately 55 km north of the OA) tides are typically diurnal and microtidal. In the wider EMBA, Fremantle (approximately 260 km south-east of the OA) also experiences mainly diurnal microtidal conditions, with an average tidal range of approximately 0.7 m (DoT 2023) and surge and mean sea level fluctuations of comparable amplitude to the tide (BoM 2023a; Eliot 2018).

Due to the small range, tides in the SWST are influenced by the inter-annual variability of mean sea level and global long-term sea level rise, as well as meteorological processes including winds and cyclonic events that may override tidal patterns and contribute to greater sea level changes, such as storm tides (Eliot 2018).

4.2.2.2 Waves

The SWMR has high wave energy on the continental shelf around the whole region (DSEWPC 2012a). The offshore wave climate in the SWST is characterised by persistent moderate energy swell from the south to south-west, together with a variable local wind wave climate (Lemm et al. 1999; Masselink & Pattiaratchi 2001). Sea breezes have a strong influence on the offshore wave conditions during summer, therefore swell is from the south to south-west with predominantly low period (less than eight second [s]) waves in the range of 1–2 m (Lemm et al. 1999). In winter, north-westerly to south-westerly storm waves occur, characterised by high period (more than 8 s) swell and waves in the range of 1.5–2.5 m that show significant inter-annual variation (Lemm et al. 1999; Masselink & Pattiaratchi 2001). As such, there is a distinctive shift in the offshore wave regime from moderate, locally generated seas in summer to greater, distantly generated swell in winter. Persistent background swell above 0.5 m occurs year-round from the Indian and Southern oceans (Lemm et al. 1999).

Closer to the shore, the swell is frequently attenuated by up to 90% as waves propagate across the continental shelf through several offshore reef systems and islands, contributing to smaller wave heights (Sanderson et al. 2000; Hegge 1994). As such, the nearshore wave climate is more protected from longer waves in the prevailing south-westerly swell (Hegge 1994; Lemm et al. 1999; Masselink & Pattiaratchi 2001). Wave heights are approximately 30–70% of offshore outside the reef system depending on the location and typically increase northward due to a reduction of reefs, ridges, and islands (Masselink & Pattiaratchi 2001). For example, in the Perth metropolitan area in the south of the SWST, mean significant wave heights in the summer and winter are approximately 1.5 m and 2.5 m, respectively (Masselink & Pattiaratchi 2001).

Waves are also highly influenced by meteorological processes including winds and cyclonic events. In WA, continental shelf waves are generated by the passage of tropical cyclones in the northern part of the state and may propagate for thousands of kilometres influencing local wave climates in the SWST (Eliot & Pattiaratchi 2010).

4.2.2.3 Oceanic temperature

Current data available from the National Oceanic and Atmospheric Administration (NOAA) shows the mean annual sea surface temperature (SST) in the OA and EMBA is approximately 21–23 °C (Boyer et al. 2018a). SST typically peaks in January–February and is lowest in July–August (BoM 2023b; IMOS 2023).

Oceanic temperatures in the SWST transition between warmer waters of the tropics (at the northern limit) and cooler waters of the mid latitudes (at the southern limit), with seasonal and depth variations related to the currents in the region.

Oceanic temperatures vary in cycles: inter-annual (longer-term), annual (seasonal), short-term (multi-day weather related) and diurnal (daily).

Historically, oceanic temperatures recorded in the region were approximately 19–24 °C in summer and 16–21 °C in winter, with a mean annual temperature range (i.e., winter minimum to summer maximum) of 3–7 °C (Pearce et al. 1999). The along-shore temperature gradient was approximately 0.4 °C per degree of latitude. The short-term cycle had a typical range of 1–2 °C, while the mean diurnal temperature range was approximately 0.2 °C (deep offshore waters) to 1.7 °C (inshore waters during mid-summer; Pearce et al. 1999).

At the Abrolhos Islands (approximately 60 km north-west of the OA), the Leeuwin Current (LC) maintains warmer temperatures over winter, effectively dampening atmospheric influences and restricting the annual variation to approximately 20–24 °C (Pearce et al. 1999; Phillips & Huisman 2009). Conversely, the shallow coastal waters of Dongara (approximately 6 km east of the OA) are more directly influenced by atmospheric conditions, with mean monthly temperatures ranging between 17.5 °C in July and 23.9 °C in February (based on data from 1990 to 1994), in phase with coastal air temperatures (Pearce et al. 1999; Phillips & Huisman 2009).

Climate change has caused a warming trend (approximately 0.02 °C year) in SSTs in the south-eastern Indian Ocean, and warmer than average temperatures persist off the WA coast (BoM 2023c). SSTs along the WA coast have also shown strong seasonal and inter-annual variability over recent decades, with increases/decreases in mean monthly SST by up to 2 °C in interannual cycles between 1993 and 2018, mainly associated with ENSO events (Pattiaratchi & Hetzel 2020). During La Niña events, a strong LC transports warm water southwards, whereas during El Niño events, the LC is weaker with generally lower water temperatures (Chen et al. 2019). This variability greatly influences coastal ecosystems, for example, the 2011 La Niña event, created a severe marine heatwave along the WA coast (Pearce & Feng 2013).

4.2.2.4 Currents

The primary current in the SWST is the LC system, which includes three main currents: the LC, the Leeuwin Undercurrent (LU), and the shelf current systems consisting of the Capes and Ningaloo currents (Pattiaratchi & Woo 2009). The LC is a shallow (<300 m), narrow band (<100 km wide) of warm, lower salinity, nutrient depleted water of tropical origin that flows southward along the western perimeter of the region from Exmouth to Cape Leeuwin and into the Great Australian Bight (Pattiaratchi & Woo 2009) (Figure 4-5). The LC flows year-round with seasonal variability, typically strengthening in autumn–winter and weakening in summer when winds blow from the south (Cresswell & Domingues 2009; Pattiaratchi & Woo, 2009). The strength of the LC is also driven by ENSO events, strengthening during La Niña and weakening during El Niño periods (DEWR 2007; Pattiaratchi & Woo, 2009).

The LC strongly affects the ecology of the region by supressing the upwelling of cooler, nutrient-rich waters while generating localised eddies through the interaction with seabed topography and offshore waters of different densities (Pattiaratchi & Woo 2009; DEWHA 2008b). Eddies form at the shelf break and eventually separate from the current and drift westward (McClatchie et al. 2006). Eddies generate cross-shelf currents that connect the continental shelf and deeper waters, providing nutrients on the continental shelf that enhance biological productivity (DEWHA 2008b). LC eddies have been observed off Shark Bay, the western edge of the Abrolhos Islands, south-west of Jurien Bay, the Perth Canyon, south-west of the Capes region, south of Albany and south of Esperance (DEWR 2007) (Figure 4-5).

The LC also plays a key role in the distribution of species in the region. The warm water transported southward has extended the distribution of tropical and subtropical species to areas further south than would otherwise occur. Additionally, the LC and the deeper Flinders Current form a ‘conveyor belt’ system that is likely used for large-scale movements by migratory species (DEWR 2007). The LC system interacts with the other main currents in the region: the LU, the Western Australian Current (WAC), and the coastal Ningaloo, Capes and Cresswell currents (McClatchie et al. 2006) (Figure 4-5). The LU is a deeper, subsurface current that flows northward beneath the LC over the continental slope, while the WAC is a shallow, northward flowing surface current farther offshore from the LC (Pattiaratchi & Woo 2009; DEHWA 2008b) (Figure 4-6).

The coastal currents are driven by wind and subsequently exhibit considerable seasonal variability and influence on the biological communities in the region (Pattiaratchi & Woo 2009). The Capes current is an inner shelf current that originates in the Capes region and flows northward in the summer months to the Abrolhos Islands. The current transports cool and saline water, together with the larvae of temperate species, contributing to the upwelling of cold water on the continental shelf by displacing the LC further offshore (Pattiaratchi & Woo 2009; DEHWA 2008b). Typical seasonal current distributions in the OA are shown in Figure 4-7.

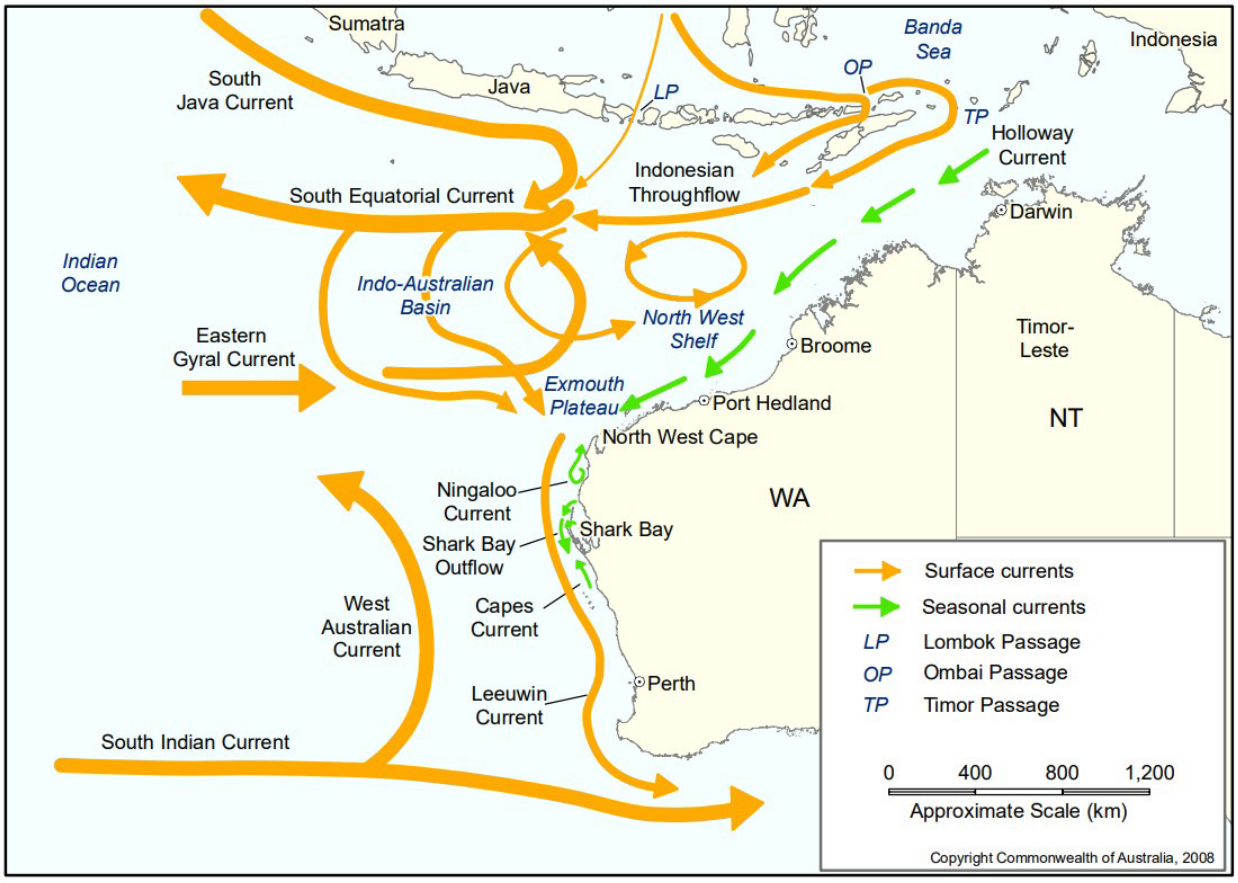


Figure 4-5: Surface currents in Western Australian waters. Source: DEWHA (2007)

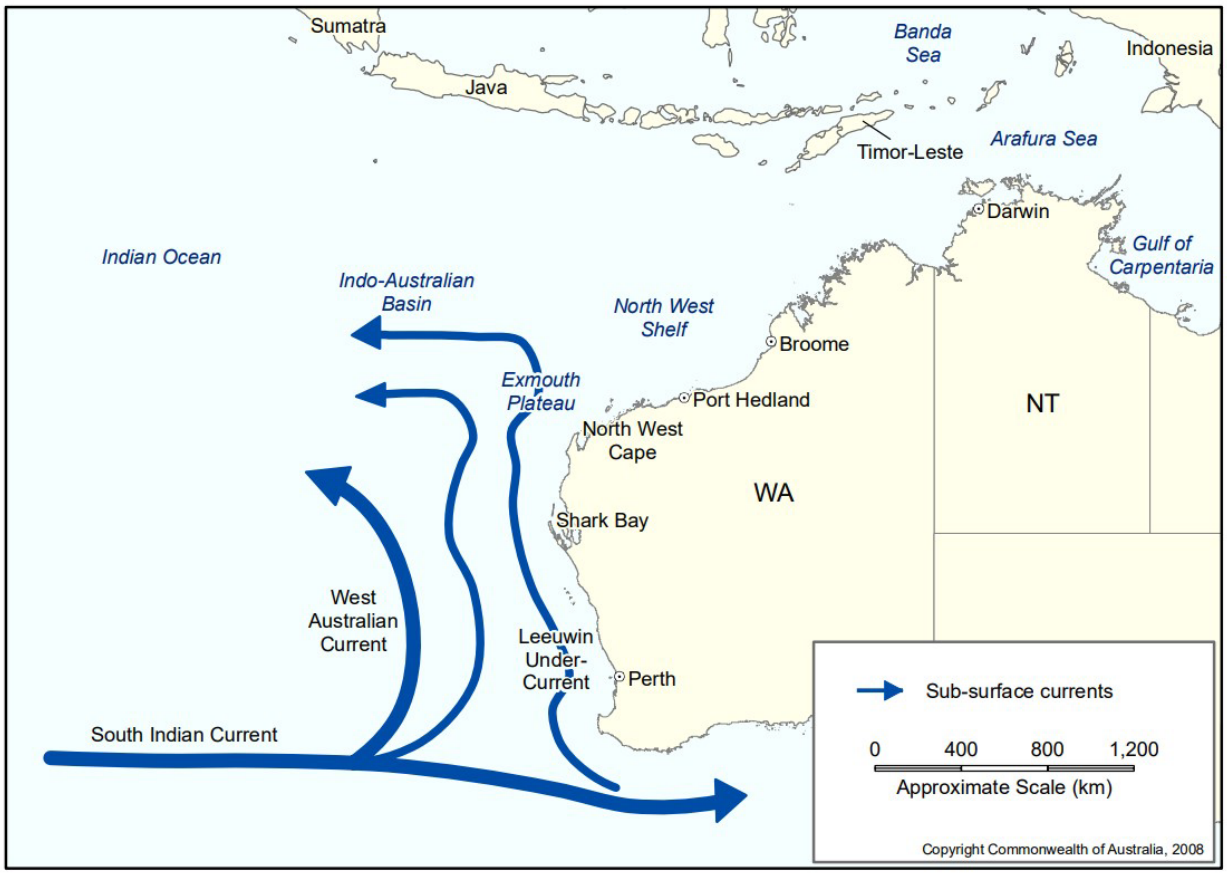


Figure 4-6: Subsurface currents in WA waters (Source: DEWHA 2007)

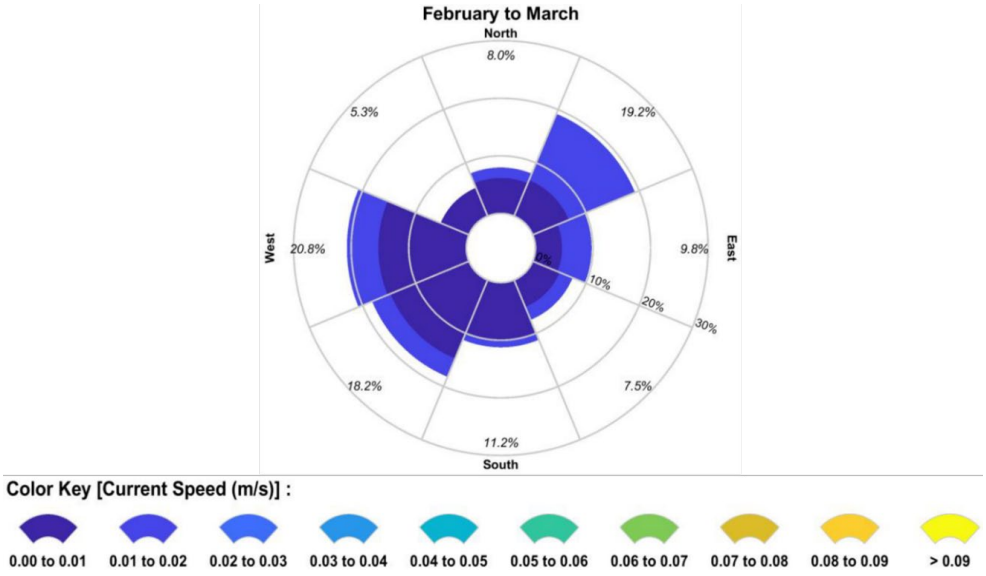


Figure 4-7: Typical seasonal current distributions (2006 – 2015, inclusive) in the OA. The colour key shows the current magnitude, the compass direction provides the direction towards which the current is flowing, and the size of the wedge gives the percentage of the record (Source: RPS 2023)

4.2.2.5 Salinity

Current data available from NOAA and BoM shows annual surface salinity in the OA and EMBA is approximately 35–36 practical salinity units (PSU) (Boyer et al. 2018b; BoM 2023b). Historically, salinity recorded in the region was also approximately 35–36 PSU (McClatchie et al. 2006; Pattiaratchi & Woo 2009; Chen et al. 2019).

Salinity off the WA coast transitions between warmer, lower salinity waters near the tropics to cooler, higher salinity waters off south-western Australia (McClatchie et al. 2006), with seasonal and interannual variability associated with the LC and ENSO events. The LC brings lower salinity water of tropical origin southward through the SWST and is typically stronger in the autumn–winter, reducing local salinity (Chen et al. 2019; Pattiaratchi & Woo 2009). ENSO events drive interannual variability, for example, higher salinity was recorded during the El Niño event in 2010, with a corresponding decrease in salinity during the strong La Niña event in 2011 (Chen et al. 2019).

WA also experiences high evaporation rates during the summer months, especially in the northern region, resulting in more saline and dense shallow coastal waters. This creates a cross-shelf gradient with deeper waters, i.e., salinity is more uniform in the surface waters offshore (Chen et al. 2019).

4.2.2.6 Water quality

Waters in the SWMR are characterised by low levels of biological productivity and nutrients (DEWR 2007; DEWHA 2008b). The LC is the primary driver of water quality off the WA coast, bringing nutrient depleted water of tropical origin southward while suppressing the upwelling of nutrient-rich waters of the northward WAC along the continental shelf (Pearce 1991; Pattiaratchi & Woo 2009). The LC typically weakens during summer, facilitating more upwelling of nutrient-rich waters along the continental shelf (Cresswell & Domingues 2009; Pattiaratchi & Woo, 2009). The LC also increases biological productivity around localised eddies that generate cross-shelf currents connecting the continental shelf and deeper waters, providing nutrients on the continental shelf (DEWHA 2008b).

The SWMR is also characterised by the absence of high-flowing river systems and consequently a limited amount of terrigenous (originating from the land) nutrient inputs, which greatly influences the ecology of the region (DEWR 2007; DEWHA 2008b). The suppression of large-scale upwelling by the LC together with limited nutrient inputs from the land maintains the relatively nutrient-poor conditions in the region compared to other marine environments. The low river discharge and generally low biological productivity also results in low turbidity (suspended sediments), making the waters of the region relatively clear (DEWR 2007; DEWHA 2008b). This allows light to penetrate to benthic communities at greater depths and provides for light-dependent species and associated communities to be found deeper than elsewhere (up to 120 m in some parts of the SWMR; DEWR 2007; DEWHA 2008b).

In nearshore areas, turbidity also varies due to periodic storm run-off and wind generated waves (Pearce et al. 2003). For example, major sediment transport associated with tropical cyclones in the northern part of WA may influence turbidity on a regional scale (Brewer et al. 2007).

4.2.3 Bathymetry and geomorphology

The bathymetry in the OA and EMBA is primarily characterised by flat seabed and parallel ridges along the continental shelf. Water depths in the OA range from approximately 10 m on the eastern perimeter (shallower over reefs) to approximately 60 m in the south-west corner, with most of the OA between 25 and 50 m deep (Figure 3-2). The wider EMBA gradually slopes from the coastline towards the shelf edge and is approximately 10–200 m deep (Figure 3-2). Prominent features in the EMBA include the reefs, submerged banks/shoals, deep holes, and valley features surrounding the Abrolhos Islands 60–80 km offshore, as well as fringing coastal reefs and intertidal areas along the coastline (Figure 4-8). During consultation information was provided to indicate that some reef areas may at times be shallower than 10m.

The continental shelf between Geraldton and Cape Leeuwin is named the Rottnest Shelf (RS), which ranges from approximately 40 to 80 km wide, with a depth of 10–200 m. Important features on the RS include the Abrolhos Islands, Beagle Islands, Rottnest Island, Garden Island, Cockburn Sound, and inshore lagoons that run parallel to the coastline

(DEWR 2007). The RS includes a steep shoreface (<30 m deep), a flat inner shelf plain (30–50 m deep), a linear ridge complex (~40 m deep) and an outer shelf sloping to the shelf edge (~200 m deep) (McClatchie et al. 2006). Parallel limestone ridges and depressions 5–10 km offshore stand 10–20 m above the sea floor creating an extensive area of shallow water on the shelf, which is indicative of the geomorphology of the OA (DEWR 2007). The edge of the RS contains a series of broken offshore ridges that extend to the northern limits of the SWST, where they emerge to support the carbonate reef growth of the Abrolhos Islands (DEWHA 2008b). The RS supports sandy seabed, limestone pavement, patch reef, emergent reef, and seagrasses, providing shallow water habitats for many marine communities (DEWR 2007).

The escarpment at the RS boundary marks the ancient sub-aerially exposed land surface and coastline (beach and dune deposits), known as the ancient coastline. The ancient coastline between 90 and 120 m depth is designated as a Key Ecological Feature (KEF) and runs through the western perimeter of the EMBA (Figure 4-9). This area provides hard substrate and may support greater diversity and species richness relative to surrounding areas of soft sediment (DSEWPC 2012a).

Beyond the RS lies an extensive continental slope incised by terraces and submarine canyons, a well-developed continental rise, and an extensive area of abyssal plain/deep ocean floor (McClatchie et al. 2006; Richardson et al. 2005). The continental slope includes the Perth Canyon, which is the largest and most significant on the Australian margin, and a designated KEF.

4.2.4 Sedimentology

Sediments in the OA and EMBA are broadly characterised by calcareous gravel, sand, and silt. This type of substrate is known to support relatively little seabed structure or sessile epibenthos. Habitats closer to the shore are categorised as sand and reef, with some small areas of exposed reef and macroalgae meadow.

In the SWST, surface sediments primarily contain cool-water carbonate facies on the shelf and warm-water tropical carbonate facies on the reef platforms (Richardson et al. 2005). Shelf sediments contain the skeletal remains of bryozoans, molluscs, foraminifers, and coralline algae, and typically occur as discontinuous sheets over rocky or algal substrates (Richardson et al. 2005). On the reef platforms, scattered zooxanthellate coral fragments reflect warm-water sediment types (Richardson et al. 2005).

Oceanographic processes drive sediment transport in the region. Off the coast of south-west WA, sediments are mobilised in up to 100 m water depth and are generally transported off the shelf (Richardson et al. 2005). The micro tides in SWST play a relatively minor role in sediment transport on the shelf (Richardson et al. 2005).

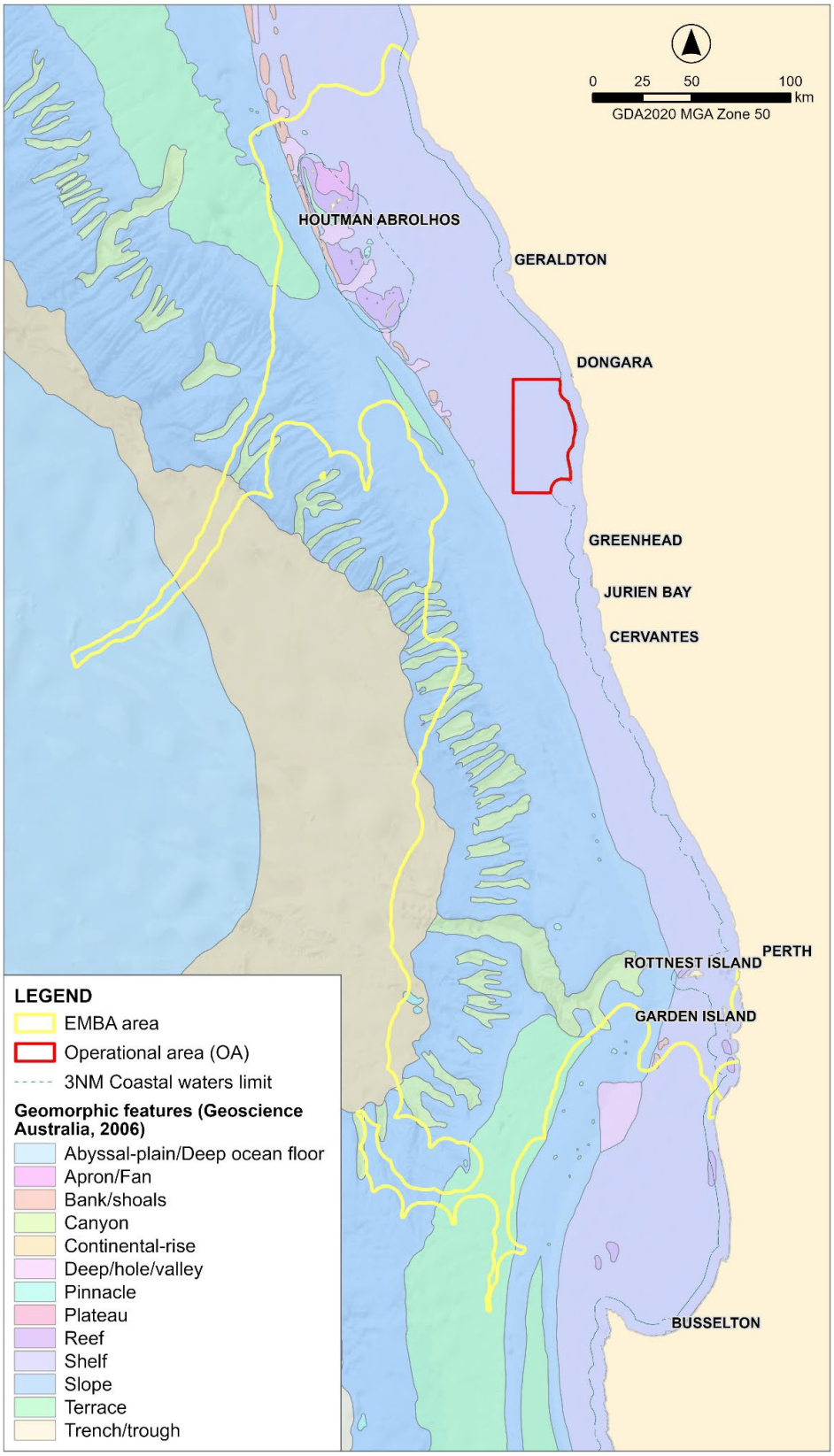


Figure 4-8: Geomorphic features of the OA and EMBA

4.3 Biological environment

4.3.1 Plankton communities

Plankton consists of microscopic organisms typically divided into phytoplankton (algae) and zooplankton (fauna including larvae). Plankton play a major role in the trophic system with phytoplankton being a primary producer and zooplankton being a primary consumer. Phytoplankton rapidly multiply in response to bursts of nutrient availability and are subsequently consumed by zooplankton that in turn are consumed by other fauna species.

Spatial distribution of phytoplankton and zooplankton is irregular, both vertically and horizontally and temporally. Sporadic/short-lived and potentially localised episodes of nutrient upwelling can occur as a result of internal waves (the rising and sinking of sea water layers of different densities) at the shelf break, wind-driven currents, or cyclonic activity, which influence higher plankton concentrations.

Plankton within the OA are expected to reflect the conditions of the SWMR on-shelf areas. A large-scale study of plankton dynamics across the northern areas of the SWMR found distinct phytoplankton and zooplankton assemblages from on-shelf and offshore areas (Koslow et al. 2006). Surface waters of the south-western shelf have low nutrient availability, with phytoplankton occurring in higher concentrations near areas where upwelling of deeper, nutrient-rich water occurs (Koslow et al. 2006). The most common plankton in the offshore waters of the south-west Australian shelf are diatoms (single-cell algae with cell walls made of silica); however, the LC also supplies a high proportion of tropical phytoplankton to the area (Koslow et al. 2006). Significant predictable eddy fields occur near the OA, such as offshore of the Abrolhos Islands and south-west of Jurien Bay (Pattiaratchi 2007). These eddies provide mesoscale upwelling, providing nutrients to the local region and increasing plankton productivity. Occasional blooms may occur in the OA, increasing productivity in the region. However, typically the area will consist of warm, nutrient-poor waters (Pattiaratchi 2007).

4.3.2 Benthic habitats and communities

The distribution of benthic communities in the SWMR depends on the water depth, substrate, sediment characteristics, and the availability of food. The OA lies within the Central West Coast (CWC) IMCRA meso-scale region. The CWC is characterised by a relatively narrow continental shelf with diverse moderate energy coastal landforms (IMCRA 1997). The area is typically characterised by temperate species; however, due to warm currents is also characterised by many tropical and sub-tropical species (Fletcher et al. 2011). The sediments within the CWC are expected to be broadly characterised by calcareous gravel, sand, and silt. This type of substrate is known to support relatively little seabed structure or sessile epibenthos. The area is likely sparsely covered by sessile filter-feeding organisms (e.g., gorgonians, sponges, ascidians, and bryozoans) and mobile invertebrates such as echinoderms, prawns, and detritus-feeding crabs (DEWHA 2008b). Habitat closer to the shore is categorised as sand and reef, with some small areas of exposed reef and macroalgae meadow. These areas have greater biodiversity and complexity.

Figure 4-8 shows several banks and shoals located within the EMBA that may support diverse benthic assemblages. Previous benthic surveys commissioned by Roc Oil in 2004–2007 for the Cliff Head Development found five key benthic habitats in the area:

- Sand sea floor habitat:
  - Sub-tidal areas with thick layer of sand over limestone pavement
  - Low epibiota, small patches of macroalgae/ephemeral seagrasses
- Limestone pavement habitat:
  - Red and brown macroalgae dominated habitat
  - Low epibiota, some presence of sessile fauna filter feeders (sponges, ascidians, soft corals) and sparse hard corals
- Patch reef habitat:

- High profile structures, rising one to four metres above sea floor
- Tropical and subtropical hard coral species as well as macroalgae and sessile filter feeders (sponges, soft coral)

- Emergent reef habitat:
  - Rich in epibiota diversity
  - High abundance of sponges and ascidians, macroalgae and encrusting corals
  - Approximately 37 genera of coral present at Abrolhos Islands reefs (within the EMBA)
- Seagrass/macroalgae habitat:
  - Fourteen species of seagrass present in region, covering sea floor and limestone pavement habitats
  - Only present in fringe shallow areas of the OA and EMBA.

It is expected that the OA and EMBA would support similar epibenthos as those found in the Cliff Head benthic surveys due to shared bioregions and comparable benthic habitat, sediments, and geomorphic features. The EMBA also contains KEFs that support a range of benthic habitats and communities. Benthic habitats associated with KEFs within the OA and/or EMBA are described in Section 4.3.6.

4.3.2.1 Corals

Corals in WA span over 12,000 km of coastline, ranging from tropical to temperate waters, and from coastal reefs to offshore atolls. Coral communities off the west coast are characterised by widely contrasting environments, with high biodiversity and species richness, partly due to the biogeographic overlap of tropical and temperate species (DEWHA 2008b).

Coral diversity typically decreases with increasing latitude (Gilmour et al. 2016). Low latitude reefs in the Kimberley have the highest species diversity and the greatest differences in community composition between oceanic and coastal reefs (Gilmour et al. 2016). The sub-tropical reefs of the Abrolhos Islands are the most southern extensive coral community along the west coast, comprising 184 known coral species (McClatchie et al. 2006). The southward flowing LC moderates winter temperatures and assists the transport of coral larvae, extending the distribution of tropical and subtropical species to areas further south than would otherwise occur. To the south of the Abrolhos Islands, abundant corals mainly occur around offshore islands, with corals at inshore sites occurring in isolated patches (DEWHA 2008b). Smaller localised pockets do occur as far south as Cape Naturaliste (DEWHA 2008b).

The primary differences in community composition across WA are the greater abundance of Acroporidae and massive *Porites* on offshore reefs and tropical reefs north of the Abrolhos Islands, with *Faviidae*, Pocilloporidae, *Turbinaria* and/or *Pavona* more abundant among inshore reefs and those souths of the Abrolhos Islands (Gilmour et al. 2016).

WA also has a diverse range of coral reproduction patterns, which vary with coral community composition, modes of reproduction and the cycles of gametogenesis for coral species (Gilmour et al. 2016). The dominant mode of coral reproduction is broadcast spawning; however, the spawning period and the degree of synchrony varies between tropical and temperate regions. The primary period of coral spawning in WA, including in the mid-west and around the Abrolhos Islands is in autumn, often culminating in the mass spawning of many species and colonies during March and/or April (Gilmour et al. 2016). In the temperate south-west, where corals are near their geographical limit, coral spawning occurs around summer and autumn between approximately January and May (Gilmour et al. 2016).

4.3.3 Fish assemblages

Fish communities in the SWMR are diverse, with over 900 species occupying a variety of habitats (DSEWPC 2012a). The SWST supports a gradient of fish communities that extends from the tropical ecosystems of Shark Bay, south along the continental shelf to the temperate ecosystems at Rottnest Island (DEWHA 2008b). Fish assemblages are shaped by depth

and habitat, as well as currents such as the LC, which extends the distribution of many tropical and sub-tropical species south down the west coast. Consequently, the EMBA represents the northern limit of many warm temperate fish species, and the southern limit of many sub-tropical and tropical species. For example, the coral reefs around the Abrolhos Islands support a diverse and unique mix of temperate and tropical species (DEWHA 2008b).

The fish assemblages in the OA and/or EMBA are primarily characterised by temperate and subtropical fishes, including many species endemic to the west coast (McClatchie et al. 2006) and several that are targeted by commercial and recreational fishers. On the continental shelf, the variety of benthic habitats support diverse demersal fish assemblages. Key inshore (20–250 m) demersal species include the commercially important WA dhufish (*Glaucosoma hebraicum*), pink snapper (*Pagrus auratus*), baldchin groper (*Choerodon rubescens*) and red-throat emperor (*Lethrinus miniatus*), as well as blue groper (*Achoerodus gouldii*) and the endemic breaksea cod (*Epinephelides armatus*). The Abrolhos region supports approximately 400 known species of demersal fish (DEWHA 2008b) and marks the southern limit in WA for some widespread Indo-Pacific tropical finfish species, such as goldband snapper (*Pristipomoides multidens*). Tropical reef fish species such as those found at the Abrolhos Islands are unlikely to occur in the OA. Key nearshore (<20 m) demersal or benthopelagic (living and feeding near the bottom as well as in midwaters or near the surface) species include the commercially important sea mullet (*Mugil cephalus*) and yellowfin whiting (*Sillago schomburgkii*) (Newman et al. 2023; McClatchie et al. 2006). Key offshore (>250 m) demersal species include the commercially important hapuku (*Polyprion oxygeneios*), blue-eye trevalla (*Hyperoglyphe antarctica*) and eightbar grouper (*Hyporthodus octofasciatus*) (Newman et al. 2023). Other demersal fishes such as apogonids/cardinalfishes (Family Apogonidae), leatherjackets (Family Monacanthidae) and flatheads (Family Platycephalidae) may also occur in the EMBA.

Some demersal species are site-attached or habitat dependent, and do not move away from their home reef, seagrass bed or sand patch. Other species occupy a wide range across several habitats throughout their life cycle (McClatchie et al. 2006). The inshore lagoons in the EMBA are important for the recruitment of commercially and recreationally important species (and it is assumed many other fish species; DEWR 2007). Many juvenile demersal species use inshore, seagrass or sandy/muddy bay habitats for feeding and protection, before migrating offshore as adults to reefs or other habitats (e.g., pink snapper; McClatchie et al. 2006; DEWR 2007).

Key pelagic fishes that occur in the EMBA include mackerels (e.g., Spanish mackerel; *Scomberomorus commerson*), large carangids (e.g., samson fish; *Seriola hippos*), tunas (e.g., southern bluefin tuna; *Thunnus maccoyii*) and billfishes. These large predatory species are typically highly mobile, although they may be associated with specific habitats or bathymetric features. Due to their typical depth and range, oceanic species such as southern bluefin tuna are unlikely to occur in the OA. Schools of migratory fish that visit the inshore/nearshore areas of the EMBA include tailor (*Pomatomus saltatrix*; pelagic-oceanic) and WA salmon (*Arripis truttacea*; pelagic-netric; Newman et al. 2023; DEWHA 2008b). These mid-sized predators feed on small pelagic fish and invertebrates found throughout the inshore lagoons, and in turn are preyed upon by larger predators such as snapper, samson fish, Spanish mackerel, and sharks (DEWHA 2008b). Smaller pelagic fishes in the EMBA include Australian herring (*Arripis georgiana*; pelagic-netric), southern garfish (*Hyporhamphus melanochir*; pelagic-neritic), pilchards (family *Clupeidae*; mostly pelagic-neritic), and whitebait (*Hyperlophus vittatus*; pelagic-neritic, brackish, amphidromous; Newman et al. 2023; McClatchie et al. 2006). Smaller pelagic species are typically pelagic-netric (occupying shallow pelagic zone over the continental shelf) and may also occupy brackish habitats. Small pelagic fishes are key fish communities in the SWMR, providing a critical link between primary production and higher predators and are an important prey item for a diverse range of species (DEWHA 2008b).

Fish spawning may occur year-round, although some species are known to have distinct seasonal spawning periods (Table 4-3). Most finfish species undergo a planktonic larval phase.

The EPBC Act Protected Matters Search Tool (PMST) was used to identify listed species under the EPBC Act that may occur within the OA and/or EMBA (report in Appendix B). The PMST identified three species listed as threatened under the EPBC Act that may occur in the OA and/or EMBA (Table 4-5). A description of the identified threatened fishes is provided in Table 4-2, including their distribution, migratory movements, preferred habitat, and likely presence within the EMBA. Balston's pygmy perch (*Nannatherina balstoni*) is a freshwater species identified by the PMST. Balston's pygmy perch complete their life cycle in freshwater environments (Bray & Gomon 2023; Froese & Pauly 2023); therefore, this species is not included in Table 4-2 and Table 4-5.

The PMST (Appendix B) also identified 18 pipefish species, three pipehorse species, three seahorse species and two seadragon species listed as Marine under the EPBC Act that may occur in the OA and/or EMBA. Listed marine species are not considered threatened under the EPBC Act. The majority of the listed syngnathids (pipefish, pipehorses, seahorses, and seadragons) occupy nearshore and inner shelf habitats that occur in the OA and/or EMBA, typically among seagrasses, mangroves, coral reefs, macroalgae dominated reefs, and sand or rubble (Bray & Gomon 2023; Froese & Pauly 2023; McClatchie et al. 2006). Where depth ranges are known, only two of the 26 listed species are typically recorded in water depths greater than 50 m (Bray & Gomon 2023; Froese & Pauly 2023). Consequently, the listed species may occur in the shallow inshore habitats of the OA and/or EMBA.

4.3.4 Commercially targeted fish stocks

The SWMR supports commercial fisheries that target a variety of demersal and pelagic fish species. The WA Department of Primary Industries and Regional Development (DPIRD) provided data on the distribution and spawning of fish species that are indicative of fish stocks targeted by fisheries in the OA and EMBA. These species are known as key indicator species and are used in the management of commercial fish stocks. Indicator species are selected from a suite of commercially targeted fishes (based on their vulnerability, management importance and sustainability risk) to represent the status of the overall resource. The status of a suite (e.g., demersal finfish) is evaluated based on the risk status of several indicator species, which represent the more vulnerable species within that suite (Newman et al. 2023).

Table 4-3 summarises the distribution, habitat, depth range and spawning period of indicator species that are relevant to the OA and EMBA. Refer to Section 4.4.2 for more information on commercial fisheries in the OA and EMBA.

4.3.5 Commercially targeted invertebrates

The SWMR supports commercial fisheries that target a variety of invertebrate species. Table 4-4 summarises the distribution, habitat, depth range and spawning period of indicator species that are relevant to the OA and EMBA. Refer to Section 4.4.2 for more information on commercial fisheries in the OA and EMBA.

Table 4-2: Listed threatened fishes potentially occurring within the EMBA

Common name	Habitat, distribution, and seasonality	Presence in EMBA
Orange roughy	Habitat and distribution	May occur
	Orange roughy (*Hoplostethus atlanticus*) are a benthopelagic (living and feeding near the bottom as well as in midwaters or near the surface) species that inhabits the deep ocean, with a depth range of approximately 180–1809 m and a usual depth range of 400–900 m (Froese & Pauly 2023). Orange roughy are widespread and are found around southern and south-eastern Australia and New Zealand, in the western Pacific Ocean, the Atlantic Ocean, and in the eastern Pacific Ocean off Chile. In Australian waters, they occur from central NSW, through to south-western Australia, including Tasmania (Bray & Gomon 2023). Orange roughy typically aggregate over steep continental slopes, ocean ridges and seamounts, where they feed on crustaceans and fish (Froese & Pauly 2023). They are slow growing, late to mature, and one of the longest-lived fish species known (Froese & Pauly 2023). Orange roughy may occur in the EMBA; however, their presence in the OA is unlikely as their typical depth range exceeds the maximum depth of the OA.	
	Seasonality	
	Orange roughy are oceanodromous, typically migrating between spawning and different feeding areas (Froese & Pauly 2023). They are synchronous annual spawners, forming dense spawning aggregations around seamounts, ridges, canyons, and plateaus. Several stocks may exist at distinct seasonal spawning sites (Bray & Gomon 2023; Froese & Pauly 2023).	

Table 4-3: Key inshore and offshore commercial indicator fish species relevant to the OA and EMBA

Species	Distribution and habitat	Biological stock range	Principal depth range	Reproduction and recruitment	Spawning season	Relevance to EP
WA dhufish (*Glaucosoma hebraicum*)	WA dhufish are a demersal, non-migratory species endemic to western and southwestern Australia, from Shark Bay to Esperance (Lewis et al. 2012; Bray & Gomon 2023; Froese & Pauly 2023). Adults are generally sedentary and inhabit low to high profile reefs, rocky outcrops, ledges, and hard/flat seabeds, typically 20–50 m deep (Lewis et al. 2012; Bray & Gomon 2023; Froese & Pauly 2023). Juveniles inhabit predominantly sandy areas of low to medium profile reef with mixed macroalgae, sponge and seagrass, as well as seagrass beds in sandy areas (Lewis et al. 2012; Bray & Gomon 2023; Froese & Pauly 2023). Juveniles typically occur in shallower waters 2–48 m deep (Lewis et al. 2012).	WA dhufish are genetically homogeneous in WA, representing a single biological stock (Berry et al. 2012; Fairclough et al. 2013; Smallwood et al. 2013).	Adults 3–200 m (Fairclough & Fisher 2023). Typically occur in 20 – 50 m (Bray & Gomon, 2023; DoF 2011). Juveniles 2–48 m (Lewis et al. 2012).	WA dhufish are gonochoristic broadcast spawners, releasing floating, pelagic eggs into the water column (Froese & Pauly 2023; Smallwood et al. 2013). Eggs and larvae are dispersed by currents and may travel long distances, contributing to variability in dhufish recruitment (addition of young fish to the overall fish population) to different parts of the coast (Berry et al. 2012; DPIRD 2023a). Spawning occurs throughout their range, typically over isolated reef outcrops and weed-covered sandy areas (DPIRD 2023a). WA dhufish with spawning and recently spent gonads have been captured in water depths ranging from 10 to 150 m, indicating spawning is not restricted to any particular water depth (Hesp et al. 2002) Older and larger female dhufish release more eggs per spawning season, making them important for overall dhufish stocks (DPIRD 2023a). Adults are generally sedentary and there is little evidence of movement once they recruit to an area as juveniles (Fairclough et al. 2013). Stock status Inadequate (Newman et al. 2023).	October to May. Peak December to March (Fairclough & Fisher 2023; Hesp et al. 2002; Berry et al. 2012).	Given their distribution, habitat, and principal depth ranges, adult and juvenile WA dhufish are likely to occur in the OA and/or EMBA. The proposed acquisition window (February–March) overlaps with two months of the eight-month WA dhufish spawning period (Table 4-12).
Pink snapper (*Pagrus auratus,* also known as *Chrysophrys auratus*)	Pink snapper are widely distributed throughout the western Indo-Pacific, including in coastal waters off southern Australia and northern New Zealand (Bray & Gomon 2023; DPIRD 2023b). In WA, they occur in warm temperate to sub-tropical waters from north of Karratha to the Great Australian Bight (Bray and Gomon 2023; DPIRD 2023b; Smallwood et al. 2013). Adults are primarily demersal and inhabit rocky reefs, muddy and sandy areas typically 20–200 m deep, moving to more protected waters for spawning (Bray & Gomon 2023; DPIRD 2023b). Adults can show strong site fidelity to a range of habitats (Bray & Gomon 2023; Froese & Pauly 2023). Juveniles and small adults typically occur in shallower habitats such as bays, inlets and estuaries, often over muddy and seagrass areas (Bray & Gomon 2023).	Pink snapper generally shows low genetic differentiation and high connectivity across WA (Bertram et al. 2022), representing a consistent biological stock. Genetic differentiation typically occurs only at large spatial scales (several hundred km) in Australia; however, it has been recorded at smaller scales in areas of the mid-west (e.g., Shark Bay) and south-east (Fairclough et al. 2013; Bertram et al. 2022).	1–200 m (Fairclough & Fisher 2023)	Pink snapper are gonochoristic serial spawners. Adults migrate to inshore waters for spawning, forming aggregations in known regions off the WA coast, typically in waters less than 50 m deep (Froese & Pauly 2023; Smallwood et al. 2013). In the north, individuals aggregate at inshore reefs around Shark Bay between autumn and spring (May–November), while further south, aggregations form in Cockburn Sound, Owen Anchorage and Warnbro Sound between mid-spring and early summer (October–December) as water temperatures increase (Moran et al. 2003; Lenanton et al. 2009; DPIRD 2023b; Froese & Pauly 2023). Adults that aggregate to spawn in certain areas (e.g., Cockburn Sound) may return to that location each year (DPIRD 2023b). Pelagic eggs and larvae produced at the two aggregation sites are kept there by localised currents. This helps keep the offspring in a protected environment, which juveniles use as a nursery (DPIRD 2023b). Stock status Inadequate (Newman et al. 2023).	May to November in the Mid-west/Kalbarri. Peak June to August (Fairclough & Fisher 2023).	Given their distribution, habitat, and principal depth range, pink snapper is likely to occur in the OA and/or EMBA. The proposed acquisition window (February–March) does not overlap with the pink snapper spawning period (Table 4-12).
Red-throat emperor (*Lethrinus miniatus*)	Red-throat emperor primarily occur in the western Pacific. In Australia, they occur from the central coast of WA to the central coast of NSW, with a discontinuous distribution across northern Australia (Bray & Gomon 2023; Froese & Pauly 2023). The Montebello Islands are the northern-most range in WA for red-throat emperor (van Herwerden et al. 2009). Adults are primarily demersal and non-migratory, inhabiting coral reefs, sandy and rubble areas during the day, before moving to sandy areas to forage at night (Bray & Gomon 2023; Froese & Pauly 2023). Juveniles inhabit shallower, inshore seagrass and mangrove habitats, moving into deeper water as they age (Bray & Gomon 2023; Froese & Pauly 2023).	There are two separate biological stocks of red-throat emperor in western and eastern Australian waters (van Herwerden et al. 2009). Genetic diversity is lower in the west coast population, and higher in the east coast population (van Herwerden et al. 2009). East and west coast populations are managed as separate stocks due to the level of genetic subdivision.	5–50 m (Fairclough & Fisher 2023)	Red-throat emperor are serial spawning, protogynous hermaphrodites that first function as females before changing sex during their life cycle to become males (Froese & Pauly 2023). Spawning occurs throughout their range but may occur at different times in different populations. Regional variation also occurs in reproductive parameters such as size and age at sex change (Williams et al. 2006). Eggs and larvae are pelagic. Stock status Undefined.	October to February. Peak December to February (Fairclough & Fisher 2023).	Given their distribution, habitat and principal depth range, red–throat emperor is likely to occur in the OA and/or EMBA. The proposed acquisition window (February–March) overlaps with one month of the three-month peak red-throat emperor spawning period.

Species	Distribution and habitat	Biological stock range	Principal depth range	Reproduction and recruitment	Spawning season	Relevance to EP
Baldchin groper (*Choerodon rubescens*)	Baldchin groper are a demersal species endemic to the west coast of WA, from Coral Bay to Geographe Bay (Bray & Gomon 2023; Froese & Pauly 2023). They are most abundant at the Abrolhos Islands, although are becoming increasingly common further south (Bray & Gomon 2023; DPIRD 2023c). Adults are generally sedentary and inhabit coral, rocky, and weedy reefs, while juveniles typically inhabit shallower, weedy areas near reefs (Bray & Gomon 2023; Froese & Pauly 2023).	Baldchin gropers are genetically homogeneous over all or most of WA, comprising a single biological stock (Fairclough et al. 2011; Gardner et al. 2015).	20–100 m	Baldchin groper are serial spawning, monandric protogynous hermaphrodites that first function as females before changing sex during their life cycle to become males (Smallwood et al. 2013; Bray & Gomon 2023; DPIRD 2023c). They usually mature as females at approximately 2–3 years of age and 27 cm long. They produce eggs for several years, before changing sex to male at approximately 8–12 years of age and 48–55 cm long (Bray & Gomon 2023; DPIRD 2023c). Spawning occurs near or in benthic reef habitats and at all depths throughout their distribution (Wise et al. 2007; Smallwood et al. 2013). Adults may form large spawning aggregations of up to 100 fish. Spawning at the Abrolhos Islands occurs from early spring to mid-summer (Bray & Gomon 2023; DPIRD 2023c). Eggs and larvae are pelagic (Smallwood et al. 2013). Baldchin gropers are relatively sedentary, and movement is confined to small spatial scales. Adults typically occupy the same areas where they were recruited (Fairclough et al. 2011). Stock status Inadequate (Newman et al. 2023).	August to January. Peak October to December (Fairclough & Fisher 2023)	Given their distribution, habitat, and principal depth range, baldchin groper are likely to occur in the OA and/or EMBA. The proposed acquisition window (February–March) does not overlap with the baldchin groper spawning period.
Hapuku (*Polyprion oxygeneios*)	Hapuku are a demersal species widespread in temperate oceans of the southern hemisphere (Wakefield et al. 2010; Bray & Gomon 2023). In Australia, they occur in deep (>100 m), continental shelf waters from NSW to south-west WA and Rottnest Island (Wakefield et al. 2010; Smallwood et al. 2013; Bray & Gomon 2023). Adults inhabit deep reefs, canyons and seamounts on the mid-continental shelf to upper slope (Wakefield et al. 2010; Bray & Gomon 2023). Juveniles are pelagic and primarily inhabit surface waters in association with drifting seaweed or floating objects (Smallwood et al. 2013; Bray & Gomon 2023; Froese & Pauly 2023).	The biological stock structure of hapuku throughout Australian waters is unknown. While there may be separate stocks in different geographic regions, the long pelagic juvenile phase of *Polyprion* spp. suggests widespread geographic connectivity and pan-oceanic mixing between southern hemisphere populations (Ball et al. 2000; Wakefield et al. 2010).	115–500 m	Hapuku is gonochoristic (separate males and females) and spawns during the Australian winter following a pre-spawning migration (Wakefield et al. 2010; Bray & Gomon 2023; Froese and Pauly 2023). Eggs and larvae are pelagic (Smallwood et al. 2013). *Polyprion* spp. have an extended pelagic juvenile stage of up to four years in oceanic waters (Ball et al. 2000; Wakefield et al. 2010). Juvenile hapuku in this phase reach sizes up to 670 mm total length (Wakefield et al. 2010). Stock status Sustainable (Newman et al. 2023).	June to September. Peak July to August (Fairclough & Fisher 2023).	Given their distribution, habitat, and principal depth range, hapuku are likely to occur in the EMBA. However, as their principal depth range is greater than the maximum depth of the OA, hapuku are unlikely to occur in the OA. The proposed acquisition window (February–March) does not overlap with the hapuku spawning period.
Blue-eye trevalla (*Hyperoglyphe antarctica*)	Blue-eye trevalla are widespread in oceans of the southern hemisphere (Bray & Gomon 2023). They are widely distributed southern temperate Australia and extend to sub-tropical latitudes in WA and southern Queensland (QLD) (Williams et al. 2017). Adults are benthopelagic and inhabit deep reefs, seamounts, ridges, and steep features on the upper continental slope, remaining close to the seabed during the day and moving up in the water column at night (Williams et al. 2017; Bray & Gomon 2023; Froese & Pauly 2023). Juveniles inhabit near-surface waters for the first two years of their life, sometimes in association with floating debris (Bray & Gomon 2023; Froese & Pauly 2023).	Recent studies have identified four adult blue-eye trevalla stock areas in Australia west, south, east and seamounts-Lord Howe (Williams et al. 2017). Each of these areas represents a discrete adult sub-population without extensive migration between them. However, there is broad-scale connectivity between regional populations of blue-eye trevalla during their pelagic early life phase, and some of the adult subpopulations act as larger 'sinks' than others, i.e., benefiting more from recruitment derived from 'upstream' spawning areas (Williams et al. 2017).	250–650 m	Blue-eye trevalla are serial spawners. Females reach reproductive maturity at 11–12 years of age, and males at 8–9 years of age (Bray & Gomon 2023). Spawning occurs in summer and autumn as adults aggregate in shallower waters from central NSW to north-eastern Tasmania (Smallwood et al. 2013; Bray & Gomon 2023). Females produce approximately 2–11 million eggs per spawning season, releasing them in several batches (Bray & Gomon 2023; Froese & Pauly 2023). Eggs and larvae are pelagic (Smallwood et al. 2013). Stock status Sustainable (Newman et al. 203).	November to May (Fairclough & Fisher 2023).	Given their distribution, habitat, and principal depth range, blue-eye trevalla are likely to occur in the EMBA. However, as their principal depth range is greater than the maximum depth of the OA, blue-eye trevalla are unlikely to occur in the OA. The proposed acquisition window (February–March) overlaps with two months of the blue-eye trevalla seven-month spawning period.

Species	Distribution and habitat	Biological stock range	Principal depth range	Reproduction and recruitment	Spawning season	Relevance to EP
Eightbar grouper (*Hyporthodus octofasciatus*)	Eightbar grouper are a deep-water demersal species distributed throughout the western and central Indo-Pacific (Wakefield et al. 2013a; Bray & Gomon 2023). In Australia, they occur in tropical and temperate waters on the outer continental shelf from WA, across northern Australia to QLD. They are widely distributed throughout WA off the north, west and south coasts, and typically inhabit offshore atolls and deeper, rocky reefs (Wakefield et al. 2013a; Bray & Gomon 2023).	The biological stock structure and population connectivity of eightbar grouper is unknown in Australian waters (Wakefield et al. 2013a). They have a continuous distribution throughout WA but do not reproduce in temperate waters south of ~30°S (Wakefield et al. 2013a), suggesting connectivity and recruitment from the northern tropical region.	105–480 m	Eightbar grouper are monandric protogynous hermaphrodites that first function as females before changing sex during their life cycle to become males (Wakefield et al. 2013a). Spawning occurs from late spring to summer in north-western Australia (Wakefield et al. 2013a). Eggs and larvae are pelagic (Smallwood et al. 2013). There is no evidence of eightbar grouper reproduction or males being observed south of ~30°S. While population connectivity is unknown, the spawning omission in temperate waters suggests recruitment from the northern tropical region (Wakefield et al. 2013a). Stock status Sustainable (Newman et al. 2023).	October–February. Peak November–January (Fairclough & Fisher 2023).	Given their distribution, habitat, and principal depth range, eightbar grouper are likely to occur in the EMBA. However, as their principal depth range is greater than the maximum depth of the OA, eightbar grouper are unlikely to occur in the OA. The proposed acquisition window (February–March) overlaps with one month of the eightbar grouper five-month spawning period.
Bass groper (*Polyprion americanus*)	Bass grouper are a deep-water demersal species with a global, discontinuous distribution in temperate and sub-tropical waters. In the south-western Pacific, they occur in southern Australia and New Zealand, including south-western Australia to Rottnest Island in WA (Smallwood et al. 2013; Bray & Gomon 2023). Adults inhabit deep continental and oceanic island slopes, as well as rocky reefs, caves, and shipwrecks (Wakefield et al. 2013b; Bray & Gomon 2023; Froese & Pauly 2023). Juveniles are pelagic and may associate with floating objects (Bray & Gomon 2023; Froese & Pauly 2023).	There are separate northern and southern hemisphere biological stocks of bass grouper (Ball et al. 2000). Life history characteristics of *Polyprion* spp. suggest widespread geographic connectivity and mixing throughout southern stocks due to their long pelagic juvenile phase (Ball et al. 2000; Wakefield et al. 2013b). However, southern stocks may be differentiated in certain geographic areas, e.g., temperature profiles and current patterns throughout the southern oceans may prevent significant gene flow between the south and eastern Pacific (Ball et al. 2000).	50–1000 m	Bass grouper is gonochoristic and spawns during the Australian winter (Bray and Gomon 2023). The eggs, larvae and juveniles are pelagic. *Polyprion* spp. have an extended pelagic juvenile stage of up to four years in oceanic waters (Ball et al. 2000; Wakefield et al. 2013b). Stock status Sustainable (Newman et al. 2023).	March–June (Fairclough & Fisher 2023).	Given their distribution, habitat, and principal depth range, bass groper are likely to occur in the EMBA. However, as their principal depth range is greater than the maximum depth of the OA, bass groper are unlikely to occur in the OA. The proposed acquisition window (February–March) overlaps with one month of the bass groper four-month spawning period.

Table 4-4: Key commercial invertebrate species relevant to the OA and EMBA

Species	Distribution and habitat	Biological stock range	Principal depth range	Reproduction and recruitment	Spawning season	Relevance to EP
Western rock lobster	Western rock lobster (WRL; *Panulirus cygnus*) are a temperate species that are endemic to WA. The WRL range extends along the continental shelf from Northwest Cape to Albany, with the highest densities between Perth and Geraldton (de Lestang et al. 2016; DPIRD 2020b). WRL are demersal invertebrates that nocturnally forage by walking through seagrass and algal beds (de Lestang et al. 2024). Juveniles inhabit shallow coastal reefs and seagrass beds, which provide shelter and abundant food sources, while adults prefer deeper offshore reefs and rocky substrates, often found at depths ranging from 0 to 200 m (de Lestang et al. 2016; Bellchambers et al. 2017).	WRL are considered a single biological stock, which extends along the mid to lower west coast of WA, from Northwest Cape to Cape Leeuwin (de Lestang et al. 2016).	Juveniles 0-40 m Adults 0-80 m (de Lestang et al 2016).	WRL reproduce by males attaching a sperm packet ("tarspot") to the underside of females in late winter and spring. Females then release eggs and sperm simultaneously, fertilizing the eggs, which are carried under the female's tail for 4 to 8 weeks until they hatch, depending on water temperature (DPIRD 2020b). WRL recruitment is highly variable and influenced by environmental factors, particularly the strength of the LC. Spawning and egg hatching occur at depths below 40 m in spring-summer. The phyllosoma larvae are then transported offshore into the Indian Ocean via the LC, where they spend 9 to 11 months, aggregating at depths of 50 to 120 m (Hayes et al. 2008). Late-stage larvae metamorphose into pueruli beyond the continental shelf before they return to the coast and settle on shallow near-shore reefs (de Lestang et al. 2016). They remain there for 3 to 4 years before migrating to deeper waters to spawn, completing their life cycle (MacArthur et al. 2007).	September to February with a peak in October and November (de Lestang et al. 2016).	Given their distribution, habitat, and principal depth ranges, adult and juvenile WRL are likely to occur in the OA and/or EMBA. The proposed acquisition window (February–March) overlaps with one month of the six-month WRL spawning period (Table 4-12).

Species	Distribution and habitat	Biological stock range	Principal depth range	Reproduction and recruitment	Spawning season	Relevance to EP
Roe's abalone	Roe's abalone (*Haliotis roei*) is primarily found along the coast of WA, from Shark Bay to Victoria (DPIRD 2016; Hart et al. 2017), although they are not uniformly distributed throughout this range and are most abundant on the south-west coast around Perth and Cape Naturaliste (Strain et al. 2019). They inhabit shallow limestone reefs, particularly around Perth and Geraldton, preferring rocky areas, crevices, caves, and under rocks in shallow coastal waters (DPIRD 2016). Roe's abalone are generally found in shallow coastal waters on intertidal reef platforms and shallow adjoining subtidal reef to about 10 m depth (Strain et al. 2019). Their populations occur on semi-continuous reef complexes, typically less than 10 km in coastal length, occupying intertidal reef platforms and adjoining subtidal reefs up to 30 to 40 m beyond the reef platforms (Hart et al. 2017).	The biological stock range of Roe's abalone extends from Shark Bay in WA to western Victoria. Genetic evidence indicates high levels of connectivity and gene flow across their geographic range (Hancock 2004; Sandoval-Castillo et al. 2015).	Principal depth range 0-10 m (Strain et al. 2019) and typically < 5 m (DoF, 2011). May occur in depths up to 30 m (Hart et al. 2017).	Roe's abalone are broadcast spawners, releasing gametes (sperm and eggs) into the water column where fertilisation occurs. The ova develop into veliger larvae, which settle onto suitable habitats around 8 to 10 days post-hatching (Hart et al. 2017). The length at which 50% of Roe's abalone attain maturity is estimated to be 40 mm, at approximately two and a half years old (DoF 2011). Roe's abalone in the Perth metropolitan area have major spawning events in winter (Wells and Keesing 1989; DoF 2011). The fertilized eggs develop into free-swimming larvae, which settle onto suitable rocky substrates after a few days. Recruitment is influenced by environmental factors, including water temperature and habitat availability. Juveniles grow in shallow coastal waters before moving to deeper areas as they mature (Hart et al. 2017).	Roe's abalone mostly spawn in winter and larvae are in the water column for approximately one week only (Wells and Keesing 1989; DoF 2011).	Given their distribution, habitat, and principal depth range, Roe's abalone are likely to occur in the shallowest areas of the OA only (around 10 m deep), but may occur in water depths up to 30 m. Roe's abalone are likely to occur in the EMBA in water depths less than 10 m, but may also occur in depths up to 30 m.

Species	Distribution and habitat	Biological stock range	Principal depth range	Reproduction and recruitment	Spawning season	Relevance to EP
Western rock octopus	Western Rock Octopus (WRO; *Octopus djinda*) is endemic to the temperate waters of WA from Shark Bay to Esperance. WRO complete their life cycle in a range of nearshore habitats, including rocky reefs, seagrass meadows and sandy substrates, typically using limestone reefs around 20 m deep (Hart et al. 2018).	The species has an extended pelagic larval phase and are assumed to be a single stock over their distribution in WA (Hart et al. 2018).	0-70 m (Hart et al. 2018)	WRO is short-lived (up to 1.5 years), with early maturity and year-round spawning (Hart et al. 2018). WRO has a merobenthic life cycle; females lay ~100,000 eggs that take ~30 days to hatch then spend ~50 days in the water column as paralarvae before settling on the benthos (Hart et al. 2016). After settlement, octopuses are believed to move to protected inshore waters, with females later migrating to rocky temperate reefs to mature and find suitable lairs for brooding their eggs (Leporati et al. 2015).	Year-round. The greatest frequency of spawning is during periods of transitional temperature in autumn and spring (Leporati et al. 2015).	Given their distribution, habitat, and principal depth range, adult and juvenile WRO are likely to occur in the OA and/or EMBA.
Crystal crab	The crystal crab (*Chaceon albus*) is endemic to WA and distributed from Northwest Cape to Esperance. They inhabit deep water sand, mud or broken shell habitats (DPIRD 2020d).	There is little information available regarding the biological stock range of crystal crabs. Most of the catch (> 95%) comes from a small geographic area, and it is considered a single stock for the purpose of fisheries assessment (de Lestang 2023).	300-1450 m (DPIRD 2020d)	There is little information available regarding the reproduction and recruitment of crystal crabs. Tagging studies indicate crystal crabs are slow-growing and long-lived with a likely maximum age of 25 to 30 years. Preliminary studies indicate that maturity in males is attained at 12 years (DPIRD 2020d).	Year-round. There is little evidence of seasonality in the crystal crab reproductive cycle (Smith et al. 2004; Melville-Smith et al. 2007).	Given their distribution, habitat, and principal depth range, crystal crabs are unlikely to occur in the OA, but may occur in the EMBA.

4.3.6 Key Ecological Features

Key Ecological Features (KEFs) are the parts of the marine ecosystem that are considered important for a region's biodiversity or ecosystem function and integrity (DCCEEW n.d.). KEFs have been identified by the Australian Government based on advice from scientists regarding the ecological processes and characteristics of the area. KEFs are not Matters of National Environmental Significance (MNES) and have no legal status. However, they may be considered as components of the Commonwealth marine area.

Two KEFs occur within the OA: Commonwealth marine environment within and adjacent to the west coast inshore lagoons; and Western rock lobster. Four additional KEFs occur within the EMBA: Ancient coastline at 90–120 m depth; Commonwealth marine environment surrounding the Houtman Abrolhos Islands; Perth Canyon and adjacent shelf break, and other west coast canyons; and western demersal slope and associated fish communities (Figure 4-9). These KEFs are described below.

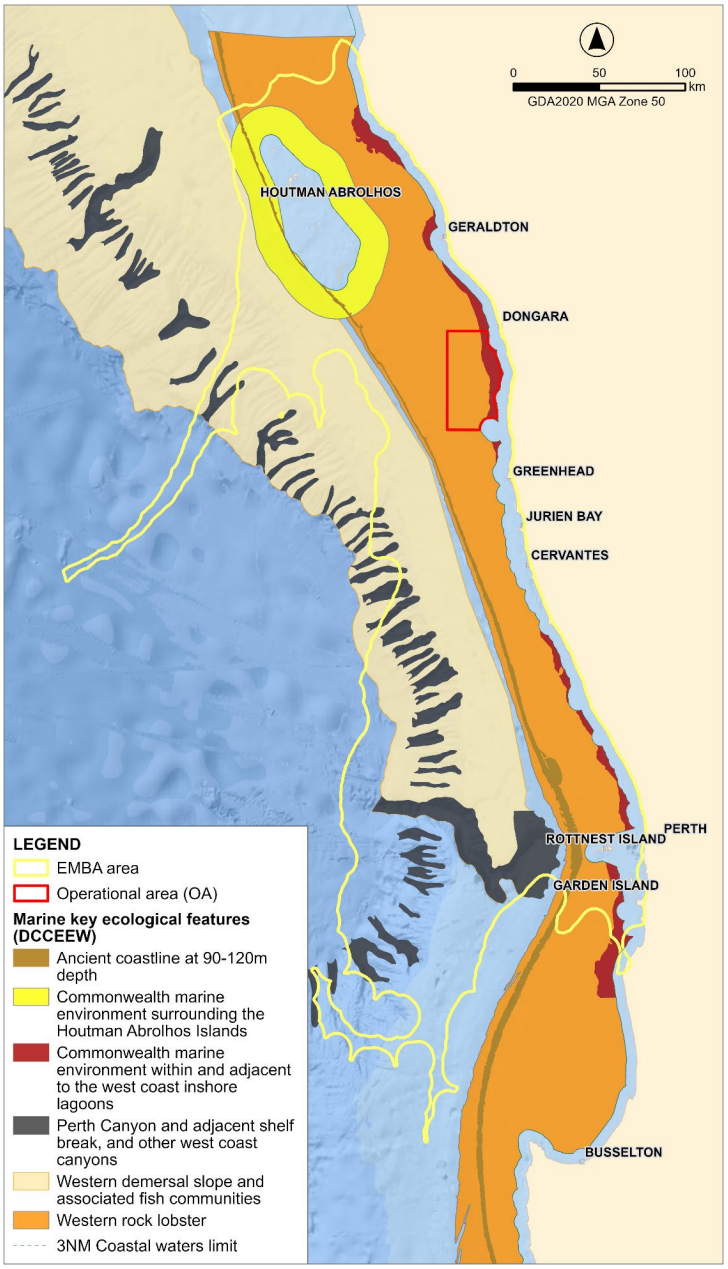


Figure 4-9: KEFs overlapping the OA and EMBA

4.3.6.1 Commonwealth marine environment within and adjacent to the west coast inshore lagoons

The Commonwealth marine environment within and adjacent to the west coast inshore lagoons is a chain of inshore lagoons extending along the WA coast (from Mandurah to Kalbarri) that were formed by limestone reef ridges approximately 0 to 30 m deep (DSEWPC 2012b). Both the OA and EMBA overlap the Commonwealth marine environment within and adjacent to the west coast inshore lagoons KEF (Figure 4-9).

The lagoons support habitat that is regionally and nationally important for high benthic productivity and aggregations of marine life (DSEWPC 2012b). The lagoons contain a unique community of marine species, due to an influx of warm water and propagules from tropical and subtropical regions carried by the LC. Macroalgae (e.g., extensive beds of Ecklonia spp.) and seagrass are the main sources of production, together with groundwater enrichment that may also supply nutrients to the lagoons (Dambacher et al. 2009). The seagrass provides critical habitat for many marine species, with epiphytes attached to the seagrass providing the main sources of food within the lagoons.

The unique mix of tropical, subtropical, and temperate flora and fauna mean the lagoons are associated with high diversity and endemism (McClatchie et al. 2006). The seagrass habitats provide valuable feeding grounds for protected species such as green and leatherback turtles and are important nursery areas for many recreational and commercial fish species, including western rock lobster, dhufish, pink snapper, breaksea cod, baldchin and blue gropers, abalone, and many other reef species (DSEWPC 2012b). Schools of migratory fish also rely on these lagoons, including herring, garfish, tailor, and Australian salmon. The inshore lagoons are important for the recruitment of commercially and recreationally important species (and it is assumed many other fish species; DEWR 2007). Many juvenile demersal species use inshore, seagrass or sandy/muddy bay habitats for feeding and protection, before migrating offshore as adults to reefs or other habitats (e.g., pink snapper; McClatchie et al. 2006, DEWR 2007).

4.3.6.2 Western rock lobster

WRL are the dominant large benthic invertebrate in the SWMR. The species plays an important trophic role, as both predator and prey, and is a highly valued recreational and commercial fishing target. The lobster significantly reduces the densities of a diverse variety of invertebrate prey (e.g., epifaunal gastropods), and is a key prey for many species, particularly during the post-larval puerulus phase (MacArthur et al. 2007). While inhabiting the inshore reefs, the lobsters are valuable prey for a large range of species, including octopus, cuttlefish, baldchin groper, blue groper, dhufish, pink snapper, wirrah cod, breaksea cod and Australian sea lions (ASLs) (Hayes et al. 2008). Due to the vulnerability and high biomass of lobster, the species is a critical trophic pathway for many inshore species. WRL are also directly targeted by commercial and recreational fishers. Further information on the commercial fishing of WRL is provided in Section 4.4.2.

Within the SWMR, western rock lobsters (WRL; *Panulirus cygnus*) can be found north of Cape Leeuwin to a depth of 150 m and 40-60 km seaward of the coast (DSEWPC 2012a; Peinado et al, 2024). Both the OA and EMBA overlap the Western rock lobster KEF. The EMBA overlaps 57.85% of the KEF, and the OA overlaps the KEF by 3.94% (Figure 4-9). Within this area, WRL are largely confined to limestone reef systems where they inhabit caves and ledges, and foraging occurs within adjacent seagrass meadows. Fine scale tracking studies have found that WRL generally forage at night within 500 m of their den, with 90% of WRL foraging activity within 60 m of the nearest reef (MacArthur et al. 2008). There are several shallow reef areas within the OA that are likely to provide suitable habitat for WRL. Unvegetated areas such as those in deeper waters of the OA are likely to be utilised by juveniles during offshore migrations (see below).

To inform the evaluation of impacts, it is important to understand the spatio-temporal overlap of WRL habitats and life stages with the timing and location of the proposed Eureka MSS in more detail. As stated above, the shallow reef areas of the Eureka MSS OA are likely to provide habitat for juvenile WRL prior to migration into deeper waters. The migration of juvenile WRL from shallow water to deeper waters (>40 m) is commonly known as the 'whites' migration due to their pale colour post moulting (Bellchambers et al., 2012). This migration occurs in November through to mid-January each year (Melville-Smith & Beale, 2009; Caputi et al. 2009; Miller et al. 2023) when they migrate from coastal reefs to the edge of the continental shelf. A small percentage of WRL makes a longer migration to the north along the edge of the continental shelf (DoF, 2011). This northerly migration typically occurs between late January to February towards the big bank area, north of the Houtman Abrolhos (deep water between Kalbarri and Onslow).

Once in deeper water, breeding females prefer limestone or coral reef habitats and breeding grounds are between 40 and 100 m deep (de Lestang et al., 2016). Mating of WRL occurs in August – September and the females generally release fertilised eggs between September and February (Peinado et al. 2024). These eggs hatch within 4-8 weeks releasing phyllosoma larvae that are carried offshore by nightly wind-driven currents as far as 1500 km from the mainland (Peinado et al. 2024). Hatching is generally completed by the end of February or March (Gray 1992). The phyllosoma larvae spend 9-11 months in the open ocean before metamorphosing into pueruli which swim across the continental shelf with help from the prevailing currents to settle on inshore reefs (Peinado et al. 2024). The settlement of puerulus larvae on inshore reefs can occur throughout the year (Miller et al. 2023), with peaks from late-winter to mid-summer (Caputi et al. 2009). There is therefore some potential for the MSS to overlap with the hatching and puerulus settlement period on inshore reefs, but there is no temporal overlap with the peak puerulus settlement period.

The phyllosoma life stage lasts 9 to 11 months, spreading the species' larvae throughout the south-eastern Indian Ocean, aggregating at depths 50 to 120 m (Hayes et al. 2008). Late phyllosoma larvae metamorphose into a post-larval puerulus beyond the edge of the continental shelf, after which they swim towards shallow inshore reefs. The lobsters stay in these reefs for three to four years, before migrating out to deeper waters to spawn, completing their life cycle (MacArthur et al. 2008).

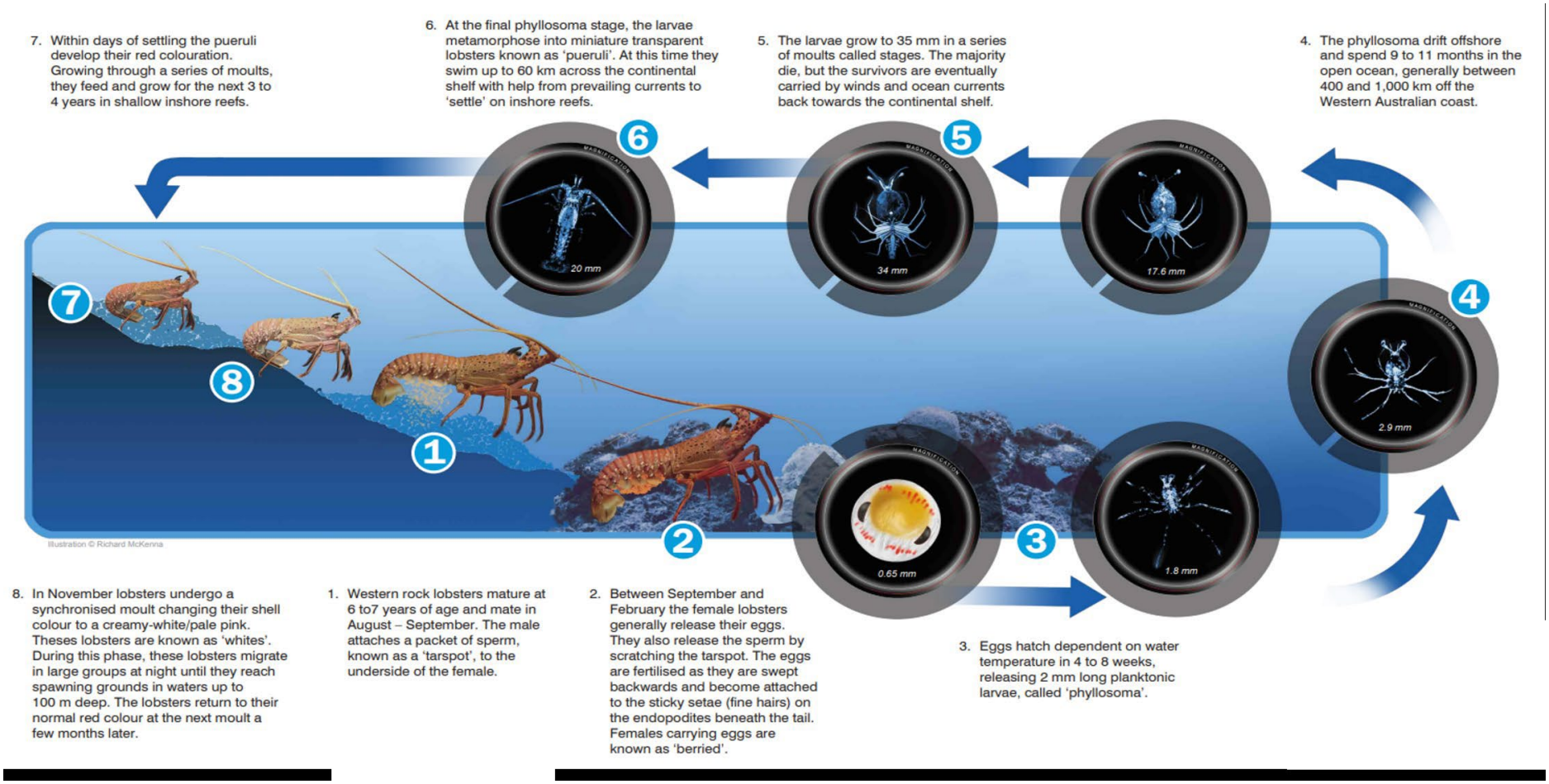


Figure 4-10: Western rock lobster life cycle (Western Australian Department of Primary Industries and Regional Development)

4.3.6.3 Ancient coastline at 90–120 m depth

The Ancient coastline between 90 m and 120 m depth KEF contains terraces, escarpments, and steps, reflecting the gradual increase in sea level across the shelf that occurred during the Holocene (DSEWPC 2012a). The south-west corner of the OA is located ~30 km north-east of the ancient coastline, whilst the EMBA overlaps this feature (Figure 4-9).

The ancient coastline is thought to provide areas of hard substrate that contribute to enhanced productivity, biodiversity, and aggregations of marine life (DSEWPC 2012a). The hard substrate may contribute to greater benthic diversity and species richness relative to the surrounding soft sediment habitat, and may include sponges, crinoids, molluscs, echinoderms, and other benthic invertebrates (DSEWPC 2012a). The topographic complexity of these escarpments may also provide a relatively nutrient-rich environment for sessile communities (DSEWPC 2012a).

While little published information is currently available, the hard substrates of the ancient coastline represent distinct benthic habitats for associated mesophotic (approximately 30–150 m depth) demersal fish species (DEWHA 2008b), which may exhibit some level of site fidelity. These habitats may also support some demersal fish species travelling across the continental shelf to the upper continental slope (DSEWPC 2012a), as well as pelagic species that may aggregate in the region. For example, research into fish communities that inhabit the ancient coastline region in the north-west of WA showed that depth, sea floor complexity, and habitat type explained patterns in the richness and abundance of fish assemblages, which were greater in shallower depths featuring benthic biota and pockets of complex substrate (Currey-Randall et al. 2021). Commercially important demersal indicator species with principal depth ranges that include 90–120 m are WA dhufish, pink snapper, baldchin groper, hapuku, eightbar groper, and bass groper (Bray & Gomon 2023; Fairclough & Fisher 2023; Froese & Pauly 2023).

4.3.6.4 Commonwealth marine environment surrounding the Houtman Abrolhos Islands

The Houtman Abrolhos Islands are located ~60 km offshore from the WA coast and comprise 122 islands and reefs at the edge of the continental shelf between 28°15’ S and 29°S (DSEWPC 2012a). The north-west corner of the OA is located ~70 km south-east of the Abrolhos, while the EMBA overlaps this feature (Figure 4-9).

The Commonwealth marine environment surrounding the Houtman Abrolhos Islands KEF has conservation value as an area of high biodiversity and endemism in benthic and pelagic habitats and provides important nesting/breeding habitat for many seabird and mammal species (DSEWPC 2012a).

The Abrolhos region supports the highest-latitude coral reefs in the Indian Ocean, as warm water transported southward by the LC extends the distribution of tropical and subtropical species to areas further south than would otherwise occur. The reefs support fauna species typical of the oceanic coral reef communities of the Indo-West Pacific (DEC 2007), including approximately 400 species of demersal fish, 492 species of molluscs, 110 species of sponges, 172 species of echinoderms and 234 species of benthic algae (DEWHA 2008b; Wells & McDonald 2010).

The Abrolhos region marks the northern limit in WA of many warm temperate fish species, as well as the southern limit for some widespread Indo-Pacific tropical finfish species, such as goldband snapper. The islands also represent the northernmost breeding site of ASLs and an important resting area for migrating humpback whales (DSEWPC 2012a).

The major benthic habitats of the Abrolhos include intertidal and subtidal reefs that support a diverse range of benthic communities, including many tropical and sub-tropical species of coral, macroalgae and sessile filter feeders that are not found elsewhere in the CWC (Smale et al. 2012). The Houtman Canyon, like the Perth Canyon, supports many endemic deep-sea species of hard coral, motile feeder feeders and sessile filter feeders, with significantly greater diversity compared to the surrounding soft sediments (Smale et al. 2012).

The Abrolhos Marine Park is described in Section 4.4.1.

4.3.6.5 Perth Canyon and adjacent shelf break, and other west coast canyons

The Perth Canyon and adjacent shelf break, and other west coast canyons KEF includes the Perth, Geographe, Busselton, Pelsaert, Geraldton, Wallaby, Houtman and Murchison canyons (Figure 4-9). The OA is located ~220 km north of the Perth Canyon, whilst the EMBA overlaps this feature.

The Perth Canyon is the largest known undersea canyon in Australian waters and is recognised as a unique sea floor feature with ecological properties of regional significance (DSEWPC 2012a). Deep ocean currents rise to the surface, creating nutrient-rich, cold-water upwelling zones that increase local productivity and attract aggregations of marine life (DSEWPC 2012a). These habitats support small fish, crustaceans, molluscs, and varying epibiota, together with deep-diving mammals (primarily pygmy blue whales) and large predatory fish (Pattiaratchi 2007). The canyons also transport shelf material into the deep ocean and are an important link between continental shelf and deepwater habitats.

Benthic communities in the Perth canyon include endemic, prehistoric deep-sea corals along the 200–700 m bathyal depths (Trotter et al. 2019), as well as localised concentrations of endemic epibiota between 680–1800 m deep, such as sponges, molluscs, echinoderms, crustaceans, brachiopods, and worms (Trotter et al. 2019). The canyon contains far greater biodiversity and endemic species compared to the nearby soft sediment habitats. The Perth Canyon Marine Park is described in Section 4.4.1.

4.3.6.6 Western demersal slope and associated fish communities

The Western demersal slope and associated fish communities KEF extends from the edge of the shelf to the limit of the Australian EEZ, between Perth and the northern boundary of the SWMR (DSEWPC 2012a). The south-west corner of the OA is located ~30 km north-east of the shelf, whilst the EMBA overlaps this feature (Figure 4-9).

The demersal slope and associated fish communities of the CWP are recognised as a KEF for their high levels of biodiversity and endemism when compared to other more intensively sampled oceanic regions of the world (DSEWPC 2012a). Species diversity is attributed to the overlap of Indo-west Pacific and temperate Australasian fauna (Williams et al. 2001). Scientists have described 480 species of demersal fish that inhabit the slope of the CWP, 31 of which are considered endemic to the bioregion (DSEWPC 2012a).

Demersal fish assemblages occurring at depths greater than 400 m are characterised by relatively small benthic species such as grenadiers, dogfish, and cucumber fish (DSEWPC 2012a). Unlike other slope fish communities in Australia, many of these species display unique physical adaptations to feed on the sea floor (such as a mouth position adapted to bottom feeding), and many do not appear to migrate vertically in their daily feeding habits (Williams et al. 2001, DCCEEW n.d).

4.3.7 Threatened and migratory species

The EPBC Act Protected Matters Search Tool (PMST) was used to identify species listed under the EPBC Act that may occur within the OA and/or EMBA. The results of the search inform the assessment of planned events in Section 7 and unplanned events in Section 8. It should be noted that the EPBC Protected Matters database is a general database that conservatively identifies areas in which protected species potentially occur.

The PMST identified 32 EPBC Act listed Threatened species and 43 listed migratory species that potentially occur within the OA. Of those listed, a total of 49 individual species were identified as Threatened and/or migratory under the EPBC Act, consisting of eight mammals, four reptiles, 26 birds, and 11 sharks and rays ().

The PMST identified 109 EPBC Act listed Threatened species and 85 listed migratory species that potentially occur within the EMBA. Of those listed, 107 individual species were identified as Threatened and/or migratory that occur within the EMBA but outside of the OA, consisting of 11 mammals, three reptiles, 50 birds, and two sharks and rays (Table 4-5).

Numerous species (e.g., grey wagtail; Motacilla cinerea, Balston's pygmy perch; Nannatherina balstoni, and various land animals) were identified by the PMST as potentially occurring within the EMBA have been excluded from further assessment due to the lack of a credible impact scenario.

The complete list of species identified by the PMST is provided in Table 4-5 contains species that are deemed likely to occur within the OA and/or EMBA, based on the PMST search and background research. All species below are listed as Marine under the EPBC Act.

Table 4-5: Threatened and migratory marine species listed potentially occurring within the OA and EMBA

Scientific name	Common name	Threatened	Migratory	Relevance to EP	
				OA	EMBA
Marine mammals					
Balaenoptera musculus	Blue whale	Endangered	✓	✓	✓
Eubalaena australis	Southern right whale	Endangered	✓	✓	✓
Neophoca cinerea	Australian sea lion	Endangered	X	✓	✓
Balaenoptera borealis	Sei whale	Vulnerable	✓	✓	✓
Balaenoptera physalus	Fin whale	Vulnerable	✓	✓	✓
Balaenoptera bonaerensis	Antarctic minke whale, Dark-shoulder minke whale	N/A	✓	X	✓
Balaenoptera edeni	Bryde's whale	N/A	✓	✓	✓
Caperea marginata	Pygmy right whale	N/A	✓	X	✓
Lagenorhynchus obscurus	Dusky dolphin	N/A	✓	X	✓
Megaptera novaeangliae	Humpback whale	N/A	✓	✓	✓
Orcinus orca	Killer whale, Orca	N/A	✓	✓	✓
Physeter macrocephalus	Sperm whale	N/A	✓	X	✓
Marine reptiles					
Caretta	Loggerhead turtle	Endangered	✓	✓	✓
Dermochelys coriacea	Leatherback turtle	Endangered	✓	✓	✓
Chelonia mydas	Green turtle	Vulnerable	✓	✓	✓
Natator depressus	Flatback turtle	Vulnerable	✓	✓	✓
Sharks and rays					
Centrophorus uyato	Little gulper shark	Conservation Dependent	X	X	✓
Galeorhinus galeus	School shark, Eastern school shark	Conservation Dependent	X	X	✓
Sphyrna lewini	Scalloped hammerhead	Conservation Dependent	X	✓	✓
Carcharias taurus	Grey nurse shark (west coast population)	Vulnerable	X	✓	✓
Carcharodon carcharias	White shark, Great white shark	Vulnerable	✓	✓	✓
Pristis	Freshwater sawfish	Vulnerable	✓	✓	✓
Rhincodon typus	Whale shark	Vulnerable	✓	✓	✓
Carcharhinus longimanus	Oceanic whitetip shark	N/A	✓	✓	✓

Scientific name	Common name	Threatened	Migratory	Relevance to EP	
				OA	EMBA
Isurus oxyrinchus	Shortfin mako, Mako shark	N/A	✓	✓	✓
Isurus paucus	Longfin mako	N/A	✓	✓	✓
Lamna nasus	Porbeagle, Mackerel shark	N/A	✓	✓	✓
Mobula alfredi	Reef manta ray, coastal manta ray	N/A	✓	✓	✓
Mobula birostris	Giant manta ray	N/A	✓	✓	✓
Fish					
Hoplostethus atlanticus	Orange roughy, Deep-sea perch	Conservation Dependent	X	X	✓
Avifauna					
Calidris ferruginea	Curlew sandpiper	Critically Endangered	✓	✓	✓
Numenius madagascariensis	Eastern curlew, Far Eastern curlew	Critically Endangered	✓	✓	✓
Charadrius mongolus	Lesser sand plover, Mongolian plover	Endangered	✓	X	✓
Diomedea amsterdamensis	Amsterdam albatross	Endangered	✓	✓	✓
Diomedea dabbenena	Tristan albatross	Endangered	✓	X	✓
Diomedea sanfordi	Northern royal albatross	Endangered	✓	X	✓
Limosa	Black-tailed godwit	Endangered	✓	X	✓
Macronectes giganteus	Southern giant-petrel	Endangered	✓	✓	✓
Rostratula australis	Australian painted snipe	Endangered	X	X	✓
Thalassarche cauta	Shy albatross	Endangered	✓	✓	✓
Tringa nebularia	Common greenshank	Endangered	✓	X	✓
Anous tenuirostris melanops	Australian lesser noddy	Vulnerable	X	✓	✓
Ardenna grisea	Sooty shearwater	Vulnerable	✓	X	✓
Arenaria interpres	Ruddy turnstone	Vulnerable	✓	X	✓
Calidris acuminata	Sharp-tailed sandpiper	Vulnerable	✓	✓	✓
Calidris canutus	Red knot, Knot	Vulnerable	✓	✓	✓
Calidris tenuirostris	Great knot	Vulnerable	✓	X	✓
Charadrius leschenaultii	Greater sand plover, large sand plover	Vulnerable	✓	X	✓
Diomedea epomophora	Southern royal albatross	Vulnerable	✓	✓	✓
Diomedea exulans	Wandering albatross	Vulnerable	✓	✓	✓
Halobaena caerulea	Blue petrel	Vulnerable	X	X	✓
Macronectes halli	Northern giant petrel	Vulnerable	✓	✓	✓

Scientific name	Common name	Threatened	Migratory	Relevance to EP	
				OA	EMBA
Phoebetria fusca	Sooty albatross	Vulnerable	✓	X	✓
Pluvialis squatarola	Grey plover	Vulnerable	✓	X	✓
Pterodroma mollis	Soft-plumaged petrel	Vulnerable	X	✓	✓
Sternula nereis	Australian fairy tern	Vulnerable	X	✓	✓
Thalassarche carteri	Indian yellow-nosed albatross	Vulnerable	✓	✓	✓
Thalassarche impavida	Campbell albatross	Vulnerable	✓	✓	✓
Thalassarche melanophris	Black-browed albatross	Vulnerable	✓	✓	✓
Thalassarche steadi	White-capped albatross	Vulnerable	✓	✓	✓
Xenus cinereus	Terek sandpiper	Vulnerable	✓	X	✓
Actitis hypoleucos	Common sandpiper	N/A	✓	✓	✓
Anous stolidus	Common noddy	N/A	✓	✓	✓
Apus pacificus	Fork-tailed swift	N/A	✓	✓	✓
Ardenna carneipes	Flesh-footed shearwater	N/A	✓	✓	✓
Ardenna pacifica	Wedge-tailed shearwater	N/A	✓	X	✓
Calidris alba	Sanderling	N/A	✓	X	✓
Calidris melanotos	Pectoral sandpiper	N/A	✓	✓	✓
Calidris pugnax	Ruff	N/A	✓	X	✓
Calidris ruficollis	Red-necked stint	N/A	✓	X	✓
Calidris subminuta	Long-toed stint	N/A	✓	X	✓
Charadrius bicinctus	Double-banded plover	N/A	✓	X	✓
Fregata ariel	Lesser frigatebird, Least frigatebird	N/A	✓	X	✓
Gallinago megala	Swinhoe's snipe	N/A	✓	X	✓
Gallinago stenura	Pin-tailed snipe	N/A	✓	X	✓
Glareola maldivarum	Oriental pratincole	N/A	✓	X	✓
Hydroprogne caspia	Caspian tern	N/A	✓	✓	✓
Limicola falcinellus	Broad-billed Sandpiper	N/A	✓	X	✓
Limosa lapponica	Bar-tailed Godwit	N/A	✓	X	✓
Motacilla cinerea	Grey wagtail	N/A	✓	X	✓
Numenius minutus	Little curlew	N/A	✓	X	✓
Numenius phaeopus	Whimbrel	N/A	✓	X	✓
Onychoprion anaethetus	Bridled tern	N/A	✓	✓	✓
Pandion haliaetus	Osprey	N/A	✓	X	✓

Scientific name	Common name	Threatened	Migratory	Relevance to EP	
				OA	EMBA
Phaethon lepturus	White-tailed tropicbird	N/A	✓	X	✓
Phaethon rubricauda	Red-tailed tropicbird	N/A	✓	X	✓
Phalaropus lobatus	Red-necked phalarope	N/A	✓	X	✓
Pluvialis fulva	Pacific golden plover	N/A	✓	X	✓
Sterna dougallii	Roseate tern	N/A	✓	✓	✓
Sternula albifrons	Little tern	N/A	✓	X	✓
Thalasseus bergii	Greater crested tern	N/A	✓	X	✓
Tringa brevipes	Grey-tailed tattler	N/A	✓	X	✓
Tringa glareola	Wood sandpiper	N/A	✓	X	✓
Tringa stagnatilis	Marsh sandpiper, Little greenshank	N/A	✓	X	✓
Tringa totanus	Common redshank	N/A	✓	X	✓

4.3.7.1 Listed threatened species recovery plans and conservation advice

Species Recovery Plans set out the research and management actions necessary to stop the decline of, and support the recovery of, listed threatened species or threatened ecological communities (DoEE, n.d.). Recovery plans are enacted under the EPBC Act and remain in force until the species is removed from the threatened list. Conservation advice provides guidance on immediate recovery and threat abatement activities that can be undertaken to ensure the conservation of a listed species or ecological community (DoEE, n.d.). Table 4-6 lists the applicable recovery plans and/or conservation advice for EPBC Act-listed species within the OA and EMBA, as identified by the PMST search. Any relevant requirements applicable to the activity will be considered as part of the Environmental Risk Assessment (Section 7 and Section 8).

Table 4-6: Recovery plans and conservation advice for EPBC Act-listed species occurring within the operational area and EMBA

Species	Recovery plan / conservation advice	Key threats identified in the plan/ advice	Actions relevant to the Eureka 3D MSS	Environmental risk assessment section
All vertebrate fauna	Threat abatement plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans (Commonwealth of Australia 2018)	Marine-based sources of debris.	Contribute to long-term prevention of marine debris, through waste management and resource recovery. Limit the amount of single use plastic material lost to the environment in Australia.	Section 8.5
Mammals				
Sei whale	Conservation advice *Balaenoptera borealis* sei whale (TSSC, 2015a).	Anthropogenic noise and acoustic disturbance. Vessel strike.	Assessing and addressing anthropogenic noise. Minimising vessel collisions.	Section 7.1 Section 7.2 Section 8.2
Blue whale	Conservation management plan for the blue whale A recovery plan under the *Environment Protection and Biodiversity Conservation Act 1999* 2015–2025 (Commonwealth of Australia, 2015a).	Noise interference. Vessel disturbance.	Assessing and addressing anthropogenic noise. Minimising vessel collisions.	Section 7.1 Section 7.2 Section 8.2
Fin whale	Conservation advice *Balaenoptera physalus* fin whale (TSSC, 2015b).	Anthropogenic noise and acoustic disturbance. Vessel strike.	Assessing and addressing anthropogenic noise. Minimising vessel collisions.	Section 7.1 Section 7.2 Section 8.2
Australian sea lion	Recovery Plan for the Australian Sea Lion (*Neophoca cinerea*; DSEWPC 2013a)	Anthropogenic noise and acoustic disturbance. Vessel strike. Oil spill.	Assessing and addressing anthropogenic noise. Minimising vessel collisions.	Section 7.1 Section 7.2 Section 8.2 Section 8.6
Southern right whale	National Recovery Plan for the Southern Right Whale (DCCEEW 2024)	Anthropogenic noise and acoustic disturbance. Vessel strike.	Assessing and addressing anthropogenic noise. Minimising vessel collisions.	Section 7.1 Section 7.2 Section 8.2
Reptiles				
Loggerhead turtle	Recovery plan for marine turtles in Australia (Commonwealth of Australia, 2017)	Threats to the WA stock include: Light pollution. Vessel disturbance (strike) – rated as 'almost certain' likelihood of occurrence, minor consequence.	Minimise light pollution No specific actions for vessel disturbance are identified by the plan. The Australian Government has	Section 7.1 Section 7.2 Section 7.4 Section 8.2

Species	Recovery plan / conservation advice	Key threats identified in the plan/ advice	Actions relevant to the Eureka 3D MSS	Environmental risk assessment section
		Noise interference (acute) – rated as a 'likely' likelihood of occurrence, minor consequence. An "almost certain" rating means the event is expected to occur every year. A "minor" rating means that individuals are affected, but there is no effect at stock level.	developed a National Strategy for Mitigating Vessel Strike of Marine Mega-fauna (2017) to provide guidance on reducing the risk of vessel collisions and the impacts they may have on marine fauna. A precautionary approach to acute noise exposure should be applied to seismic surveys.	
Green turtle	Recovery plan for marine turtles in Australia (DoEE, 2017)	Threats to the WA stock include: Light pollution. Vessel disturbance (strike) – rated as a 'likely'* likelihood of occurrence, minor consequence. Noise interference (acute and chronic) – rated as 'unknown' likelihood of occurrence, minor consequence. *A "likely" rating means the event is expected to occur at least once every five years. No specific actions for vessel disturbance are identified by the plan. The Australian Government has developed a National Strategy for Mitigating Vessel Strike of Marine Mega-fauna (2017) to provide guidance on reducing the risk of vessel collisions and the impacts they may have on marine fauna.	Minimise light pollution A precautionary approach to acute noise exposure should be applied to seismic surveys.	Section 7.1 Section 7.2 Section 7.4 Section 8.2
Flatback turtle	Recovery plan for marine turtles in Australia (Commonwealth of Australia 2017)	Threats to the Pilbara stock include: Light pollution. Vessel disturbance (strike) – rated as an 'almost certain' likelihood of occurrence, minor consequence. Noise interference (acute) – rated as a 'likely' likelihood of occurrence, minor consequence. No specific actions for vessel disturbance are identified by the plan. The Australian Government has developed a National Strategy for Mitigating Vessel Strike of Marine Mega-fauna (2017) to provide guidance on reducing the risk of vessel collisions and the impacts they may have on marine fauna.	Minimise light pollution A precautionary approach to acute noise exposure should be applied to seismic surveys.	Section 7.1 Section 7.2 Section 7.4 Section 8.2

Species	Recovery plan / conservation advice	Key threats identified in the plan/ advice	Actions relevant to the Eureka 3D MSS	Environmental risk assessment section
Leatherback turtle	Recovery plan for marine turtles in Australia (Commonwealth of Australia 2017) Approved conservation advice for *Dermochelys coriacea* (leatherback turtle) (DEWHA 2008c)	Vessel disturbance	Minimising vessel collisions.	Section 8.2
Sharks and rays				
Great white shark	Recovery plan for the great white shark (*Carcharodon carcharias*) (DSEWPaC 2013)	No threats identified that are applicable to this EP.	N/A	N/A
Whale shark	Conservation advice *Rhincodon typus* whale shark (TSSC 2015c)	Vessel disturbance	Minimising vessel collisions.	Section 8.2
Freshwater sawfish	Approved Conservation Advice for *Pristis* (largetooth sawfish) (DoE, 2014a) Sawfish and River Shark Multispecies Recovery Plan (Commonwealth of Australia 2015b)	No threats identified that are applicable to this EP	N/A	N/A
Grey nurse shark	Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) (DoE 2014b)	No threats identified that are applicable to this EP	N/A	N/A
Seabirds and shorebirds				
Red knot	Conservation advice *Calidris canutus* red knot (TSSC 2016a)	Habitat degradation (oil pollution). Human disturbance (general).	Manage disturbance at important sites when red knots are present.	Section 7.1 Section 7.5 Section 8.6 Section 8.7
Curlew sandpiper	Conservation advice *Calidris ferruginea* curlew sandpiper (DoE 2015a)	Habitat degradation (oil pollution). Human disturbance (general).	Manage disturbance at important sites when curlew sandpipers are present.	Section 7.1 Section 7.4 Section 8.6 Section 8.7
Far eastern curlew	Conservation advice *Numenius madagascariensis* eastern curlew (DCCEEW, 2023)	Habitat degradation (oil pollution). Human disturbance (general).	Manage disturbance at important sites when eastern curlews are present.	Section 7.1 Section 7.4 Section 8.6 Section 8.7
Common sandpiper, red knot, pectoral sandpiper, sharp-tailed sandpiper, greater sand plover	Wildlife Conservation Plan for Migratory Shorebirds (Commonwealth of Australia 2015)	Habitat degradation (oil pollution).	Ensure all areas important to migratory shorebirds in Australia continue to be considered in development assessment processes.	Section 8.6 Section 8.7

Species	Recovery plan / conservation advice	Key threats identified in the plan/ advice	Actions relevant to the Eureka 3D MSS	Environmental risk assessment section
Greater sand plover	Conservation Advice *Charadrius leschenaultii* greater sand plover (TSSC, 2016b)	Habitat degradation (oil pollution). Human disturbance (general).	Manage disturbance at important sites when greater sand plovers are present.	Section 7.1 Section 7.4 Section 8.6 Section 8.7
Albatrosses and petrels	National Recovery Plan for albatrosses and petrels (DCCEEW 2022b)	Marine infrastructure interactions – Threats from interactions with offshore installations and ships, including artificial lighting. Marine pollution - Threats from marine pollution, contamination and debris, including plastics and microplastics.	Minimise light pollution No specific actions for artificial light are identified by the plan. The IAATOs Guidelines to Minimize Seabirds Landing on Ships including seabirds landing on ships capture, handling and release procedure should be considered for the survey. Contribute to long-term prevention of marine debris, through waste management and resource recovery.	Section 7.1 Section 7.4 Section 8.5 Section 8.6 Section 8.7
Seabirds	Wildlife Conservation Plan for seabirds (Commonwealth of Australian 2020)	No threats identified that are applicable to this EP	N/A	Section 7.1 Section 7.4 Section 8.6 Section 8.7

4.3.7.2 Biologically important areas

Biologically Important Areas (BIAs) are regions where a particular species is known or likely to display important behaviours such as breeding, foraging, nesting, or migration (DoEE n.d.). BIAs provide information to help inform regulatory and management decisions. Table 4-7 identifies the BIAs associated with Threatened and Migratory species potentially occurring within the OA and EMBA, as identified during the PMST search conducted on 3 March 2023 (Appendix B). Further information on BIAs is provided in the individual species descriptions below (Section 4.3.8 and Section 4.3.9).

Table 4-7: Listed Threatened and Migratory species' BIAs within the OA and EMBA

Species	BIA	Distance from OA	Overlaps EMBA
Humpback whale	Migration (north and south)	Overlaps OA and ASA	✓
Pygmy blue whale	Migration	<1 km (~19km to ASA)	✓
	Known Foraging	Overlaps (~19km to ASA)	✓
Southern right whale	Seasonal calving (calving buffer)	185 km	✓

Species	BIA	Distance from OA	Overlaps EMBA
	Migration	<1 km to OA and ASA	✓
Sperm whale	Foraging	215 km	✓
Australian sea lion	Foraging	Overlaps OA and ASA	✓
White shark	Foraging	Overlaps	✓
Common noddy	Foraging	40 km	✓
Australian lesser noddy	Foraging (provisioning young)	55 km	✓
Flesh-footed shearwater	Aggregation	250 km	✓
Wedge-tailed shearwater	Foraging (in high numbers)	Overlaps	✓
Little penguin	Foraging (provisioning young)	250 km	✓
Caspian tern	Foraging	Overlaps	✓
Pacific gull	Foraging (in high numbers)	Overlaps	✓
Bridled tern	Foraging (in high numbers)	Overlaps	✓
Sooty tern	Foraging	16 km	✓
White-faced storm petrel	Foraging (in high numbers)	Overlaps	✓
Great winged petrel	Foraging (provisioning young)	400 km	✓
Soft-plumaged petrel	Foraging (in high numbers)	22 km	✓
Little shearwater	Foraging (in high numbers)	Overlaps	✓
Roseate tern	Foraging	Overlaps	✓
Australian fairy tern	Foraging (in high numbers)	Overlaps	✓

4.3.8 Marine mammals

Several species of marine mammals are known to occur in the region and have wide distributions that are associated with feeding and migration patterns linked to reproductive cycles. There are at least 38 marine mammal species known to occur regularly in the SWMR, including at least 27 whale species, 11 species of dolphin and two species of pinnipeds (McClatchie et al. 2006; DEWHA 2008a).

Four Threatened and Migratory, seven Migratory and one Threatened marine mammal species were identified by a search of the EPBC Act Protected Matters Database as potentially occurring in the OA and/or EMBA, consisting of nine whales, two dolphins and one pinniped (Table 4-7).

Cetacean species, such as the pygmy blue whale (*Balaenoptera musculus brevicauda*), southern right whale (*Eubalaena australis*) and humpback whale (*Megaptera novaeangliae*), are known to transit between Southern Ocean feeding grounds and tropical water breeding grounds. However, some mammal species (e.g., the ASL; *Neophoca cinerea*) are resident in the region throughout the year (DEWHA 2008a). The SWMR is an important foraging and breeding region for Australian sea lions, with 99% of the population occurring within the SWMR (McClatchie et al. 2006). ASLs are also present in the OA; including the foraging areas for WA's largest breeding colony at Beagle Island (DSEWPC 2013a, Gales et al. 1994).

The long-nosed fur seal (*Arctocephalus forsteri*) was not identified as occurring in the OA or EMBA in the searches of the Protected Matters Database; however, there are observations of haul outs of long-nosed fur seals at the Beagle Islands, 10 km south of the OA (Campbell et al. 2014).

A description of the identified Threatened and/or Migratory marine mammals, including their distribution, migratory movements, preferred habitat, and likely presence within the OA and EMBA is provided in Table 4-8.

Five marine mammal species have BIAs within the OA and/or EMBA, as follows:

- The humpback whale migration, breeding, and calving BIA extend along the length of the WA coast, to its northernmost extent offshore of the Kimberley. The migration BIA overlaps the OA (Figure 4-13).
- Pygmy blue whale migration and known foraging area BIAs pass along the shelf edge at depths between 500 m and 1,000 m. The OA overlaps with the known foraging BIA (Figure 4-11), whilst the EMBA overlaps the migration BIA (Figure 4-12).
- The southern right whale migration BIA, which extends all the way up the west coast of WA as far north as Ningaloo Reef, is located just inshore of the OA (Figure 4-13) and overlaps the EMBA. The nearest reproductive BIA is 185 km away.
- The sperm whale foraging BIA is located approximately 215 km south of the OA but overlaps the EMBA
- ASL foraging BIAs extend along the west coast of Australia, south of Geraldton down to Perth. The OA and EMBA overlap both foraging BIAs (Figure 4-14). As central placed foragers, ASLs forage year-round in the OA. There is a defined breeding BIA for ASLs on the Beagle Islands, located ~10 km south of the southern boundary of the OA.

The distribution range of the pygmy blue whale is described as cosmopolitan in the conservation management plan (CMP) for blue whales and has been designated as extending from the shorelines of WA to beyond the continental slope, shown as a layer in the Australian Marine Spatial Information System (AMSIS). Studies investigating the seasonal presence of the pygmy blue whale in the south-east Indian Ocean have identified a seasonal migration of the animals from the southern coast of WA at Cape Leeuwin (McCauley et al. 2018, Thums et al. 2022) to as far north as Indonesian waters (Double et al. 2014; Thums et al. 2022). The northern migration of the pygmy blue whales – Augusta to Derby, WA, occurs between April and July (peak periods in May and June), with a return southbound migration from October to January (peak periods in November and December) (McCauley & Jenner 2010, McCauley & Duncan 2011, Double et al. 2012, 2014, Thums et al. 2022). The animals migrate as solitary individuals or in small groups along the continental slope, typically at depths between 500 m and 1000 m on the way to the Banda and Molucca seas near Indonesia, where calving is thought to occur (Double et al. 2014). A recent study by Thums et al. (2022) tracked the northern and southern migratory movements of 22 satellite tagged pygmy blue whales along the WA coastline from Bremer Bay to Scott Reef and on to Indonesian waters. The tracking data indicated extensive use of the continental slope by the animals as they migrated, rather than the shelf (Thums et al. 2022). Three areas of high pygmy blue whale occupancy were identified: The Perth Canyon, the Montebello Islands, and waters off Timor-Leste (Thums et al. 2022). Further, based on these tracking data of pygmy blue whales, Thums et al. (2022) designated important animal usage areas such as foraging and resting in regions along their migratory corridor. Figure 4-11 and Figure 4-12 display the minor overlap of the OA with the pygmy blue whale foraging BIA and the adjacent migration BIA and 'most important foraging area' and 'most important migration area' as calculated by Thums et al. (2022) from the overlap between three metrics of pygmy blue whale spatial use.

The southern right whale occurs off the coast of Australia, with two subpopulations identified: a south-western population of ~2585 animals in 2020 and a south-eastern population of ~268 animals in 2018 (Stamation et al. 2020, Smith et al. 2021). The south-western population occupies WA and SA waters, predominantly in southern regions from Cape Leeuwin, WA (Bannister 2010) to Fowlers Bay, SA (Charlton et al. 2019). Recently, the DCCEEW has extended the BIAs for the species in the NCVA, outlining migration and reproduction zones as far north as Exmouth Gulf, WA. The shallow coastal waters near Albany in WA and Head of the Bight in SA host the greatest concentrations of the western population during their breeding season (Bannister 2001, Charlton et al. 2022). While the main aggregation of individuals is along the southern coastline, they have been recorded further north, with the northern extremity of their distribution being Exmouth / Ningaloo on the west coast (Bannister 2001, Sprogis et al. 2022). However there have been few recorded observations this far north (Bannister 2001), with the latest published sighting in 2021 of a single cow calf pair in Exmouth Gulf (Sprogis et al. 2022). As the populations increase in abundance there has been an expansion and re-occupation of

historic breeding grounds, notably Geographe Bay in south-western Australia, Fowlers Bay and Encounter Bay in SA (Charlton et al. 2019, Kemper et al. 2022, Salgado Kent et al. 2022).

Right whales are capital breeders relying on stored fat to sustain long fasting periods on breeding grounds. Recent studies have identified a body condition threshold (~40% below average, ~3% blubber) beyond which survival is compromised. An average southern right whale can endure ~17 months of fasting in good condition, but calves and lactating females have limited reserves (a 4 m calf may only survive ~20 days without nutrition). Notably, North Atlantic right whales – often already in poorer body condition – have much reduced fasting endurance; a severely entangled 5-year-old could only survive ~1–2 months without feeding. These findings underscore the very narrow survival margin for any right whale in suboptimal condition, such as an underweight or entangled individual, highlighting their heightened vulnerability to any prolonged loss of feeding opportunities or added energetic stress (Christensen et al. 2025).

There are currently no identified historic high use areas (locations where intensive shore-based whaling effort occurred, and southern right whales occupied the area) within WA (DSEWPAC, 2012c). The recent publication of the National Recovery Plan for the Southern Right Whale (DCCEEW, 2024) identifies the migratory BIA as a continuous coastal path between Hervey Bay in QLD extending along the southern coastline of Australia and up Western Australia to Exmouth Gulf (DCCEEW, 2024). The temporal extent of southern right whale presence in this migratory BIA is approximately May to October, with the peak abundance occurring late July to August. Between season variation can occur with the possibility of early and late individuals between April and November (Department of the Environment, 2024). The most recent recovery plan includes the addition of a reproductive BIA in Exmouth Gulf (approximately May to September) (DCCEEW, 2024). The single sighting of the cow calf pair in Exmouth Gulf occurred late July (Sprogis et al. 2022). Aerial surveys conducted between 1999 to 2010 to identify cetaceans utilising Shark Bay, North-West Cape, Exmouth Gulf and Anketell Point recorded no observations of southern right whales (Jenner et al. 2010, Jenner and Jenner 2011).

A 2025 report on the western population of SRW surveyed calving areas south of Perth, including Albany, Esperance and the Head of Bight, and found a slowing trajectory in the population recovery at these locations. These results are consistent with existing knowledge already reflected in this EP, namely that calving occurs in southern Western Australia. The findings do not alter the understanding of SRW distribution in the northern Perth Basin (Smith et al. 2025). It is therefore highly unlikely that southern right whales will utilise the migratory BIA inshore of the OA during the MSS period of February to March.

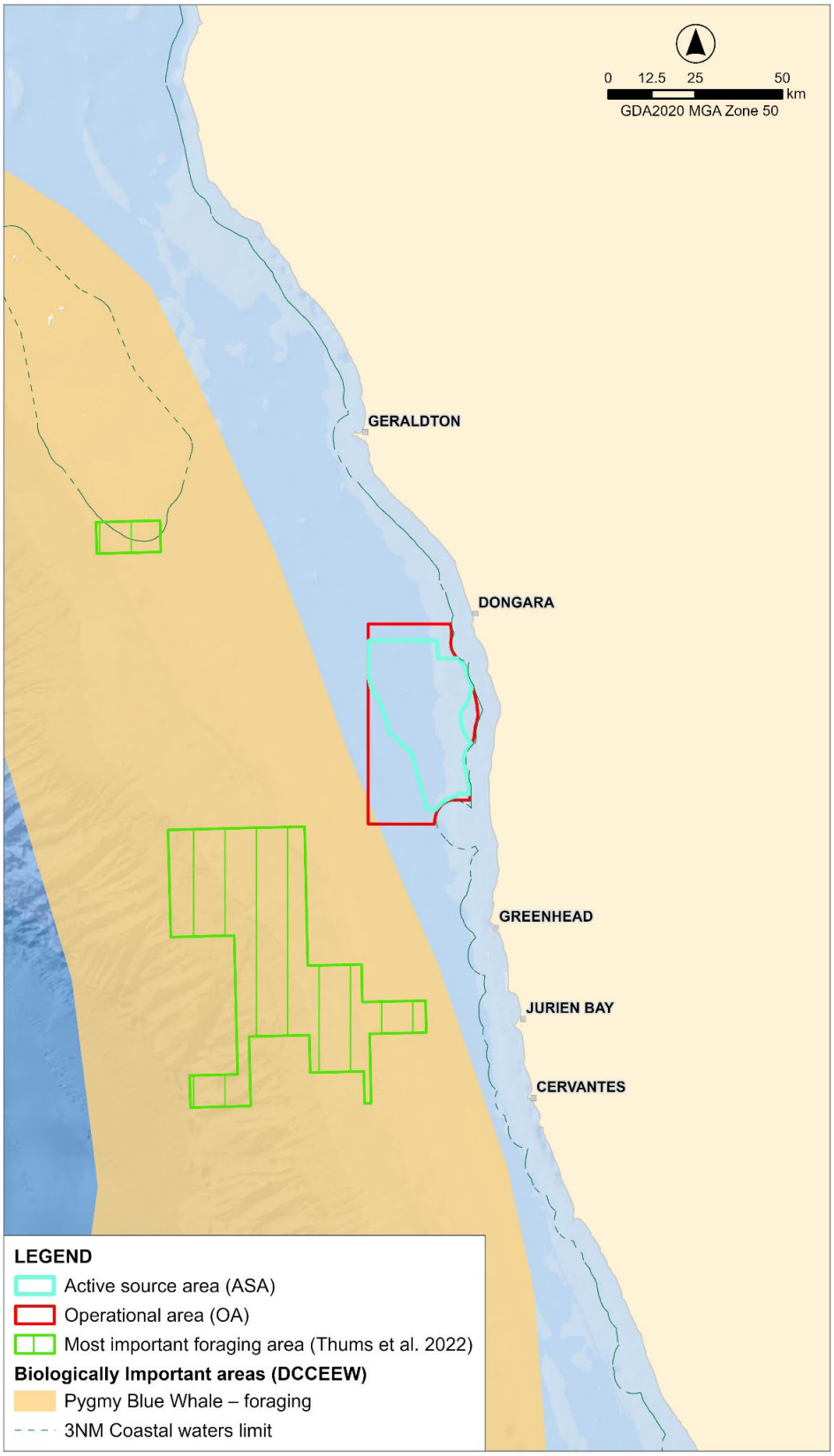


Figure 4-11: Pygmy blue whale known foraging BIA and most important foraging area, as detailed in Thums et al. (2022)

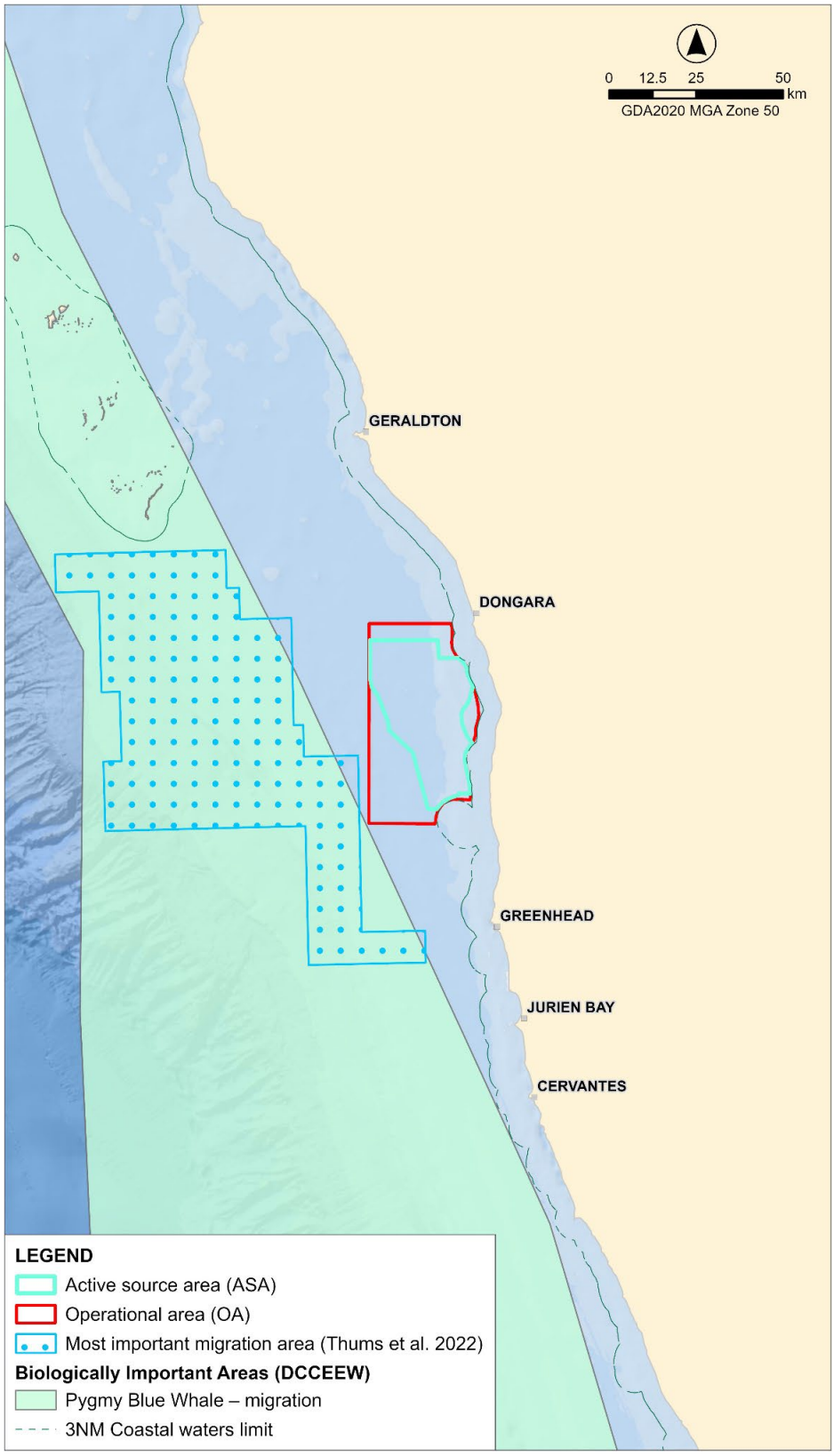


Figure 4-12: Pygmy blue whale migration BIA and the most important migration path, as detailed in Thums et al. (2022)

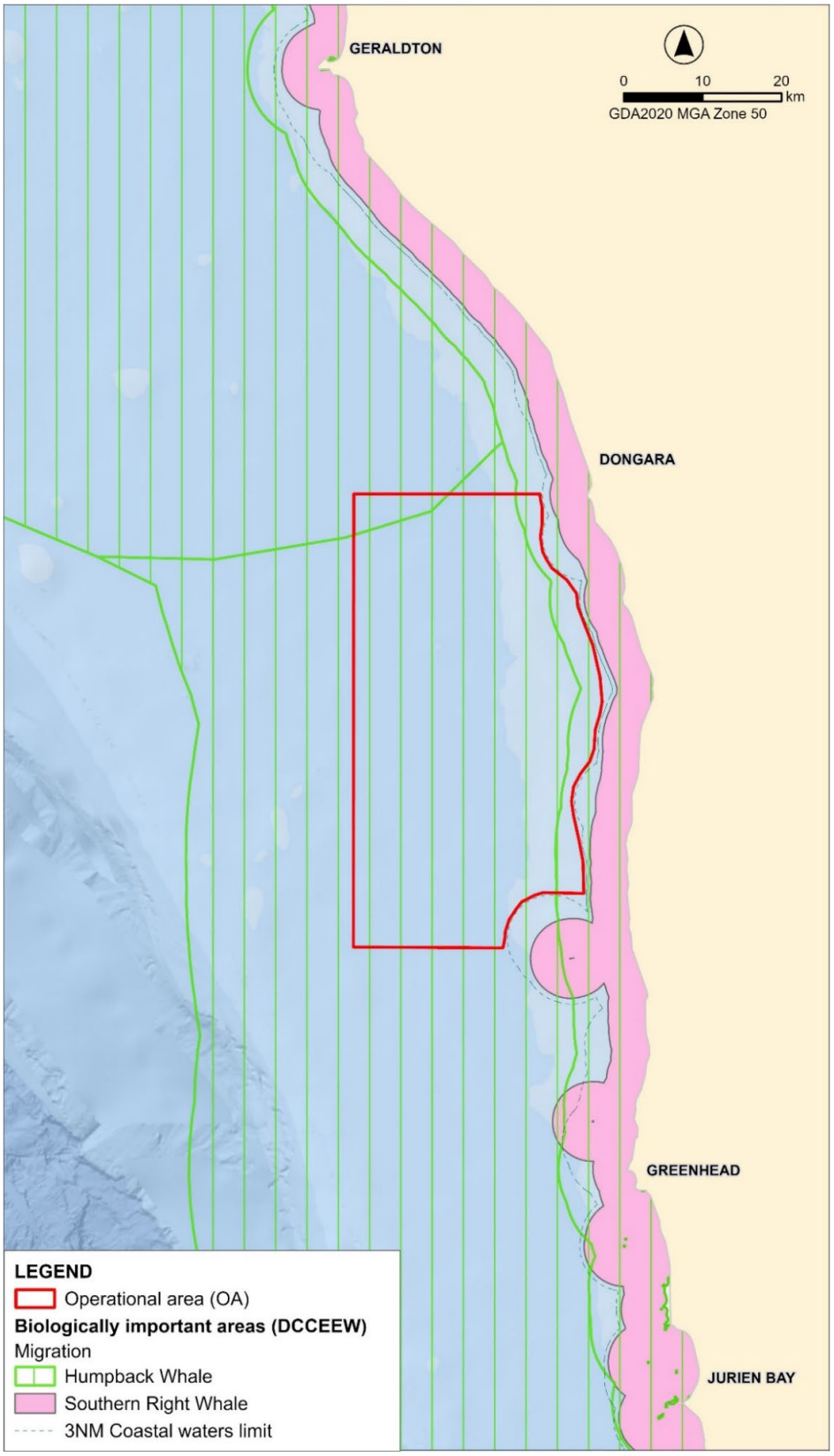


Figure 4-13: Humpback and southern right whale migration BIAs

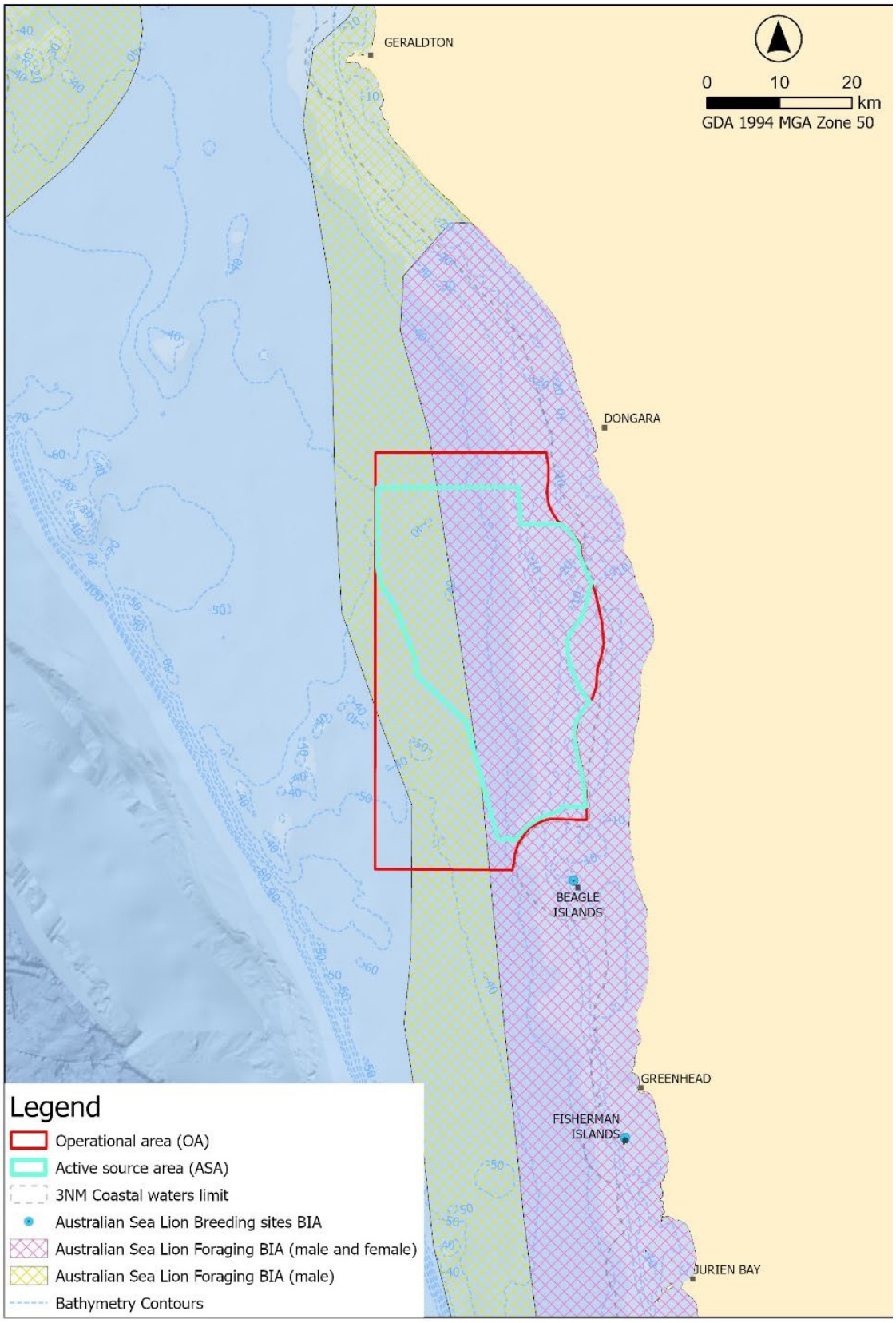


Figure 4-14: Australian sea lion foraging BIA

Table 4-8: Threatened and Migratory mammals potentially occurring within the OA and EMBA during February and March

Common name	Habitat, distribution and seasonality	Presence
Marine mammals potentially occurring within the OA		
Blue whale	Habitat and distribution	May Occur
	Two subspecies of blue whale are found in the southern hemisphere The pygmy blue whale (*Balaenoptera musculus brevicauda*) and the Antarctic blue whale (*B. m. intermedia*). During the southern hemisphere summer, Antarctic blue whales are usually found south of 60°S, while pygmy blue whales are usually found north of 55°S (DoEE 2019). The pygmy blue whale has a worldwide oceanic distribution and are regularly sighted in Australian waters. Whilst the species prefer deep waters (500 – 1,000 m), whale sightings in Australia are usually related to migration purposes or opportunistic feeding. The pygmy blue whale has BIAs for migration and foraging along the WA coastline. The OA and EMBA overlap the migration and foraging BIAs. Satellite tracking of pygmy blue whales undergoing their northern migration indicates whales generally follow known migration paths, along the WA coast (Double et al. 2012, 2014; Thums et al. 2022).	
	Seasonality	
	The annual northbound migration past Perth Canyon and Geraldton has been detected between April and July (peak May-June), with the return southbound migration from October to January (peak November and early December; McCauley and Jenner 2010; McCauley and Duncan 2011; Double et al. 2012, 2014; Möller et al. 2020; Thums et al. 2022).	
Humpback whale	Habitat and distribution	Unlikely
	Humpback whales occur globally and throughout Australian waters with their distribution being influenced by migratory pathways and aggregation areas for resting, breeding, and calving (DoEE 2019). There are two genetically distinct west and east coast populations of humpback whales in Australia (DoEE 2019). The southbound migration corridor tends to be within the 200 m isobath (Jenner et al. 2001). The humpback whale migration (north and south) BIA overlaps the OA and EMBA.	
	Seasonality	
	The annual peak northbound migration along the Jurien Bay to Carnarvon migration route occurs between June and July, while the southbound migration peak occurs between September and October (Jenner et al. 2001). The west coast population of the humpback whale is thought to be increasing in size by about 9% per year (TSSC 2015e); estimates conducted suggest that in 2008 the population migrating up the WA coast was at 21,750 individuals (Hedley et al. 2011).	
Bryde's whale	Habitat and distribution	May occur
	Bryde's whales are distributed throughout oceanic and inshore, tropical, and warm temperate waters between 40˚N and 40˚S year-round. They have been recorded off all states of Australia, except for the Northern Territory (NT) (DoEE 2019).	
	Seasonality	
	The inshore form of the Bryde's whale is typically limited to the 200 m depth contour and breeds and calves year-round, whilst the offshore form is found in deeper waters (500 to 1000 m) and breeds and calves over several months during winter (Best et al. 1984; Kato 2002). The nearest known area of aggregation is Ningaloo Reef (over 600 km away; DoEE 2019) There is currently no evidence of large-scale movements of the inshore form of the Bryde's whale. However, the offshore form may migrate seasonally, heading towards warmer tropical waters during the winter months. There is limited data on migration, mating, breeding, and calving patterns for Bryde's whales, and no specific feeding or breeding grounds have been discovered off Australia.	

Common name	Habitat, distribution and seasonality	Presence
Fin whale	Habitat and distribution	May occur
	Fin whales occur from polar to tropical waters, but rarely in inshore waters (DoEE 2019). Fin whales are widely distributed in both hemispheres between latitudes 20–75°S (Mackintosh 1965). This species is common in temperate waters, the Arctic Ocean and Southern Ocean. Fin whales feed intensively in high latitudes and may feed in lower latitudes to some extent depending upon prey availability and locality. Fin whales feed on planktonic crustacea, fish, and cephalopods (crustaceans). The Australian Antarctic waters are important feeding grounds for fin whales. Sightings of fin whales feeding in the Bonney Upwelling area indicate that this area is also a potentially important feeding ground. There is no known mating or calving areas for fin whales in Australian waters. Fin whales are killed by ship strike more than any other whale, which may be linked to surface feeding (DoEE 2019).	
	Seasonality	
	Fin whales are seasonally present in eastern Antarctic waters from February to June, before migrating to lower-latitude Australian waters (Aulich et al. 2022). In Australian waters, fin whales have a seasonal, migratory presence from May to October on both the east and west coasts (Aulich et al. 2022). Peak presence of the animals has been observed from June to August in the Perth Canyon, WA, approximately 200 km south of the OA (Aulich et al. 2019, 2022).	
Sei whale	Habitat and distribution	Likely
	Sei whales are considered a cosmopolitan species, ranging from polar to tropical waters, but tend to be found more offshore than other species of large whales. They show well defined migratory movements between polar, temperate, and tropical waters (Mackintosh 1965). Migratory movements are essentially north–south with little longitudinal dispersion. Sei whales have been infrequently recorded in Australian waters (Bannister et al. 1996). The similarity in appearance of sei whales and Bryde's whales has resulted in confusion about distributional limits and frequency of occurrence.	
	Seasonality	
	This species is known to breed in tropical and subtropical waters, while Australian Antarctic waters are important feeding grounds for sei whales, as are temperate, cool waters (Horwood 1987). Sei whales have the same general pattern of migration as most other baleen whales, although it is timed a little later and they do not go to such high latitudes (Gambell 1968).	
Southern right whale	Habitat and distribution	Unlikely
	The southern right whale is found predominately along the southern coastline of Australia, from Sydney to Perth, though some sightings have occurred as far north as Exmouth (Bannister 2001). Distribution is presumed to be between about 32°S and 65°S, with the main feeding areas thought to occur between 40°S and 55°S (Bannister et al. 1996). Most feeding areas are assumed to be in deeper offshore waters. Recently, the DCCEEW have extended the BIAs for the species, outlining migration and reproduction zones as far north as Exmouth Gulf, WA. The migration BIA, which extends all the way up the west coast of WA as far north as Ningaloo Reef, is located just inshore of the OA. The seasonal calving and calving buffer BIAs overlap the EMBA and are located ~215 km south of the OA. Southern right whales are seasonally present in Australian water from as early as April and as late as November (Department of the Environment, 2024), outside of the Eureka MSS period of February to March.	
	Seasonality	

Common name	Habitat, distribution and seasonality	Presence
	Southern right whales migrate to more temperate coastal waters to calve from April to November with peak abundance typically occurring in July and August (Watson et al. 2021, DCCEEW 2024). The closest calving area to the study area is approximately 400 km away near Mandurah; however, occasional sightings and strandings have been observed further north (refer Atlas of Living Australia [ALA] database). The defined migratory period for the southern right whale within the migration BIA up the west coast of WA is April to October (DCCEEW, 2024).	
Orca, killer whale	Habitat and distribution	May occur
	The orca is found in all the world's oceans, from the Arctic and Antarctic regions to tropical seas (Ford et al. 2005). The species has been recorded in all the coastal waters of Australia, with concentrations reported in Tasmania, and common sightings in SA and Victoria (DoEE 2019).	
	Seasonality	
	The preferred habitat of the species includes oceanic, pelagic, and neritic (relatively shallow waters over the continental shelf) regions, in both warm and cold waters. They may be more common in cold, deep waters, but off Australia, orcas are most often seen along the continental slope and on the shelf, particularly near seal colonies. Orcas have regularly been observed within the Australian territorial waters along the ice edge in summer. No areas of significance and no determined migration routes have been identified for this species within waters off WA (DoEE 2019). Mating is known to occur all year round, whilst the calving season spans several months.	
Australian sea lion	Habitat and distribution	Known
	Australian sea lions (ASL's) have a breeding distribution from the Abrolhos Islands in WA to the Pages Islands in SA. Population numbers and distribution has significantly reduced due to human pressures such as hunting and coastal development (McClatchie et al. 2006). Breeding predominantly occurs in SA, with only ~17% occurring in WA. Foraging BIAs for the species overlap the OA and EMBA. There is a defined breeding BIA for ASLs on the Beagle Islands, located ~10 km south of the southern boundary of the OA. Beagle Island is the largest breeding colony in Western Australia, contributing 47-79 pups per breeding cycle (AMSIS). The foraging BIAs for males, and males and females, overlaps the EMBA and OA.	
	Seasonality	
	ASLs are the only seal that has an asynchronous non-annual breeding cycle, with breeding cycles ranging from 16 to 20 months and pupping occurring at different times throughout the SWMR (McClatchie et al. 2006). Discussion with DBCA has advised that based on current knowledge of the breeding patterns at Beagle Island there may be overlap with the timing of the survey and ASL breeding for a survey conducted during the 2025 period, however there is no overlap of breeding with the 2026 period. Foraging occurs year-round within the OA and EMBA (DSEWPC 20133, Campbell & Holley 2007).	
Mammals potentially occurring within the EMBA		
Antarctic minke whale	Habitat and distribution	Likely
	The distribution of Antarctic minke whales along the west coast of Australia is currently unknown, however, it is likely that they do not migrate as far north as dwarf minke whales (to 11°S; DoEE 2019). The southern distribution of Antarctic minke whales extends down to approximately 65°S in the Australian Antarctic Territory (DoEE 2019). It is possible that Antarctic minke whales may transit through the OA; however, no BIAs have been identified in the region, and it is not likely that the area is used for feeding, breeding, or resting.	
	Seasonality	

Common name	Habitat, distribution and seasonality	Presence
	There is insufficient data to prescribe migration times and routes for Antarctic minke whales; however, most sightings in WA waters occur from December to March, indicating this may be their migration period (Sobtzick 2010; DoEE 2019).	
Sperm whale	Habitat and distribution	Likely
	Sperm whales are abundant from polar waters to the equator and typically found in deep temperate and tropical offshore waters (greater than 600 m) or closer to the shore in water depths greater than 200 m (DoEE 2019). Sperm whales tend to be found where the seabed rises steeply from great depth and are probably associated with concentrations of major food in areas of upwelling (Bannister et al. 1996). There is limited information on their distribution in Australian waters, although they have been recorded off the coast of all Australian states, where they occur in groups of up to 50 individuals (DoEE 2019). The foraging BIA for sperm whales overlaps with the EMBA and is located ~215 km south of the OA.	
	Seasonality	
	In the Southern hemisphere, migrations occur from July to March, peaking in September and December. Calves may be born in tropical and temperate waters and are mainly born between November and March.	
Dusky dolphin	Habitat and distribution	Likely
	Dusky dolphins have only been reported 13 times since 1828 along southern Australia from WA to Tasmania (Gill et al. 2000). They are observed along the southern hemisphere in temperate and sub-Antarctic waters and are not known to migrate; however, some have been observed in deep waters (Ross 2006). The species has been observed to stay in shallower waters in winter and move out to deeper waters in summer (Gill et al. 2000).	
	Seasonality	
	There is limited information on the movement patterns of dusky dolphins in Australia. Globally, mating has been observed in summer, with calving occurring in the next summer (Ross 2006). The species is not known to migrate.	
Pygmy right whale	Habitat and distribution	May Occur
	In Australia, pygmy right whales are distributed between 32°S and 47°S, spread along southern Australia from Geraldton in WA to Forster in NSW, though are not spread uniformly (Kemper 2002). The species is observed more often in eastern Australia. The species is typically found in areas of upwelling (Kemper 2013).	
	Seasonality	
	The breeding cycle of pygmy right whales is unknown; however, some reports have assumed a calving seasonally between May and January (Pavey 1992; Kemper 2002). There is no evidence of large-scale migration for the species (Kemper 2002).	

4.3.9 Sharks and rays

The SWMR supports high species richness of shark, sawfish and rays stemming from the diversity of marine environments. There are approximately 500 shark and sawfish species globally, with 95 species found within the SWMR (i.e., 19% of the world's shark species; McClatchie et al. 2006).

Three Threatened and Migratory, six Migratory and four Threatened/Conservation Dependent shark and ray species were identified in the PMST search as potentially occurring in the OA and EMBA (Table 4-5).

A description of the identified threatened and/or migratory sharks, sawfish and rays is provided in Table 4-9, including their distribution, migratory movements, preferred habitat, and likely presence within the OA and EMBA.

One BIA for the shark and ray species described in Table 4-4 has been identified as overlapping the OA and EMBA: the white shark foraging BIA, which extends northwards along the 200 m isobath (Figure 4-15).

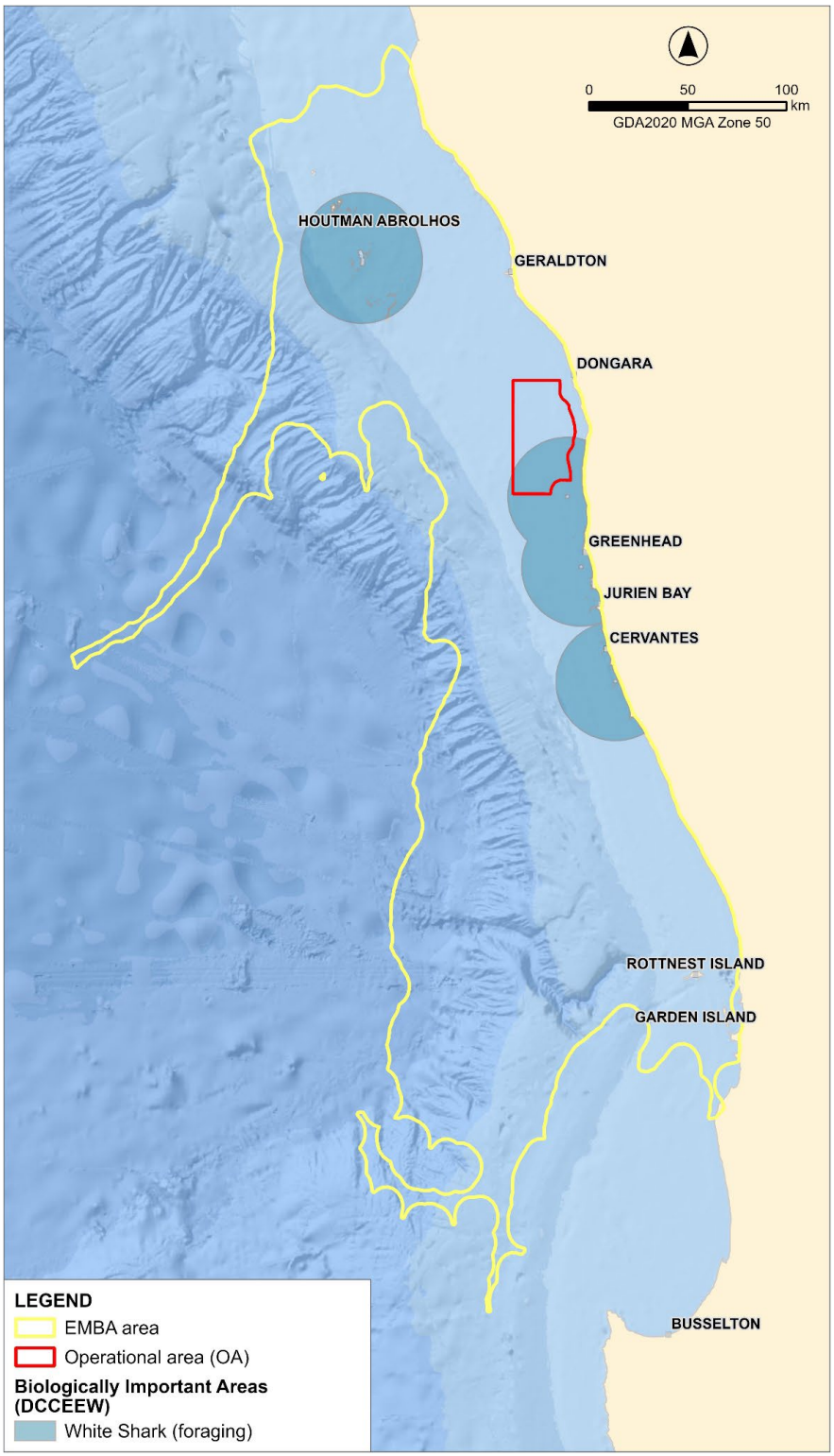


Figure 4-15: White shark foraging BIA overlap with the OA and EMBA

Table 4-9: Threatened and migratory sharks and rays potentially occurring within the OA and EMBA

Common name	Habitat, distribution and seasonality	Presence
Sharks and rays potentially occurring within the OA		
Whale shark	Habitat and distribution	May occur
	The whale shark occurs in both tropical and temperate waters with a typically oceanic and cosmopolitan distribution (Colman 1997). They are commonly recorded in WA, the NT and QLD, although they have been sighted occasionally in NSW and Victoria (VIC).	
	Seasonality	
	Whale sharks aggregate at Christmas Island (approximately 2800 km from the OA) between December and January and at Ningaloo Reef (approximately 700 km from the OA) between March and July to feed on krill and baitfish associated with coral spawning events (DoEE 2019). After this period, whale sharks disperse from Ningaloo and are understood to forage in continental shelf waters during spring. Tagged whale shark data includes records of whale sharks departing from Ningaloo in spring and travelling north-west, following the 200 m isobath on the edge of the continental shelf, though some individuals have been observed as far south as Perth (Colman 1997).	
White shark, great white shark	Habitat and distribution	Known
	White sharks have been recorded from central QLD around the south coast to north-west WA, with movements occurring between the mainland coast and the 100 m depth contour (DoEE 2019). Great white sharks are frequently recorded in waters around fur seal and sea lion colonies such as the islands off the lower west coast of WA (DoEE 2019). The foraging BIA for white sharks overlaps the OA.	
	Seasonality	
	Great white sharks are known to undertake migrations along the WA coast, with some individuals travelling as far north as Northwest Cape during spring, before returning south for summer (DoEE 2019).	
Shortfin mako shark	Habitat and distribution	Likely
	The shortfin mako is found in tropical and warm-temperate seas in water depths up to 500 m (Cailliet et al. 2009). The species is rarely found in waters cooler than 16 °C and is occasionally found close inshore where the continental shelf is narrow (Cailliet et al. 2009). The species is widespread in Australian waters, having been recorded in offshore waters all around the continent's coastline with exception of the Arafura Sea, the Gulf of Carpentaria and Torres Strait.	
	Seasonality	
	Shortfin mako sharks are a highly mobile and migratory species that can travel large distances (Rogers et al. 2009; Gibson et al. 2021). No seasonal patterns have been identified in Australia, however mako sharks have been shown to use the outer shelf of the continental slope in WA while migrating (Rogers et al. 2009).	
Longfin mako	Habitat and distribution	Likely
	Longfin makos inhabit oceanic and pelagic habits, typically in tropical regions. They are a highly mobile species and have a wide-ranging distribution (DoEE 2019) but are rarely encountered. Longfin mako usually occur to depths of 760 m but have been reported to 1752 m (Rigby et al. 2019a; Ebert et al. 2013, Hueter et al. 2016, Weigmann 2016). In Australian waters, the species is found from Geraldton, in WA, and north to Port Stephens in NSW (Last & Stevens 2009). Given the species wide-distribution and preference for deeper waters, the presence of the species within the EMBA is expected to be low.	
	Seasonality	
	There is insufficient data to determine seasonal distribution, migration times and routes in the region.	

Common name	Habitat, distribution and seasonality	Presence
Reef manta ray, coastal manta ray	Habitat and distribution The reef manta ray is found around the northern coast of Australia between south-western Australia, and central NSW (DoEE 2019). This species is often resident in or along productive near-shore environments, such as island groups, atolls, or continental coastlines. This species tends to inhabit warm tropical or sub-tropical waters. The species is commonly sighted inshore, however is also found around offshore coral reefs, rocky reefs, and seamounts (Marshall et al. 2018). Seasonality Movement patterns are likely site-specific and correlated with cycles in productivity. Individuals have been documented to make seasonal migrations of several hundred kilometres as well as daily migrations of almost 70 km (Marshall et al. 2018; Armstrong et al. 2020). The closest aggregation area for reef manta rays is Ningaloo Reef (approximately 700 km away), during May to September; however, some individuals have occasionally been observed in southwest Australia (Armstrong et al. 2020).	Known
Giant manta ray, oceanic manta ray	Habitat and distribution The giant manta ray lives in tropical, marine waters worldwide, and occasionally in temperate seas between latitudes 30°N and 35°S. In Australia, the species is recorded from south-western WA, around the tropical north to the southern coast of NSW (DoEE, 2019). Seasonality There is insufficient data to prescribe distribution behaviours, migration times and routes and seasonal patterns in the region.	May occur
Freshwater sawfish, largetooth sawfish	Habitat and distribution The freshwater sawfish may potentially occur in all large rivers of northern Australia from the Fitzroy River, WA, to the western side of Cape York Peninsula, QLD (DoEE 2019). It is a marine/ estuarine species that spends its first 3–4 years in freshwater (DoEE 2019). The preferred habitat of this species is mud bottoms of river embayments and estuaries, but they are also found well upstream. The species mainly feeds on fishes and benthic invertebrates. Seasonality A study on the movement patterns of other sawfish species, *P. clavata* and *P. zijsron*, showed that the species had a high fidelity to an area, with movements restricted to only a few square kilometres within the coastal fringe, and influenced by tides (Stevens et al. 2008).	May occur
Oceanic whitetip shark	Habitat and distribution The oceanic whitetip has a global distribution, occurring in both tropical and subtropical waters, with a temperature range of 18–28 °C but preferring >20 °C (Rigby et al 2019b; Howey-Jordan et al 2013). The species is usually found offshore in the open sea with a preference for surface waters (<200 m) but have been reported in depths of 1082 m (Rigby et al. 2019b). Seasonality Across its range the oceanic whitetip shark is highly migratory, however, there is limited information on the movement patterns and migration paths of this species (Young & Carlson 2020).	Likely

Common name	Habitat, distribution and seasonality	Presence
Grey nurse shark (west coast population)	Habitat and distribution	Known
	Grey nurse sharks (western population) are found in inshore waters, particularly sub-tropical to temperate waters (Daley et al. 2015). The western population is found primarily south-west coastal waters of WA, reaching as far north as the North-West Shelf (Last & Stevens 2009). Occasional sightings are reported near the OA.	
	Seasonality	
	The movement pattern of the west coast populations of grey nurse sharks is relatively unknown. Juveniles are known to migrate for new territory; however, seasonal migration patterns have not been observed (Last & Stevens 2009). The eastern populations have complex seasonal patterns, indicating western populations may also. Pupping for the species has been observed in July, outside of the proposed acquisition window for the Eureka 3D MSS (February-March).	
Scalloped hammerhead shark	Habitat and distribution	Likely
	In Australia, the scalloped hammerhead is found in NSW, QLD, the NT, and WA (Last & Stevens 2009). The species is predominately found along coastal shelves, though will occasionally travel into intertidal zones (White et al. 2006).	
	Seasonality	
	Scalloped hammerheads migrate yearly for foraging and breeding purposes. The closest aggregation area for the species to the OA is the Shoalwater Islands Marine Park (~250 km away), when peak numbers are observed during January and February (Lopez et al. 2022).	
Porbeagle, Mackerel shark	Habitat and distribution	May occur
	Porbeagle sharks are found circumglobally in the Southern Hemisphere between 30° and 60°S, and in the North Atlantic (Bray & Gomon, 2023). In Australia, they inhabit southern Western Australia, South Australia, Tasmania, Victoria, New South Wales, and southern Queensland (Last & Stephens, 2009). They typically inhabit cold oceanic waters (below 18°C) off the continental shelf although they occasionally enter coastal waters. Porbeagle sharks undertake daily vertical migrations, diving to 600 meters during the day with a maximum recorded depth of 1024 meters, and spending most of their nights at depths of 200–600 meters in the open ocean (Francis et al. 2015).	
	Seasonality	
	Porbeagle sharks exhibit seasonal migration patterns, although the timing and details of these movements are not well-understood. Individuals have been tracked moving large distances (i.e., 1500-1800 km along continental shelves and crossing the Atlantic Ocean between Europe and North America) (Francis et al. 2002). In the Southern Hemisphere, they likely give birth off New Zealand and Australia in winter (Francis & Stevens 2000). They also perform daily vertical migrations, diving deeper during the day and staying at mid-depths at night.	
Sharks and rays potentially occurring within the EMBA		
School shark	Habitat and distribution	May occur
	The school shark occurs throughout the temperate coastal waters of southern Australia (Daley et al. 2015). The species moves extensively through the southern waters of Australia, manly in demersal water over continental shelves, but also along upper slopes, at depths from near shore to 550 m. Inshore areas are typically breeding and nursing sites.	
	Seasonality	
	School sharks migrate yearly over long distances, likely associated with breeding, generally heading north in winter and south in summer (Daley et al. 2015). The species pupping occurs between December and January in southern Australia.	
	Habitat and distribution	Likely

Common name	Habitat, distribution and seasonality	Presence
Little gulper shark, Southern dogfish	The southern dogfish occurs in temperate waters of the upper-continental slope from 250 to 800 m depth (Daley et al. 2015). There are two distinct Australian populations, the eastern subpopulation ranging from Townsville (QLD) to Bass Strait (Victoria) and the western population ranging from the Kimberley region to Albany (WA) (Last & Stevens 2009). While the eastern subpopulation is considered Near Threatened, the western population is only considered Least Concern, due to limited fishing pressure.	
	Seasonality	
	The southern dogfish is known to undertake seasonal migrations, although the timing and details of these migratory movements are not understood (Daley et al. 2015).	

4.3.10 Marine reptiles

4.3.10.1 Marine turtles

Marine turtles have similar life cycle characteristics, which include migration from foraging areas to mating and nesting areas. All species, except for flatback turtles, have an oceanic pelagic stage before moving to nearshore waters to breed. The region is significant for supporting large feeding and nesting turtle populations. Four Threatened and Migratory marine turtle species were identified in the EPBC Act Protected Matters Database search as having the potential to occur in the OA and EMBA. Table 4-10 describes their distribution, habitats, life stages and likely presence within and around the OA during the survey. There are no BIAs (including nesting) or Habitat Critical for turtle species in the OA or EMBA.

Table 4-10: Threatened and Migratory marine turtles potentially occurring within the OA

Common name	Habitat, distribution and seasonality	Presence
Marine reptiles potentially occurring within the OA		
Loggerhead turtle	Habitat and distribution	Known
	The loggerhead turtle has a global distribution and occurs in eastern, northern, and western parts of Australia (Limpus 2008a). Loggerhead turtles are known to show fidelity to both their foraging and breeding areas and can make reproductive migrations of over 2600 km between foraging and nesting areas (DoEE 2019). The species is known to forage nearshore, in water depths up to approximately 50–60 m (DoEE 2019). In WA, the species nests on the beaches of Shark Bay (approximately 350 km away) (DoEE 2019, Guinea 1995). As a juvenile, this species feeds on algae, pelagic crustaceans, molluscs, and flotsam whilst as an adult it feeds on gastropod molluscs, clams, jellyfish, starfish, coral, crabs, and fish (DoEE 2019). There is just one anecdotal sighting of a loggerhead turtle (deceased animal washed up on beach) in proximity to the OA in the ALA database.	
	Seasonality	
	Nesting occurs between October and February, with a peak in December (DoEE 2019).	
Green turtle	Habitat and distribution	Known
	The green turtle has a global distribution and occurs in tropical and subtropical waters, with WA supporting one of the largest green turtle populations in the world (Limpus 2008b). Green turtles nest along WA's North West Shelf, ranging from the Ningaloo Reef (over 700 km away) to the northern Kimberley region. The species primarily forages in shallow benthic habitats (10 m) such as tropical tidal and subtidal coral and rocky reef habitat or inshore seagrass beds, feeding on seagrass beds or algae mats (Hazel et al. 2009).	
	Seasonality	
	Nesting occurs between November and March, peaking in December/January (DoEE 2019). Female green turtles go into an inter-nesting cycle after each nesting occurrence. The inter-nesting cycle takes approximately two weeks once nesting commences. The females spend this period in shallow waters beyond the reef edge, where they visit different substrates, occupy different depths, and move up to tens of kilometres from the nesting beach. The species undertakes extensive post-nesting migrations from foraging areas to traditional breeding areas (CoA 2017).	

Common name	Habitat, distribution and seasonality	Presence
Leatherback turtle	Habitat and distribution	Known
	Leatherback turtles are pelagic feeders, spending extended periods of time in tropical, subtropical, and temperate open ocean waters (Limpus 2009). The species has been recorded feeding in the coastal waters of all Australian states and territories in low densities. Leatherback turtles forage on pelagic soft bodied creatures (such as jellyfish, squid, salps, siphonophores and tunicates) all year round in Australian waters (DoEE 2019). No large rookeries have been identified in Australia (DoEE 2019). Nesting occurs on tropical beaches and subtropical beaches (Marquez 1990), but no major centres of nesting activity have been recorded in Australia. There are two anecdotal sightings of leatherback turtles (deceased animals) in proximity to the OA in the ALA database.	
	Seasonality	
	The species is understood to migrate from Australian waters to breed at larger rookeries in neighbouring countries such as Indonesia, Papua New Guinea and Solomon Islands between December and January (DoEE 2019).	
Flatback turtle	Habitat and distribution	Known
	The flatback turtle is found in the tropical waters of northern Australia, Papua New Guinea, and West Papua, while nesting is only known to occur in Australia (DoEE 2019). Flatback turtles are known to feed on gastropod molluscs, squid, soft corals, hydroids, and jellyfish (DoEE 2019). Flatback turtle hatchlings do not have an offshore pelagic phase. Hatchlings grow to maturity in shallow coastal waters thought to be close to their natal beaches (CoA 2017). Although turtles remain close to nesting beaches during the inter-nesting period, there is evidence that some flatback turtles undertake long-distance migrations between breeding and feeding grounds (Pendoley et al. 2014).	
	Seasonality	
	Major rookeries are present from Exmouth to the Lacepede Islands (over 800 km away) and along the Kimberley coast and islands. There are significant rookeries on Barrow Island, Thevenard Island, Montebello Islands and Lowendal Islands (CoA 2017). Nesting occurs between November and March, peaking in January (CoA 2017).	

4.3.11 Marine birds

Many migratory shorebird (including those frequenting offshore islands) and seabird species are known to occur in the SWMR. The SWMR is a key breeding, feeding and nesting region of Australia, containing the most significant and diverse seabird breeding islands in Australia's territorial waters (McClatchie et al. 2006). For example, the Houtman Abrolhos is the most important seabird breeding site in the eastern Indian Ocean (BirdLife International 2023). In 1999, the Houtmas Abrolhos was estimated to support >500,000 seabirds, including > 1% of the global population of little shearwater (*Puffinus assimilis*), wedge-tailed shearwater (*Ardenna pacificus*), roseate tern (*Sterna dougallii*), Australian fairy tern (*Sternula nereis nereis*), bridled tern (*Onchoprion anaethetus*), sooty tern (*Onchoprion fuscata*), common noddy (*Anous stolidus*) and the endemic lesser noddy (*Anous tenuirostri*) (BirdLife International 2023).

Many seabirds found in the SWMR, particularly the Procellariiformes (i.e., tube-nosed seabirds), spend most of their lives foraging across large distances of open ocean and only return to land to breed. Some species breed locally (e.g., little shearwater, wedge-tailed shearwater, white-faced storm-petrel, bridled tern and sooty tern), while others breed on distant islands and utilise the waters of the SWMR for foraging during their non-breeding period (e.g., soft-plumaged petrel, northern giant petrel) (Table **4-11**). In addition, there are several species of tern (Caspian tern, crested tern, roseate tern, and fairy tern) and gull (Pacific gull and silver gull) that are restricted to coastal waters and/or continental islands year-round.

Seventy-two percent of Australia's seabird fauna are found within the SWMR. 22 species are ecologically significant to the SWMR i.e., they are either endemic, have a high number of interactions with the region (nesting, foraging, roosting, or migrating) or have life history characteristics that make them susceptible to population decline (McClatchie et al. 2006).

A search of the EPBC Act Protected Matters Database found four Threatened, 13 Threatened and Migratory, and ten Migratory marine birds potentially occurring within the OA. A further five Threatened, ten Threatened and Migratory, and 26 Migratory marine birds potentially occur in the EMBA. Fifteen BIAs for marine bird species were identified overlapping the OA and EMBA (see Table 4-7).

Table 4-11: Threatened and Migratory birds potentially occurring within the EMBA and OA

Common name	Habitat, distribution and seasonality	Presence EMBA	Presence OA
Common noddy	Habitat and distribution	Likely	May Occur
	In Australia, the common noddy occurs mainly in the ocean off the QLD coast, but the species also occurs off the north-west and central WA coast. A large breeding population of ~160,000 pairs is found at Houtman Abrolhos Islands (BirdLife 2023) and smaller numbers (~3500 pairs) are present on Lancelin Island in WA. During the breeding season, the common noddy breeds on islands, rocky islets and shoals or cays of coral or sand. Birds often nest on bushes, saltbush, or other low vegetation. When not at the nest, adults forage at the edge of the continental shelf or near canyon-like features on the shelf (Shephard et al. 2018). It feeds mainly on fish, although they are known to also take squid, pelagic molluscs, medusa, and aquatic insects. During the non-breeding period (April–September), the species remains at-sea in tropical seas to the north of Australia.		
	Seasonality		
	The seasonality of breeding varies greatly between sites. In WA, breeding occurs between September and April, with a peak between October and December. It is possible individuals of the species may pass through the OA, but the area is not considered an important foraging habitat.		
Roseate tern	Habitat and distribution	Likely	May Occur

Common name	Habitat, distribution and seasonality	Presence EMBA	Presence OA
	The roseate tern occurs in both coastal and marine subtropical/tropical areas. The species inhabits rocky and sandy beaches, coral reefs, sand cays and offshore islands (DAWE 2021a). Roseate terns are a diurnal coastal foraging species that feed on small schooling bait fish, often brought to the surface by predatory fish, such as tuna. This species roosts on land at night. In WA, roseate terns are regularly recorded north from Mandurah to Eighty Mile Beach, in the Pilbara Region (DAWE 2021a). Many breeding pairs are found at the Houtman Abrolhos, with smaller numbers found on islands of the Turquoise Coast. Foraging BIAs for this species overlap the OA and EMBA. Seasonality The movements of the roseate tern are poorly known but birds that breed in the region are probably sedentary or have restricted movements along the coast. Breeding in WA occurs during two distinct periods – summer and autumn (Surman 1998; DAWE 2021a).		
Black-browed albatross	Habitat and distribution The black-browed albatross breeds on in the Antarctic waters near Antarctica. Post-breeding, individuals disperse across vast stretches of open ocean and small populations are observed in south-western WA, typically in waters off the edge of the continental shelf (Barrett et al. 2007). Seasonality The black-browed albatross migrates towards the sub-Antarctic breeding islands in early September. Individuals typically remain within 500 km of their breeding island for their entire life cycle (Barret et al. 2007).	May occur	Unlikely
Northern giant petrel	Habitat and distribution The northern giant petrel breeds in the sub-Antarctic, and visits areas off the southern Australian mainland post-breeding. During this time, individuals are occasionally observed around Fremantle (WA), particularly during storm fronts, and are sometimes observed as far north as Geraldton (DoEE 2019). The primary habitat of the northern giant petrel during the non-breeding period is deep pelagic waters, although first year birds may spend more time on the continental shelf, slope and cold eastern boundary currents off Australia (BirdLife 2024) Seasonality Breeding of this species occurs from August to October. The species visits areas off the Australian mainland mainly during the winter months (May–October) (DoEE 2019).	May occur	Unlikely
Fork-tailed swift	Habitat and distribution There are sparsely scattered records of the fork-tailed swift along the WA coast. In northern WA, they are common in Broome, with maximum numbers occurring in February. The species is highly mobile with large flocks often recorded preceding or following low pressure systems. The species is found on costal cliffs, islands and inland (DoEE 2019). Seasonality The fork-tailed swift does not breed in Australia, but north in Siberia. The species return form their breeding grounds to Australia in October, reaching the	May occur (rare)	May occur (rare)

Common name	Habitat, distribution and seasonality	Presence EMBA	Presence OA
	survey area in October-March. The northern migration from southern Australia occurs in April (DoEE 2019).		
Southern giant petrel	Habitat and distribution	May occur	Unlikely
	The southern giant petrel breeds in the Antarctic waters and migrates north towards the end of the breeding season, mainly along the Bass Strait; however, small populations are observed in south-western WA (Patterson et al. 2008).		
	Seasonality		
	In summer, the southern giant petrel predominantly occurs in subantarctic to Antarctic waters, usually below a latitude of 60°S. In the winter the species travels north, predominately around southern Australia; however, some individuals travel as far north as Port Headland (WA).		
Indian yellow-nosed albatross	Habitat and distribution	May occur	Unlikely
	The Indian yellow-nosed albatross breeds on islands of the southern Indian Ocean. During the non-breeding period it forages in subtropical and warmer subantarctic waters, including the southern Indian Ocean, and is particularly abundant off WA (Rolland et al. 2009). The species concentrates over productive waters of continental shelves, often at coastal upwellings and boundary currents (DCCEEW 2023).		
	Seasonality		
	The species breeds September to April, with a northern migration occurring afterwards (Rolland et al. 2009). The species is most abundant in southern WA between March and May.		
Bridled tern	Habitat and distribution	Likely	May occur
	In Australia, bridled terns breed on offshore islands from South Australia to northeastern Australia to mid-eastern QLD (DoEE 2019; Dunlop & Greenwell 2022). Large breeding populations are found on islands of the Turquoise Coast and Houtman Abrolhos. The species forages in offshore at convergence zones near the edge of the continental shelf waters. Around April, at the conclusion of the breeding period the terns migrate north to Indonesia, moving through Lombok Strait, Lintah Strait and East Timor (DoEE 2019). The foraging BIA for this species overlaps the OA and EMBA. It is possible individuals of the species may pass through the OA but as the OA occurs well inshore off the shelf edge, it is not a primary foraging habitat.		
	Seasonality		
	On islands off south-western and eastern Australia, birds breed in the austral spring-summer, disperse annually from breeding islands after breeding, then return to breeding sites in the austral spring (DoEE 2019). In WA, almost all bridled terns return to breeding colonies between late September and mid-October and normally leave from early to mid-April.		
Caspian tern	Habitat and distribution	Known	Known
	Within Australia, the Caspian tern has a widespread occurrence and can be found in both coastal and inland habitat (Higgins 2003). In WA, the species is widespread along coastal regions, from the Great Australian Bight to the Dampier Peninsula. Breeding occurs along the entire south-west region (Higgins 2003). The closest breeding populations are found on islands of the Turquoise Coast and Houtman Abrolhos. These birds are likely to be largely sedentary or		

Common name	Habitat, distribution and seasonality	Presence EMBA	Presence OA
	make only short-range movements within the region. Caspian terns are a diurnal coastal foraging species that predominantly feed on whiting and mullets, and roost on land at night. The foraging BIA for this species overlaps the OA and EMBA. Seasonality The Caspian tern's main breeding period is September to December. The species will typically stay around their breeding region, though some will migrate (Higgins 2003). The species is likely present in the OA year-round.		
Flesh-footed shearwater	Habitat and distribution In Australia, the flesh-footed shearwater is commonly found along the southern continental shelf (south-west WA to south-east QLD). The species breed on islands off the coast of south-west WA and are nocturnally active at breeding grounds (DoEE 2019). The species is a trans-equatorial migrant. The species is unlikely to be encountered in the OA but may occur in the EMBA. Seasonality The flesh-footed shearwater breeds from August to May on islands in south-west WA, with chicks fledging from colonies around May (DoEE 2019). The species migrates north post-breeding, travelling towards the equator for winter, before returning south to breeding grounds in late September.	May occur	May occur
Australian lesser noddy	Habitat and distribution The Australian lesser noddy is a subspecies endemic to Australia and nest solely on the Houtman Abrolhos Islands (approximately 70 km from the OA). The species remains near the breeding islands throughout the year, though will occasionally move north in winter (Burbidge & Fuller 1989). Seasonality Breeding occurs in spring–summer.	May occur	Unlikely
Australian fairy tern	Habitat and distribution Within Australia, fairy terns occur along the coasts of VIC, TAS, SA, and WA. In WA, there are two populations of fairy terns. The first is a semi-migratory population that breeds between Israelite Bay on the south-eastern coast and Northwest Cape, and over-winter at the Houtman Abrolhos. The second, probably sedentary population occurs on Pilbara islands, as far north as the Dampier Archipelago near Karratha (Dunlop & Greenwell 2022). Fairy terns are a diurnal coastal foraging species that feed on small schooling bait fish and roost on land at night. Foraging BIAs for this species overlap the OA and EMBA. Seasonality In south-western Australia, fairy terns breed between October and February on the mainland and continental islands. Some birds remain at the Houtman Abrolhos, while others migrate as far north as Northwest Cape, or move south, as far as Israelite Bay (Dunlop & Greenwell 2022).	Known	Known
Pacific gull	Habitat and distribution The Pacific gull is endemic to Australia, found along the southern and western coastlines. Breeding occurs in small colonies or scattered single pairs and usually on islands or high points of headlands. Along the coast in shallow water, the	Known	Known

Common name	Habitat, distribution and seasonality	Presence EMBA	Presence OA
	Pacific gull feeds on molluscs, fish, small birds, and other marine life that inhabit tide lines (Lindsay & Meathrel 2008). Breeding pairs are found at Houtman Abrolhos and on islands of the Turquoise Coast. Pacific gulls are restricted to coastal/ island habitats and roosts on ashore at night. Foraging BIAs for this species overlap the OA and EMBA. Seasonality The Pacific gull breeding season is between October and January. The species does not typically migrate far from their breeding grounds (Surman & Nicholson 2009).		
Sooty tern	Habitat and distribution In WA, the sooty tern breeds on islands of the Houtman Abrolhos, Lancelin Island and Bedout off the north-west coast. The species nests beneath bushes or in rock crevices. Key breeding populations have been observed on the Houtman Abrolhos Islands (approximately 70 km from the OA) (Surman & Nicholson 2009). Sooty terns are oceanic foragers, typically associated with areas of upwelling. The foraging BIA for this species overlaps the EMBA. Seasonality The sooty tern breeding season occurs during late spring and throughout summer. Post-breeding, sooty terns migrate northwards into tropical waters, north of Australia.	Known	May occur
Wedge-tailed shearwater	Habitat and distribution The wedge-tailed shearwater breeding distribution in south-western WA covers areas north of and including Rottnest Island, Lancelin Island the Houtman Abrolhos Islands. Overall, the species spends most of its life at sea, but returns to its breeding colonies each year to mate and raise their young. Migration pathways are poorly known, but the WA population is thought to winter in the tropics north of the equator during the non-breeding period (DoEE 2019). The foraging BIA for this species overlaps the OA and EMBA. Seasonality The wedge-tailed shearwater breeding season occurs from September to April (DoEE 2019).	Known	May occur
Little penguin	Habitat and distribution The little penguin is endemic to Australia and New Zealand and found along the southern coast of Australia from Carnac Island (WA) to Broughton Island (NSW), including Shoalwater Islands Marine Park, Penguin Island, and the Geographe Bay area (DoEE 2019). The species tends to live in areas with rocky shores, sandy beaches, and vegetation cover, and they often nest in burrows or under vegetation. Little penguins are rarely observed north of Perth and therefore are unlikely to be encountered within the OA but may occur in the EMBA near Perth. Seasonality Little penguins breed from September to February–March (DoEE 2019). Individuals on Penguin Island begin their breeding season earlier compared to those found on the mainland, due to varying environmental conditions.	Known	Unlikely

Common name	Habitat, distribution and seasonality	Presence EMBA	Presence OA
Great-winged petrel	Habitat and distribution	Known	May occur
	The great-winged petrel inhabits offshore islands and waters, and nests in burrows on islands with steep rocky slopes or cliffs off the southern coast of Western Australia (DAWE 2020b). The species can be found in offshore waters along the entire southwest coast of Australia, including the Houtman Abrolhos Islands, the Recherche Archipelago, and the islands of the Dampier Archipelago (Barter 2002). The species is known for its long-distance migration, with some individuals traveling as far as the North Pacific and North Atlantic oceans.		
	Seasonality		
	The great-winged petrel breeding season in the region typically occurs from September to March (DAWE 2020b). The species spends most of its time at sea but returns to its breeding colonies on islands to mate and raise their young.		
White-faced storm petrel	Habitat and distribution	Known	May occur
	Within Australia, the white-faced storm petrel occurs along the southern coastline, predominantly in the southeast. Major breeding colonies have been observed on the Houtman Abrolhos Islands (approximately 70 km from the OA) (Surman & Nicholson 2009), and smaller colonies occur on Lancelin Island and Turquoise Coast islands. The species is most observed in upwelling areas over the continental shelf, including the Indian Ocean, 80–160 km offshore (Marchant & Higgins 1990). During the non-breeding season, storm-petrels are likely to be in waters well offshore (Marchant & Higgins 1990). The foraging BIA for this species overlaps the OA and EMBA.		
	Seasonality		
	The white-faced storm-petrel breeding season occurs during late spring/early summer. The species does not typically migrate far from their breeding grounds (Surman & Nicholson 2009).		
Little shearwater	Habitat and distribution	Known	May occur
	The little shearwater is found along the entire southern coast of Australia, including the Houtman Abrolhos Islands, the Recherche Archipelago, and the islands of the Dampier Archipelago in WA (DAWE 2020b). The species inhabits offshore waters and breed on small islands, in burrows or rocky crevices. Little shearwaters spend most of their lives at sea but return to breeding colonies on islands to mate and raise their young. They are known for their long-distance migrations, with some individuals traveling from their breeding grounds in south-western WA to the north Pacific and Arctic oceans (DAWE 2020b).		
	Seasonality		
	The little shearwater breeding season in the region typically occurs between September and February (DAWE 2020b).		
Far eastern curlew	Habitat and distribution	Unlikely	Unlikely
	Within Australia, the eastern curlew has a primarily coastal distribution. They have a continuous distribution from south-east WA, through the Kimberley and along the NT, QLD, and NSW coasts and the islands of Torres Strait. Elsewhere, they are patchily distributed (DoEE 2019). During the non-breeding season in Australia, the eastern curlew is most associated with sheltered coasts, especially estuaries, bays, harbours, inlets, and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass (DoEE 2019). Except for		

Common name	Habitat, distribution and seasonality	Presence EMBA	Presence OA
	migration (up to twice per year), shorebirds are not likely to be seen traversing the OA but may occur on the shoreline of the EMBA.		
	Seasonality		
	This species breeds in the northern hemisphere summer between early May and late June. Post-breeding, adults and juveniles disperse south to foraging grounds, including in Australia (DoEE 2019). Eastern curlews begin to arrive in Australia during spring and remain until early March, before returning to their Northern Hemisphere breeding grounds in late July.		
Red knot	Habitat and distribution	Unlikely	Unlikely
	The red knot is primarily found in coastal habitats around the coast of Australia, with large numbers regularly recorded in northern Australia. During the non-breeding period, the red knot mainly inhabits intertidal mudflats, sandflats and sandy, sheltered beaches or shallow pools on exposed wave-cut rock platforms or coral reefs, where it forages on soft substrate near the edge of water, intertidal mudflats or sandflats exposed at low tide. At high tide they may feed at nearby lakes, sewage ponds or floodwaters. They have also been observed foraging on thick algal mats in shallow water and in shallow pools on crests of coral reefs (DoEE 2019). The red knot feeds diurnally and nocturnally. In non-breeding areas, feeding activity is regulated by tide; they feed less just before and after high tide. The red knot is omnivorous and eats mostly worms, bivalves, gastropods, crustaceans, and echinoderms. Except for migration (up to twice per year), shorebirds are not likely to be seen traversing the OA but may occur on the shoreline of the EMBA.		
	Seasonality		
	The red knot is migratory, breeding in the high Artic and moving south to non-breeding areas between 58°N and 50°S. It lays eggs in June and nests on open vegetated tundra or stone ridge, often close to a clump of vegetation. Peak numbers of this species in the SWMR are usually between September and March (DoEE 2019).		
Common sandpiper	Habitat and distribution	Unlikely	Unlikely
	Common sandpipers are distributed along all the Australian coastline and in many areas inland. They are widespread in small numbers and are often solitary. Roebuck Bay in northern WA is an area of national importance for this species (DoEE 2019). Generally, the species forages in shallow water and on bare soft mud at the edges of wetlands. Birds sometimes venture into grassy areas adjoining wetlands and mangroves. Typically, the common sandpiper eats molluscs such as bivalves, crustaceans such as amphipods and crabs and a variety of insects. Except for migration (up to twice per year), shorebirds are not likely to be seen traversing the OA but may occur within the EMBA.		
	Seasonality		
	The common sandpiper breeds in Eurasia and moves south for the boreal winter, with most of the western breeding populations wintering in Africa, while eastern breeding populations winter in South Africa and Australia. Individuals usually arrive in WA from July onwards, spending the summer months in non-breeding foraging grounds before returning to breeding grounds from February		

Common name	Habitat, distribution and seasonality	Presence EMBA	Presence OA
	(DoEE 2019). Except for migration (up to twice per year), shorebirds are not likely to be seen traversing the OA but may occur on the shoreline of the EMBA.		
Sharp-tailed sandpiper	Habitat and distribution	Unlikely	Unlikely
	The sharp-tailed sandpiper is present in Australia during their non-breeding season. The species inhabits both inland and coastal locations, and in WA they are widely distributed from Cape Arid to Carnarvon, around coastal plains of the Pilbara Region to the south-west and east Kimberly Division (DoEE 2019). The sharp-tailed sandpiper prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emerged grass or low vegetation. Except for migration (up to twice per year), shorebirds are not likely to be seen traversing the OA but may occur within the EMBA.		
	Seasonality		
	Eighty Mile Beach (over 1200 km away from the OA) is the closest internationally important site for the species. The sharp-tailed sandpiper migrates to Australia from late June/early July, before returning to their breeding grounds by April–March.		
Pectoral sandpiper	Habitat and distribution	Unlikely	Unlikely
	The pectoral sandpiper is infrequently recorded in WA. It has been observed at the Nullarbor Plain, Reid, Stoke's Inlet, Grassmere Lake, Warden Lake, Dalyup and Yellilup Swamp, Swan River, Benger Swamp, Guraga Lake, Wittecarra, Harding River, coastal Gascoyne, the Pilbara, and the Kimberley. In Australasia, the pectoral sandpiper prefers shallow fresh to saline wetlands. The species is typically found in coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, flood plains, and artificial wetlands (DoEE 2019). Except for migration (up to twice per year), shorebirds are not likely to be seen traversing the OA but may occur on the shoreline of the EMBA.		
	Seasonality		
	The pectoral sandpiper breeds in the northern hemisphere during the boreal summer, before undertaking long distance migrations to feeding grounds in the southern hemisphere. The species occurs throughout mainland Australia between spring and autumn (DoEE 2019).		
Curlew sandpiper	Habitat and distribution	Unlikely	Unlikely
	The curlew sandpiper's breeding areas are mainly restricted to the Arctic of northern Siberia (DoEE 2019). During the non-breeding period, curlew sandpipers are found in Australia around the coasts, while also being widespread inland, though in smaller numbers (DoEE 2019). This species forages mainly on invertebrates, including worms, molluscs, crustaceans, and insects, as well as seeds. Outside Australia, they also forage on shrimp, crabs, and small fish. Curlew sandpipers usually forage in water, near the shore or on bare wet mud at the edge of wetlands (DoEE 2019). Except for migration (up to twice per year), shorebirds are not likely to be seen traversing the OA but may occur on the shoreline of the EMBA.		
	Seasonality		

Common name	Habitat, distribution and seasonality	Presence EMBA	Presence OA
	The species is known to move into certain areas in Australia during its northward migration in April, before migrating away from Australia during May. They start returning to Australia from August to September (DoEE 2019).		
White-capped albatross	Habitat and distribution	Unlikely	Unlikely
	The white-capped albatross is occasionally observed in southern WA but is typically associated with cold, deep waters of the Southern Ocean beyond the shelf edge. Breeding occurs on the southern islands of New Zealand (Baker et al. 2007). The species as been rarely seen in waters north of Perth and therefore is unlikely to be encountered within the OA.		
	Seasonality		
	The breeding biology and movement patterns are poorly understood for the species (Baker et al. 2007).		
Shy albatross	Habitat and distribution	Unlikely	Unlikely
	The shy albatross is an endemic breeder in Australia, breeding on islands off Tasmania, in the southern Indian Ocean. The dispersal migrations of non-breeding shy albatross are poorly understood; however, they are frequently observed off the south coast of WA (Higgins 2003). The species is rarely seen north of Perth and is unlikely to be encountered within the OA.		
	Seasonality		
	The breeding season for shy albatross is December to March, whereafter non-breeding individuals (juveniles and elderly) will migrate east in summer. Breeding individuals will generally stay within 500 km of the breeding islands (Brothers et al. 1998).		
Wandering albatross	Habitat and distribution	Unlikely	Unlikely
	The wandering albatross breeds on Macquarie Island, over 1500 km south-east of Tasmania (Higgins 2003). The species feeds in the Southern Ocean and has a circumpolar distribution around Australia. The species can be found south of Shark Bay all the way round to Hervey Bay; however, the greatest population densities are around the Great Australian Bight (Higgins 2003). Wandering albatross are typically associated with deep waters, beyond the shelf edge and is unlikely to be encountered within the OA.		
	Seasonality		
	The wandering albatross breeds biennially, with the breeding cycle lasting 11 months beginning in summer (Brothers et al. 1998). The adults will then migrate east, where it is predicted that the species will travel circumpolar to reach the west coast of Australia, heading towards the breeding grounds in November (Brothers et al. 1998). However, the complete migration pattern of the species is not understood.		
Southern royal albatross	Habitat and distribution	Unlikely	Unlikely
	The southern royal albatross is commonly observed in south-east Australia, as well as occasionally in southern WA. Breeding does not occur in Australia, but on the southern islands of New Zealand (Higgins 2003). The southern royal albatross is typically associated with cold and deep waters of the Southern Ocean, well beyond the shelf edge. As such, it is unlikely to be encountered within the OA.		

Common name	Habitat, distribution and seasonality	Presence EMBA	Presence OA
	Seasonality		
	The southern royal albatross breeds biennially, with the breeding cycle lasting 11 months beginning in summer (Higgins 2003). The species then travels east circumpolar, before reaching the breeding grounds again in November (Brothers et al. 1998).		
Amsterdam albatross	Habitat and distribution	Unlikely	Unlikely
	The Amsterdam albatross is a rare non-resident visitor to Australia and may occur in south-west and south Australian waters (Brothers et al. 1998). The species breeds solely on Amsterdam Island in the southern Indian Ocean. This species is unlikely to be encountered within the OA.		
	Seasonality		
	Amsterdam albatross breed from January to May. The species has a wide migration range, travelling further north during winter and spring, with some populations travelling near south-west WA during summer (Higgins 2003).		
Campbell albatross	Habitat and distribution	Unlikely	Unlikely
	The Campbell albatross is a non-breeding visitor to Australian waters. Non-breeding individuals are typically observed in the eastern states of Australia; however, are occasionally observed in south-west WA (Brothers et al. 1998). They are very rare in the Indian Ocean and are typically found in waters deeper than 200 m (Marchant & Higgins 1990). Therefore, they are unlikely to be encountered within the OA.		
	Seasonality		
	Non-breeding immatures and adults disperse through the south Pacific and across southern Australian waters year-round, typically travelling north in winter (southern Australia) and south in summer (Antarctic waters) (DoEE 2019).		
Bar-tailed godwit	Habitat and distribution	Unlikely	Unlikely
	The bar-tailed godwit breeds in the northern hemisphere but migrates to Australia during the non-breeding period. It is found in the coastal areas of all Australian states, mostly in sheltered bays, inlets, and estuaries. Large populations are found along the WA coast, particularly at Eighty Mile Beach (over 1200 km away from the Operational Area) (Higgins 2003). Bar-tailed godwit are unlikely to be encountered in the OA but may occur in the EMBA.		
	Seasonality		
	Bar-tailed godwits leave their breeding grounds in the Northern Hemisphere in July-September, reaching southwest Australia in late August, before returning in late February (Barter 2002).		
Soft-plumaged petrel	Habitat and distribution	May occur	May occur
	The soft-plumaged petrel is generally found over temperate and subantarctic waters of southern Australia, particularly the south-west (Barter 2002). The species breeds on islands of the southern coast of Tasmania, New Zealand, and sub-Antarctic islands. Birds disperse widely after breeding and forage over cold water north of 55°S, mainly over deep water beyond the continental shelf (NZ Birds Online 2023). The foraging BIA for this species overlaps the EMBA.		

Common name	Habitat, distribution and seasonality	Presence EMBA Presence OA
	Seasonality The movement patterns of soft-plumaged petrels are poorly documented. Breeding occurs during summer, whereafter the species migrates north-west (Burbidge & Fuller 1989).	

4.3.12 Timing of biological sensitivities

Several biological sensitivities related to the phenology of marine fauna are expected to occur within the OA and EMBA.

Table 4-12 identifies the timing of key biological sensitivities relevant to the OA and EMBA. The fauna included are species listed under the EPBC Act and considered relevant to this EP. The fish species are those identified as key commercial indicator species for the relevant fisheries identified in Section 4.4.2, or brood stock that may have habitat within the OA.

The timing of the Eureka 3D MSS (February–March) has been selected to minimise overlap with these receptors, together with operational and stakeholder considerations.

Table 4-12: Timing of key biological sensitivities relevant to the OA and EMBA

Sensitivity	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Proposed Eureka 3D MSS timing												
Humpback whale (north migration)[1]												
Humpback whale (south migration)[1]												
Pygmy blue whale (north migration)[2]												
Pygmy blue whale (south migration)[2]												
*Southern right whale migration[2]												
*Sperm whale migration[2]												
Australian sea lion												
White shark foraging BIA[3]												
*Scalloped hammerhead migration[4]												
WA dhufish spawning[5]												
Snapper (Mid-west/Kalbarri) spawning[5]												
Red-throat emperor spawning[4]												
Baldchin groper spawning[5]												
*Hapuku spawning[5]												
*Blue-eye trevalla spawning[5]												
*Eightbar grouper spawning[5]												
*Bass groper spawning[5]												
**WCDS commercial fishing season												
WRL puerulus settlement[6]												
WRL commercial fishing season												
WRO spawning[8]												
WRO commercial fishing season												
Roe's abalone spawning[9]												
Roe's abalone commercial fishing season												
*Australian lesser noddy foraging[7]												
*Flesh-footed shearwater foraging[7]												
*Little penguin foraging[7]												
Wedge-tailed shearwater foraging[7]												
Caspian tern foraging[7]												
Pacific gull foraging[7]												
Bridled tern foraging[7]												
*Sooty tern foraging[7]												
White-faced storm petrel foraging[7]												
*Soft-plumaged petrel foraging[7]												
*Little shearwater foraging[7]												
Roseate tern foraging[7]												
Fairy tern foraging[7]												
Coral spawning (primary period)												

1 (Source: DoEE 2019), 2 (Source: DoE 2015, McCauley & Jenner 2010; McCauley & Duncan 2011; Double et al. 2012; Double et al. 2014). 3 (DoE, 2019), 4 (Source: Lopez et al 2022), 5 (Source: DPIRD 2023), 6 (Source: Bellchambers et all 2012), 7 (Source: DAWE 2021b, Higgins 2003, DoEE 2019, Burbridge & Fuller 1989, Surman & Nicholson 2009), 8 (Source: Leporati et al. 2015, Hart et al. 2018), 9 (Source: Wells and Keesing 1989, DoF 2011)

* Occur in EMBA only

**Period outside of temporal spawning closures. Based on updated commercial fishing regulations introduced in January 2023. Subject to change depending on demersal scalefish resource recovery

WCDS = West coast demersal scale fish, WRL = Western rock lobster, WRO = Western rock octopus

Peak period		Mammals	Fish	Invertebrates	Birds	Corals

4.4 Socio-economic and cultural environment

4.4.1 Protected areas

The OA does not overlap with any Australian Marine Park (AMP), or any WA state protected marine areas; however, the EMBA overlaps the following AMPs: Abrolhos AMP, Perth Canyon AMP, Two Rocks AMP, Jurien AMP and the South-west Corner AMP. Values for these AMPs are summarised in Table 4-12 below. Definitions of the different management zones of the AMPs found within the EMBA are provided in Table 4-14.

Management plans for AMPs have been developed and came into force on 1 July 2018. Under these plans AMPs are allocated conservation objectives (IUCN Protected Area Category) based on the Australian IUCN reserve management principles in Schedule 8 of the EPBC Regulations 2000. These principles determine what activities are acceptable within the different zones of the AMP network. As the Eureka 3D MSS OA does not overlap any AMPs, there are no AMPs that restrict the undertaking of the survey. Therefore, the survey will be undertaken in compliance with the AMP network zone rules. In the event of spill response operations being required within an AMP, emergency spill response activities are allowed in accordance with the Australian National Plan for Maritime Environmental Emergencies (MEE) without the need for a permit, class approval, or activity licence or lease issued by the Director of National Parks (DNP).

The EMBA also overlaps several WA state marine protected areas, including the Jurien, Marmion and Shoalwater Islands Marine Parks; the Abrolhos Islands and Lancelin Island Lagoon Fish Habitat Protection Areas; and the Essex Rocks, Buller, Whittell and Green Islands, Cervantes Islands, Beagle Islands, Lipfert, Milligan, Etc Islands, Sandland Island, Ronsard Rocks, Outer Rocks and Fisherman Islands Nature Reserves. The values and distance from the OA of these WA state protected marine areas are detailed in Table 4-12. The Commonwealth and state Marine Protected Areas (MPAs) are shown in Figure 4-16 and Figure 4-17.

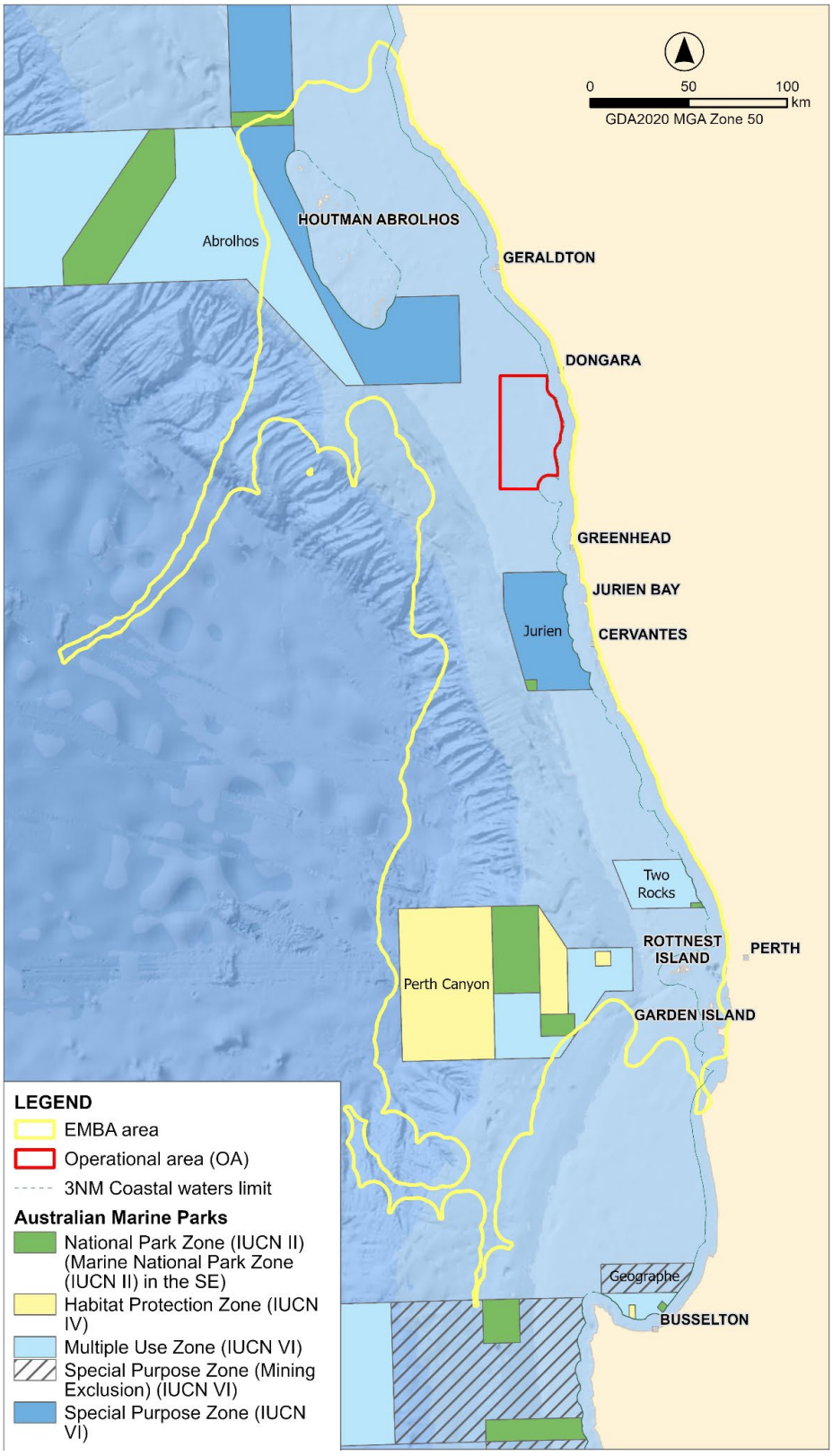


Figure 4-16: Commonwealth protected areas overlapping and adjacent to the OA and EMBA

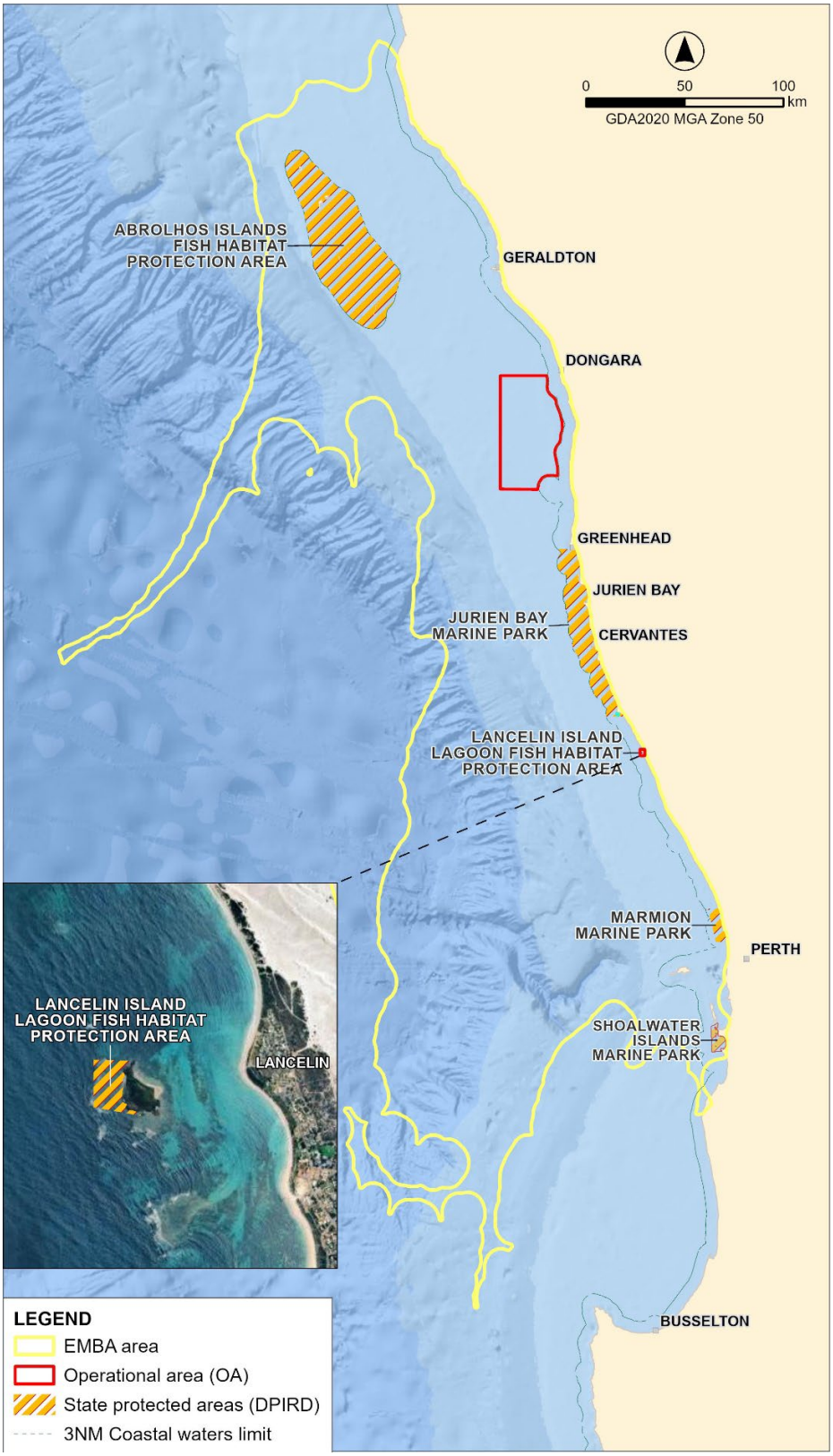


Figure 4-17: State protected areas within the EMBA

Table 4-13: Values of Commonwealth and State marine protected areas overlapping the EMBA

Reserve	Distance from OA	IUCN categories	Key values
Commonwealth Marine Protected Areas			
Abrolhos AMP	20 km W	National Park Zone (IUCN II) Special Purpose Zone (IUCN VI) Multiple Use Zone (IUCN VI)	Conservation values include: Australia's only known breeding population of lesser noddies Important feeding and nesting ground for many other seabird species Diverse benthic and pelagic fish communities (meso-scale eddies, demersal slope, and west coast canyons) Northernmost breeding colony of Australian sea lion Important migration pathway for humpback whales (protected species) Important rock lobster habitat (ecologically and economically important species) Second largest canyon in Australia (Houtman Canyon) Nanda and Naaguja people Sea Country No international heritage listings apply to the Marine Park at the commencement of this plan; however, the Marine Park is adjacent to the WA Shark Bay World Heritage Property, listed as an area of outstanding universal value under the World Heritage Convention in 1991, meeting world heritage listing criteria vii, viii, ix, and x. (DNP 2018)
Perth Canyon AMP	210 km S	National Park Zone (IUCN II) Habitat Protection Zone (IUCN IV) Multiple Use Zone (IUCN VI)	Conservation values include: Unique feeding site for pygmy blue whales (largest gathering in Australia) Important nutrient-rich upwelling Ancient coastline, diverse and abundant benthic and fish communities due to unique environment (deep sea corals and sponges) Swan River Traditional Owner Sea Country Largest deep-sea canyon in Australia (ancient and unique ecosystem) Biologically important area for seabirds, blue whales, pygmy blue whales, humpback whales and sperm whales. (DNP 2018; NESP 2018)

Reserve	Distance from OA	IUCN categories	Key values
Two Rocks AMP	190 km SW	National Park Zone (IUCN II)	Conservation values include:
		Multiple Use Zone (IUCN VI)	Important rock lobster habitat (ecologically and economically important species)
			Swan River Traditional Owner Sea Country
			Valued diving location (recreational value)
			Lagoons which support diverse macroalgae, seagrass and marine animals
			Breeding ground for key recreational/commercial fish species (western rock lobster, dhufish, and pink snapper)
			Ancient coastline between 90 – 120 m depth, valued and unique benthic ecosystem
			Important tourism and recreation zone
			Breeding and foraging zones for seabirds, ASLs and migratory pathways for humpback and blue whales. (DNP 2018)
Jurien AMP	40 km S	National Park Zone (IUCN II)	Conservation values include:
		Special Purpose Zone (IUCN VI)	Humpback and pygmy blue whale migration pathway (protected species)
			Shallow seagrass lagoons supporting large biodiversity or marine species
			Important nesting grounds for seabirds and Australian sea lions
			Unique mix of temperate and tropical species (Leeuwin Current)
			Important foraging area for white sharks
			Noongar people have responsibilities for Sea Country in the Marine Park
			Valued recreational activities, including fishing and diving. (DNP 2018)
South-west Corner AMP	400 km S	National Park Zone (IUCN II)	Conservation values include:
		Special Purpose Zone (Mining Exclusion) (IUCN VI)	Localised upwelling leads to high primary production, proving key foraging area for many species:
			Western rock lobster (ecologically and economically important species)
			Seabirds (contains foraging BIAs)
			White sharks
			Whale foraging and migration (blue/pygmy blue, humpback, sperm, and southern right)
			The Nyungar/Noongar people have responsibilities for Sea Country in the park
			Unique benthic ecosystem due to highly varied sea floor, including canyons, ancient coastline, and deep-sea plateaus (deep sea corals and sponges). (DNP 2018)
State Marine Protected Areas			

Reserve	Distance from OA	IUCN categories	Key values
Jurien Bay Marine Park	40 km S	WA State Marine Park	Marine Park values include: Recreational spot for swimming, diving, snorkelling, and kayaking Recreational fishing (dhufish, snapper, baldchin groper, and whiting) Unique mix of temperate and tropical marine species Important breeding areas for seabirds including fairy terns and osprey Only breeding area for Australian sea lions on the west coast of Australia. (DBCA n.d)
Marmion Marine Park	220 km SW	WA State Marine Park	Marine Park values include: Recreational spot for swimming, diving, snorkelling, and kayaking Proximity to Perth City, providing local area to explore nature Recreational fishing spots within Marine Park Humpback whale migration and whale watching tours. (DBCA n.d)
Shoalwater Islands Marine Park	290 km S	WA State Marine Park	Marine Park values include: Recreational spot for swimming, diving, snorkelling, and kayaking Proximity to Perth City, providing local area to explore nature Recreational fishing spots within Marine Park. (DBCA n.d)
Abrolhos FHPA	60 km NW	Fish Habitat Protection Area	Purpose and values include: Maintain sustainable fisheries and aquaculture Maintain tourism and recreation activities Nature conservation and protection Cultural heritage protection Increased fishing regulation within FHPA to properly manage stocks. (FWA 2001)
Lancelin Island Lagoon FHPA	230 km S		
Essex Rocks	55 km S	Nature Reserves part of Turquoise Coast and greater Jurien Marine Park	Purpose and values include: Turquoise Coast Island nature reserves are a chain of approximately 40 islands, islets, and rocks lying between Lancelin and Dongara Grouped into 13 nature reserves Three Australian sea lion breeding islands (Buller, North Fisherman, and East Beagle) Key dibbler populations on three islands (*Parantechinus apicalis*)
Buller, Whittell and Green Islands	90 km S		
Cervantes Islands	75 km S		
Sandland Island	40 km S		
Outer Rocks	65 km S		

Reserve	Distance from OA	IUCN categories	Key values
Fisherman Islands	35 km S	Nature Reserves part of Turquoise Coast	Key seabird breeding islands Unique CWC marine bioregion: mix of tropical and temperate species Valued recreational activities, including diving, snorkelling, and fishing Protected areas for key marine species breeding (including mammals, birds, and fish) Some commercial fishing, and important nursery habitat for commercial species. (DBCA n.d)
Ronsard Rocks	70 km S		
Beagle Islands	10 km S		
Lipfert, Milligan, Etc Islands	25 km S		

Table 4-14: Management zones and the associated objectives for the AMPs overlapping the EMBA

Management zones	Objective
Multiple Use (IUCN VI)	Managed to allow ecologically sustainable use while conserving ecosystems, habitats, and native species. The zone allows for a range of sustainable uses, including commercial fishing and mining where they are consistent with park values.
Special Purpose Zone (IUCN VI)	Managed to allow specific activities though special purpose management arrangements while conserving ecosystems, habitats, and native species. The zone allows or prohibits specific activities.
Habitat Protection Zone (IUCN IV)	Managed to allow activities that do not harm or cause destruction to sea floor habitats, while conserving ecosystems, habitats, and native species in as natural a state as possible.
National Park Zone (IUCN II)	Managed to protect and conserve ecosystems, habitats, and native species in as natural a state as possible. The zone only allows non-extractive activities unless authorised for research and monitoring.

4.4.2 Commercial fisheries

Commercial fishing in WA is comprised of both Commonwealth and WA state managed fisheries that are primarily based on low-volume, high-value products (DPIRD 2020a). The Australian Fisheries Management Authority (AFMA) manages Australian fisheries on behalf of the Commonwealth Government from 3 nm offshore to the edge of the Australian Fishing Zone (AFZ). AFMA carry out the objectives listed in the *Fisheries Administration Act 1991* and the *Fisheries Management Act 1991*. The WA Department of Primary Industries and Regional Development (DPIRD) manages state fisheries that take place predominantly within 3 nm of the coastline, although this default arrangement may be varied through the Offshore Constitutional Settlement (OCS).

Commonwealth and WA state managed fisheries with licence to operate within the OA and/or EMBA are described in the following sections.

4.4.2.1 Review of catch and effort data

Catch and effort data for Commonwealth fisheries with management boundaries that overlap the OA and/or EMBA were sourced from the latest Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) Fishery Status Report 2023 (Patterson et al. 2023a).

Catch and effort data for WA state managed fisheries with licence to operate within the OA and/or EMBA were obtained from the DPIRD FishCube database, together with the latest DPIRD State of the Fisheries Report 2021/22 (Newman et al. 2023). FishCube data were obtained for the past ten years (2012–2021) in 10 × 10 nm or 60 × 60 nm Catch and Effort System (CAES) blocks, depending on the fishery, at annual and monthly temporal scales. Data provided by DPIRD included:

- Weight (kg) – a measure of catch per CAES block during the period of interest
- Vessel Count – a measure of the number of vessels that fished in a CAES block during the period of interest
- Licence Count – a measure of the number of licences that were recorded in a CAES block during the period of interest
- Fishing Day Count – a measure of fishing effort, represented by the number of days when one or more vessels fished in a CAES block during the period of interest.

Due to confidentiality reasons, DPIRD is unable to release catch and effort data for CAES blocks where fewer than three vessels fished during the period of interest. Where this applies, the Vessel Count is marked 'less than three', while Weight and Fishing Day Count are marked 'N/A'. Where data are provided in this way, fishing effort was confirmed within the CAES block during that period, but the associated catch and effort data are not available. CAES blocks where no fishing is recorded do not return any data.

It is important to recognise the limitations of referring to CAES blocks with fewer than three vessels. Blocks may experience high catch or effort by fewer than three vessels, i.e., one or two. Alternatively, these blocks may experience less catch or effort than other blocks in which three or more vessels have fished.

Pilot has undertaken a review of up to ten years of catch and effort data which is considered appropriate for this EP to represent the potential for future fishing effort and past fishing effort considering the limited duration of the proposed MSS (40 days, see Section 3) and that the potential impacts to fish and fish stocks from the proposed activity are expected to be temporary (see Sections 7). The review cycle of Commonwealth fisheries' harvest strategies is every 5 years which is aimed at managing performance of the stock or fishery through time as well as the time scale of inter-annual variability of environmental parameters that affect fisheries resources (DAWR 2018), both indicating the suitability of this time scale to fishing decision of individual fishers.

4.4.2.2 Commonwealth managed fisheries

Commonwealth managed commercial fisheries with management boundaries that overlap the OA are:

- Southern bluefin tuna fishery (SBTF)
- Western deepwater trawl fishery (WDTF)
- Western Tuna and Billfish Fishery (WTBF).

The Commonwealth managed commercial fisheries with management boundaries that overlap the OA and/or EMBA are described in Table 4-15.

Table 4-15: Commonwealth managed fisheries with management boundaries overlapping the OA and/or EMBA

Fishery	Licence to fish		Description	Historical catch / effort		Relevance to EP
	OA	EMBA		OA	EMBA	
Southern Bluefin Tuna Fishery (SBTF)	✓	✓	The SBTF covers the entire Australian Fishing Zone (AFZ), out to 200 nm from the coast. The fishery operates year-round, targeting southern bluefin tuna (SBT; Thunnus maccoyii). The Australian Fisheries Management Authority (AFMA) uses total allowable catch (TAC) and individually transferable quotas (ITQ) in line with Australia's internationally allocated quota to manage the SBTF (AFMA 2022). Catch and effort is concentrated in the east of the Great Australian Bight, targeting juveniles (2–5 years of age) using purse seine methods, as well as along the eastern coast of Australia using pelagic longline methods (DCCEEW 2022c; Patterson & Dylewski 2023). No catch or effort occurs in WA (Patterson and Dylewski 2023a). Since 1994–1995, five to eight vessels have used purse seine methods each year, while 11 to 24 vessels have used longline methods over the past ten years (Patterson & Dylewski 2023). In 2022, the total reported commercial catch in the SBTF was 5,972 t (Patterson & Dylewski 2023). Whilst no catch or effort occurs in WA, adult SBT may migrate through the OA and/or EMBA between September and April, from their southern feeding areas to their spawning ground between northern WA and Java, Indonesia (Bray & Gomon 2023). Juveniles may also migrate southward through the OA and/or EMBA during their first year (Bray & Gomon 2023; Patterson & Dylewski 2023).	X	X	No catch or effort occurs in WA. Seismic activities may impact adult and juvenile SBT as they migrate through the OA and/or EMBA (see Table 4-2).
Western Deepwater Trawl Fishery (WDTF)	✓	✓	The WDTF covers the western portion of the AFZ from Exmouth to Augusta. The fishery operates year-round, targeting mixed fish species in water >200 m deep, using demersal trawl methods (AFMA 2023a; Keller et al. 2023). Operators catch more than 50 species in habitats ranging from temperate and subtropical in the south, to tropical in the north (Keller et al. 2023). Recent catches have been dominated by ruby snapper (Etelis sp.) and a variety of other finfish species (Keller et al. 2023). AFMA manages the WDTF through input controls to limit entry (11 permits) and restrict gear, as well as catch controls with trigger limits for key commercial species. Catch and catch-per-unit-effort (CPUE) triggers for ten species are used based on historical catch between 2000 and 2010 (Keller et al. 2023). Since 2004–2005, one to three vessels have been active in the WDTF. Two vessels were active in 2021–2022, with a total reported commercial catch of 12 t from two active vessels (Keller et al. 2023).	X	✓	Very low catch or effort occurs in WA, with two vessels operating in 2021 – 2022. Given the principal depth range of target species and trawl operations (>200 m deep), the proposed activity will not interact with fishing activities of the WDTF.

Fishery	Licence to fish		Description	Historical catch / effort		Relevance to EP
	OA	EMBA		OA	EMBA	
Western Tuna and Billfish Fishery (WTBF)	✓	✓	The WTBF operates in the western portion of the AFZ from the SA–VIC border to Cape York Peninsula, as well as the high seas of the Indian Ocean (Patterson et al. 2023b). The fishery targets several highly migratory finfish species including bigeye tuna (Thunnus obesus), yellowfin tuna (Thunnus albacares), albacore tuna (Thunnus alalunga), striped marlin (Kajikia audax) and swordfish (Xiphias gladius) (Patterson et al. 2023b). The fishery operates year-round, primarily using pelagic longline methods, as well as occasional minor line methods (DCCEEW 2022d). AFMA uses total allowable commercial catch (TACC) limits (in association with international management bodies such as the Indian Ocean Tuna Commission) to manage the WTBF (Patterson et al. 2023b). In recent years, effort has been concentrated off south-west WA and SA, and only five or fewer vessels have operated each year since 2005 (Patterson et al. 2023b). In 2022, the reported total commercial catch of the WTBF was 145 t from five active vessels (Patterson et al. 2023b). The fishery predominantly uses pelagic long-line fishing gear that are many kilometres long. Each line usually takes several hours to deploy and retrieve and has the potential to be entangled with the seismic survey streamers.	✓	✓	Low catch or effort occurs in WA. Seismic activity may affect fishing activities in the WTBF as the area fished may overlap both the OA and/or EMBA.
Small Pelagic Fishery (SPF)	X	✓	The SPF covers the southern portion of the AFZ from the QLD–NSW border to south-west WA. The SPF has three subareas (east, west, and sardine) and operates year-round (AFMA 2023b; Noriega et al. 2023). In the east and west subareas, the SPF targets blue mackerel (Scomber australasicus), jack mackerel (Trachurus declivis) and redbait (Emmelichthys nitidus), primarily using midwater trawling (Noriega et al. 2023). In the sardine subarea, the SPF targets Australian sardine (Sardinops sagax) using purse seine methods (Noriega et al. 2023). AFMA manages the SPF through input controls to limit entry and restrict gear, together with TAC and ITQs for each target stock (Noriega et al. 2023). No catch or effort was recorded in WA in the 2021–2022 or 2022–2023 seasons. In 2022–2023, the SPF reported a total commercial catch of 21,080 t from six active vessels (Noriega et al. 2023).	X	X	The OA is outside of the SPF western boundary. The SPF overlaps with the EMBA; however, no catch or effort has occurred in WA in recent years.

4.4.2.3 WA state managed fisheries

There are 14 WA state managed fisheries with management boundaries that overlap the OA and/or EMBA. Review of catch and effort data shows that the following fisheries were active in the OA within the past ten years:

- Marine aquarium fish managed fishery (MAFMF)
- Octopus interim managed fishery (OIMF)
- Open access fishery (OAF)
- Specimen shell managed fishery (SSMF)
- Tour Operator Fishery West Coast (TOFWC; see Section 4.4.4.1)
- West Coast Demersal Gillnet and Demersal Longline Managed Fishery (WCDGDLMF)
- West Coast demersal scalefish managed fishery (WCDSMF)
- West Coast rock lobster managed fishery (WCRLF).

The WA state managed commercial fisheries with licence to operate within the OA and/or EMBA are described in Table 4-16. The activity of these fisheries is described in the following sections.

Table 4-16: WA state managed fisheries with management boundaries overlapping the OA and/or EMBA

Fishery	Licence to fish		Description	Historical catch / effort		Relevance to EP
	OA	EMBA		OA	EMBA	
Abalone Managed Fishery (AMF)	✓	✓	The OA does not overlap with the area of AMF fishing effort for the ten-year period between 2012 and 2021. The AMF operates year-round in shallow coastal waters along the western and southern coasts of WA, targeting Roe's abalone (*Haliotis roei*), greenlip abalone (*Haliotis laevigata*) and brownlip abalone (*Haliotis conicopora*) using wade and dive collection methods (Newman et al. 2023). Off the west coast of WA, the AMF primarily targets Roe's abalone (Newman et al. 2023). In 2021, the total reported commercial catch of Roe's and greenlip/brownlip abalone was 29.7 t and 39 t, respectively (Newman et al. 2023).	X	✓	Fishing activity does not occur in the OA. Target species occur in the OA.
Abrolhos Islands and Mid-West Trawl Managed Fishery (AIMWTMF)	X	✓	The OA does not overlap with the area of AIMWTMF fishing effort for the ten-year period between 2012 and 2021. The AIMWTMF typically operates from March to August (subject to management controls) in the Abrolhos Islands region and primarily targets saucer scallops (*Ylistrum balloti*) using demersal trawl methods (Kangas et al. 2021; Newman et al. 2023). In 2021, the reported total commercial catch of saucer scallops in the AIMWTMF was 615 t whole weight or 123 t meat weight (Newman et al. 2023).	X	✓	Fishing activity and/or target species do not occur in the OA.
Mackerel Managed Fishery (MMF)	✓	✓	The OA does not overlap with the area of MMF fishing effort for the ten-year period between 2012 and 2021. The MMF operates year-round in WA waters between the Capes region and the NT border, primarily targeting Spanish mackerel (*Scomberomorus commerson*) and grey mackerel (*Scomberomorus semifasciatus*) in the North Coast and Gascoyne Coast Bioregions, using near surface trolling methods (Newman et al. 2023). In 2021, the total recorded commercial catch of Spanish and grey mackerel was 238 t and 10 t, respectively (Newman et al. 2023).	X	✓	Fishing activity does not occur in the OA. Target species occur in the OA.
Marine Aquarium Fish Managed Fishery (MAFMF)	✓	✓	The OA overlaps with 149 km^2 (or 0.32%) of the area of MAFMF fishing effort for the ten-year period between 2012 and 2021. The MAFMF operates year-round in all WA state waters, targeting up to 1500 species for marine aquarium display purposes, using hand collection methods (Smith et al. 2022 Newman et al. 2023). In 2021, the reported total commercial catch of the MAFMF was approximately 13,000 fish, 16,000 kg corals, 2,286 sponges, and 75,000 invertebrates (Smith et al. 2022 Newman et al. 2023).	✓	✓	Fishing activity and/or target species occur in the OA.
Octopus Interim Managed Fishery (OIMF)	✓	✓	The OA overlaps with 1482 km^2 (or 3.24%) of the area of OIMF fishing effort for the ten-year period between 2012 and 2021. The OIMF operates year-round targeting western rock octopus (*Octopus djinda*, formerly *O. aff. tetricus*) throughout most the WA state waters between Kalbarri and the SA border, primarily using 'trigger trap' methods (Newman et al. 2023). In 2021, the total reported commercial catch of western rock octopus was 487 t (Newman et al. 2023).	✓	✓	Fishing activity and/or target species occur in the OA.

Fishery	Licence to fish		Description	Historical catch / effort		Relevance to EP
	OA	EMBA		OA	EMBA	
Open Access Fishery (OAF)	✓	✓	The OA overlaps with 1575 km^2 (or 0.76%) of the area of OAF fishing effort for the ten-year period between 2012 and 2021. The OAF operates year-round targeting a range of fish resources. In the West Coast Bioregion, the fishery primarily targets the West Coast Nearshore and Estuarine Finfish Resource (WCNEFR) in coastal and nearshore waters from Kalbarri to the Capes region, using haul, beach seine and gillnetting (DPIRD 2020c; Newman et al. 2023). Catch data for the OAF is not provided by DPIRD.	✓	✓	Fishing activity and/or target species occur in the OA.
South-West Coast Salmon Managed Fishery (SWCSMF)	✓	✓	The OA does not overlap with the area of SWCSMF fishing effort for the ten-year period between 2012 and 2021. The SWCSMF targets WA salmon (*Arripis truttaceus*), typically in nearshore waters south of the Perth metropolitan area using haul, beach seine and gill netting (Newman et al. 2023). In 2021, total reported commercial catch in the SWCSMF was 89 t (Newman et al. 2023).	X	✓	Fishing activity does not occur in the OA. Target species occur in the OA.
Southern Demersal Gillnet and Demersal Longline Managed Fishery (SDGDLMF)	X	X	The OA does not overlap with the area of SDGDLMF fishing effort for the ten-year period between 2012 and 2021. The SDGDLMF operates year-round, primarily in continental shelf waters between the Capes region (below 33°S) and the SA border, using demersal gillnets and occasional demersal longlines to target sharks, with scalefish as a legitimate by-product (Newman et al. 2023). Catch data for the SDGDLMF is combined with data from the West Coast Demersal Gillnet and Demersal Longline Fishery (WCDGDLF) under the total Temperate Demersal Gillnet and Demersal Longline Fisheries (TDGDLF). In 2020-21, the TDGDLF recorded a total commercial catch of sharks and rays of 835 t and scalefish of 119 t (Newman et al. 2023).	X	✓	Fishing activity does not occur in the OA. Target species occur in the OA.
Specimen Shell Managed Fishery (SSMF)	✓	✓	The OA overlaps with 171 km^2 (or 0.19 %) of the area of SSMF fishing effort for the ten-year period between 2012 and 2021. The SSMF operates year-round along the entire WA coastline and is based upon the collection of shells for the purposes of display, collection, cataloguing, classification, and sale (Newman et al. 2023). Fishers use a variety of collection methods including diving, wading along coastal beaches, and using remotely operated underwater vehicles (Newman et al. 2023). In 2021, the total reported number of specimen shells collected was 5,443 distributed over 200 species (Newman et al. 2023).	✓	✓	Fishing activity and/or target species occur in the OA.
West Coast Deep Sea Crustacean Managed Fishery (WCDSCMF)	✓	✓	The OA does not overlap with the area of WCDSCMF fishing effort for the ten-year period between 2012 and 2021.X The WCDSCMF operates year-round between the Capes region and the NT border, in water depths of 500-800 m (DPIRD 2020d). The fishery targets crystal crabs (*Chaceon albus*), as well as champagne crabs (*Hypothalassia acerba*) and giant crabs (*Pseudocarcinus gigas*), using baited pot/trap methods operated in a long-line formation in shelf edge waters (>150 m). In 2021, the total reported commercial catch in the WCDSCMF was 155 t (Newman et al. 2023).	X	✓	Fishing activity and/or target species do not occur in the OA.

Fishery	Licence to fish		Description	Historical catch / effort		Relevance to EP
	OA	EMBA		OA	EMBA	
West Coast Demersal Gillnet and Demersal Longline Managed Fishery (WCDGDLMF)	✓	✓	The OA overlaps with 1575 km^2 (or 4.21%) of the area of WCDGDLMF fishing effort for the ten-year period between 2012 and 2021. The WCDGDLMF operates year-round, primarily in continental shelf waters between Shark Bay and the Capes region (above 33'S), using demersal gillnets and occasional demersal longlines to target sharks, with scalefish as a legitimate by-product (Newman et al. 2023). Catch data for the WCDGDLMF is combined with data from the SDGDLMF under the total TDGDLF. In 2020–2021, the TDGDLF recorded a total commercial catch of sharks and rays of 835 t and scalefish of 119 t (Newman et al. 2023).	✓	✓	Fishing activity and/or target species occur in the OA.
West Coast Demersal Scalefish Interim Managed Fishery (WCDSIMF)	✓	✓	The OA overlaps with 1575 km^2 (or 2.02%) of the area of WCDSIMF fishing effort for the ten-year period between 2012 and 2021. The WCDSIMF operates year-round between north of Kalbarri and southeast of Augusta, targeting a range of demersal species in inshore (20–250 m deep) and offshore (>250 m deep) habitats using boat-based line methods (Newman et al. 2023). In 2021, the total recorded commercial catch in the WCDSIMF was 221 t, with 92 t recorded in the Mid-West management zone (Newman et al. 2023).	✓	✓	Fishing activity and/or target species occur in the OA.
West Coast Purse Seine Managed Fishery (WCPSMF)	✓	✓	The OA does not overlap with the area of WCPSMF fishing effort for the ten-year period between 2012 and 2021. The WCPSMF operates between Geraldton and Cape Leeuwin, including development zones in the north and south, targeting small pelagic scalefish using purse seine methods (Newman et al. 2023). In 2020-2021, the total recorded commercial catch of the WCPSMF for all small pelagic scalefish species and zones combined was 504 t (Newman et al. 2023).	X	✓	Fishing activity and/or target species do not occur in the OA.
West Coast Rock Lobster Managed Fishery (WCRLMF)	✓	✓	The OA overlaps with 1,575 km^2 (or 1.94%) of the area of WCRLMF fishing effort for the ten-year period between 2012 and 2021. The fishery operates year-round from 15 January, targeting the western rock lobster (WRL; *Panulirus cygnus*) throughout their geographic range along the lower west coast of WA, using baited traps/pots (Newman et al. 2023). In the 12-month season between 15 January 2021 and 14 January 2022, the total recorded commercial catch in the WCRLMF was 6,334 t (Newman et al. 2023).	✓	✓	Fishing activity and target species occur in the OA.

4.4.2.3.1 Abalone Managed Fishery

The AMF covers WA coastal waters between the NT and SA borders. The commercial fishery operates year-round in shallow coastal waters along the western and southern coasts of WA, targeting Roe's abalone (*Haliotis roei*), greenlip abalone (*Haliotis laevigata*) and brownlip abalone (*Haliotis conicopora*) (Newman et al. 2023). Roe's abalone are primarily caught on the western and southwestern coasts, whilst greenlip/ brownlip abalone are primarily caught on the south-west and southern coasts of WA (Hart et al. 2017; Newman et al. 2023). The AMF is a dive and hand collection fishery. Fishers are typically limited by sea and weather conditions, which are generally more favourable in the summer months, as well as the market demand and unit prices of abalone (Newman et al. 2023). The AMF is divided into eight management areas, each with annual total allowable commercial catch (TACC) limits (Newman et al. 2023).

Analysis of CAES data shows that fishing effort (i.e., annual vessel counts) over the ten-year period between 2012 and 2021 occurred in coastal waters off the south-west and south coasts of WA (Figure 4-18). Low (3–20 vessels) and moderate (21–40 and 61–80 vessels) effort was recorded off the Perth coast. Spatial fishing intensity is known to correlate with areas of suitable habitat for target species, typically in shallow (<30 m) waters with easy access to beaches and for divers using hand collection methods (Newman et al. 2023). Fishing activity is also restricted by the 2011 closure of management Area 8 (north of the Moore River) in response to the 2010–2011 marine heatwave (DPIRD 2022a).

The OA does not overlap with the area of AMF fishing effort over the ten-year period (Figure 4-18). Monthly CAES data shows patterns in fishing effort (the sum of fishing vessels above confidential limits) followed a consistent seasonal trend. Average monthly effort was greatest in the summer from November to April, peaking in November, with a corresponding reduction in winter from May to October.

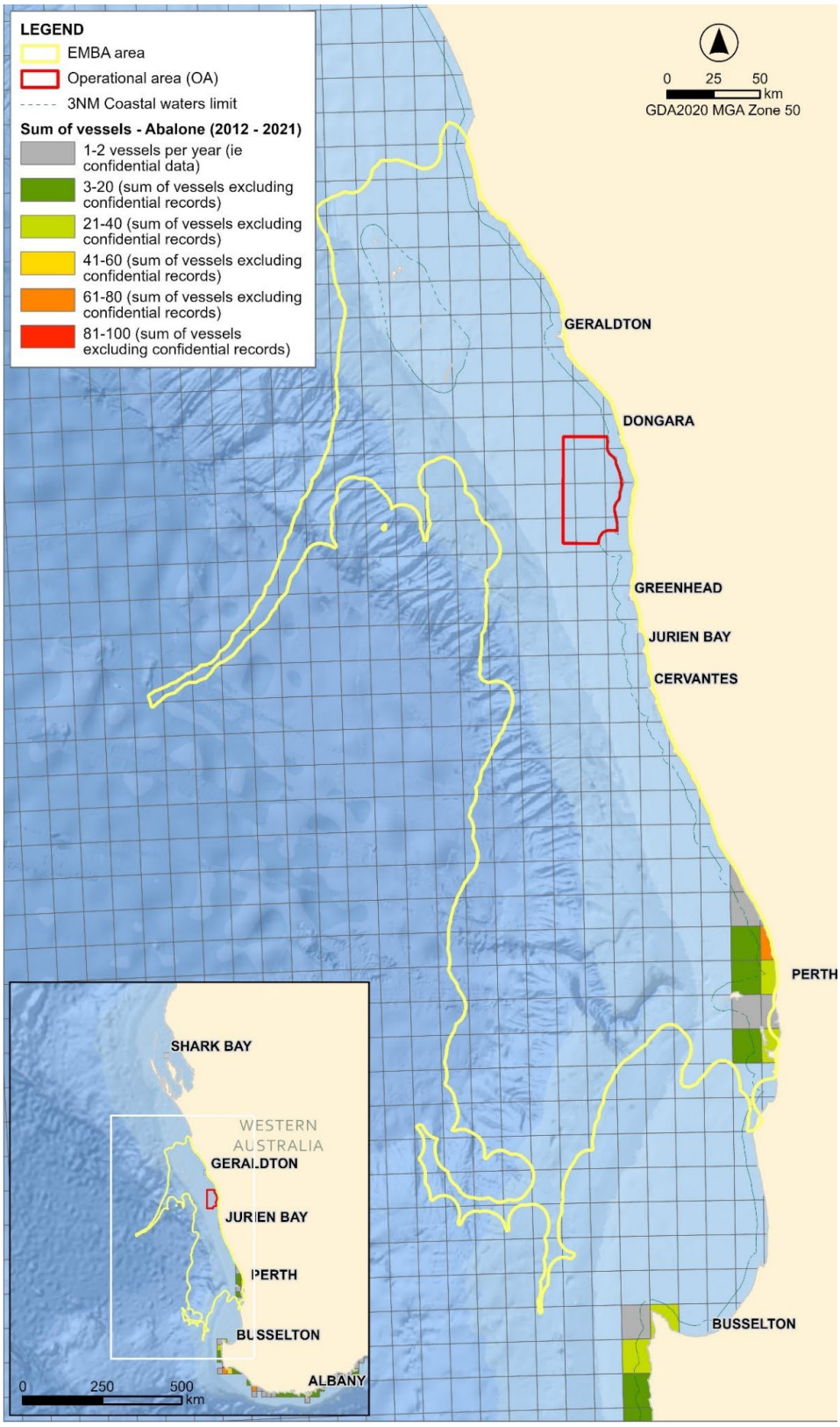


Figure 4-18: Spatial distribution and sum of annual vessel counts (excluding confidential records) in 10 × 10 nm CAES blocks recorded in the AMF for 2012–2021 combined

4.4.2.3.2 Abrolhos Islands and Mid-West Trawl Managed Fishery

The AIMWTMF operates around the Abrolhos Islands region off the west coast of WA. The fishery typically operates from March to August (subject to management controls) and primarily targets saucer scallops (*Ylistrum balloti*) using demersal trawl methods (DPIRD 2020e; Kangas et al. 2021). The AIMWTMF is managed through a 'constant escapement policy' using gear restrictions and spatial and temporal closures to manage annual catch (Kangas et al. 2021).

CAES data for the AIMWTMF was only available between 2017 and 2021. Fishing effort (i.e., annual vessel counts) over the five-year period between 2017 and 2021 occurred around the Abrolhos Islands and off the coast of Kalbarri (Figure 4-19). Low (3–5 vessels), moderate (6–10 and 11–15 vessels), and high (16–20 vessels) effort was distributed around the Abrolhos Islands. Spatial fishing intensity is known to correlate with areas of suitable habitat for target species. Fishing activity is also restricted by area closures off the WA coast, as well as various localised closures around the Abrolhos Islands.

The OA does not overlap with the area of AIMWTMF fishing effort over the five-year period (Figure 4-19). Monthly CAES data showed fishing effort (the sum of fishing vessels above confidential limits) occurred between April and August, peaking between May and July, with no activity during the temporal closure from September to March.

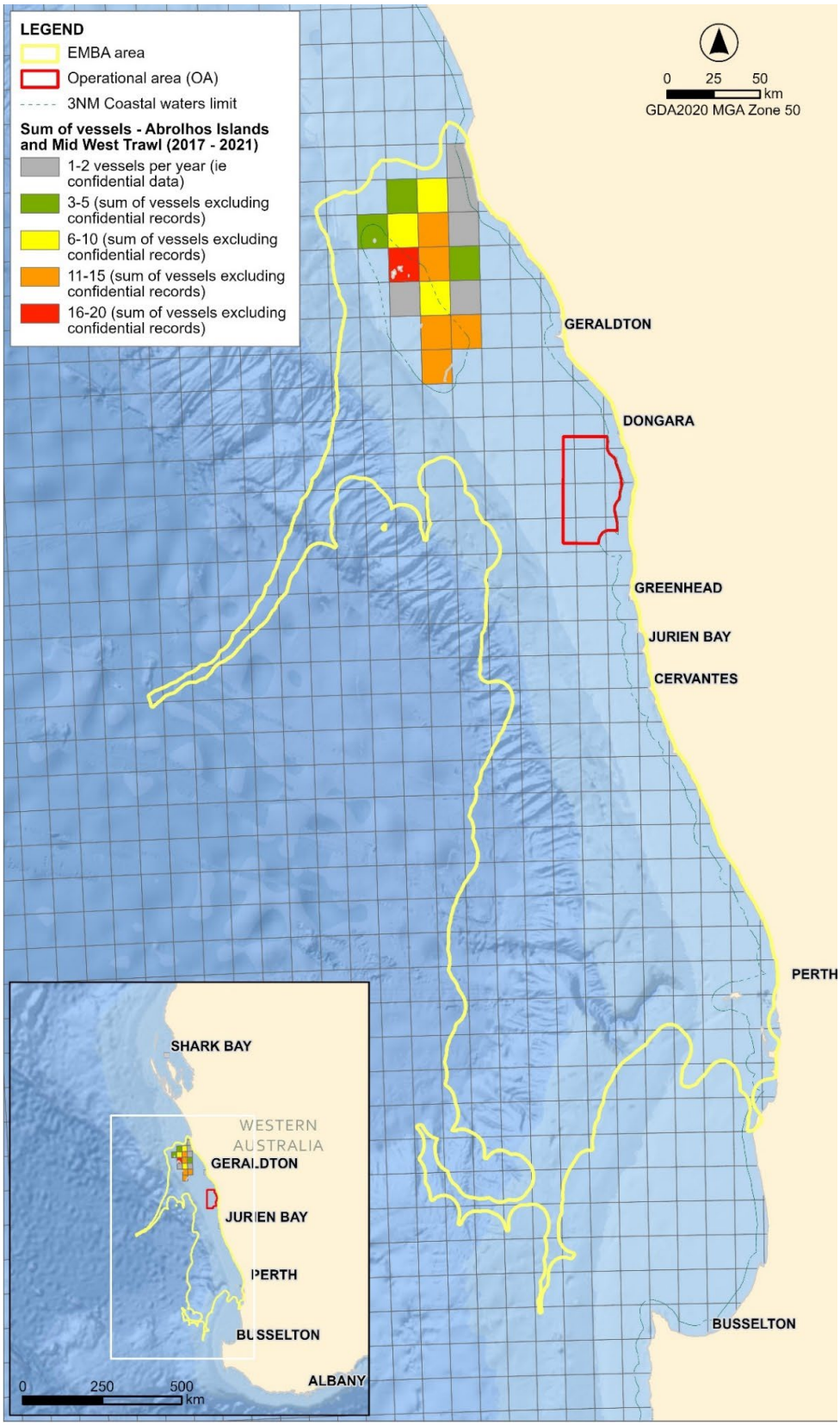


Figure 4-19: Spatial distribution and sum of annual vessel counts (excluding confidential records) in 10 × 10 nm CAES blocks recorded in the AIMWTMF for 2017–2021 combined

4.4.2.3.3 Mackerel Managed Fishery

The MMF covers WA waters between the Capes region and the NT border, and out to the extent of the AFZ. The fishery primarily targets Spanish mackerel (*Scomberomorus commerson*) and grey mackerel (*Scomberomorus semifasciatus*), using near surface trolling methods (DPIRD 2022b; Newman et al. 2023). The MMF operates year-round and is divided into three separately managed areas: Kimberley (Area 1), Pilbara (Area 2) and Gascoyne/West Coast (Area 3), with most of the catch effort concentrated in the Kimberley and Pilbara (Newman et al. 2023). Fishing activity is managed using a transferable quota system, which sets an annual TACC in each area, together with restrictions on fishing gear (DPIRD 2022b).

Analysis of CAES data shows that fishing effort (i.e., annual vessel counts) over the ten-year period between 2012 and 2021 occurred in coastal and inshore waters from Exmouth to the Abrolhos Islands (Figure 4-20). Low and moderate effort was recorded around the Abrolhos Islands and south of Shark Bay (3–6 vessels and 7–12 vessels), with the highest effort concentrated north of Shark Bay and in the north of WA (25–30 vessels). Spatial fishing intensity is known to correlate with areas of suitable habitat for mackerel species, together with proximity to ports along the coastline and at the Abrolhos Islands.

The OA does not overlap with the area of MMF fishing effort over the ten-year period (Figure 4-20). Monthly patterns in fishing effort (the sum of fishing vessels above confidential limits) followed a consistent seasonal trend. Average monthly effort over the ten-year period was greatest between May and October, with reduced effort between November and April.

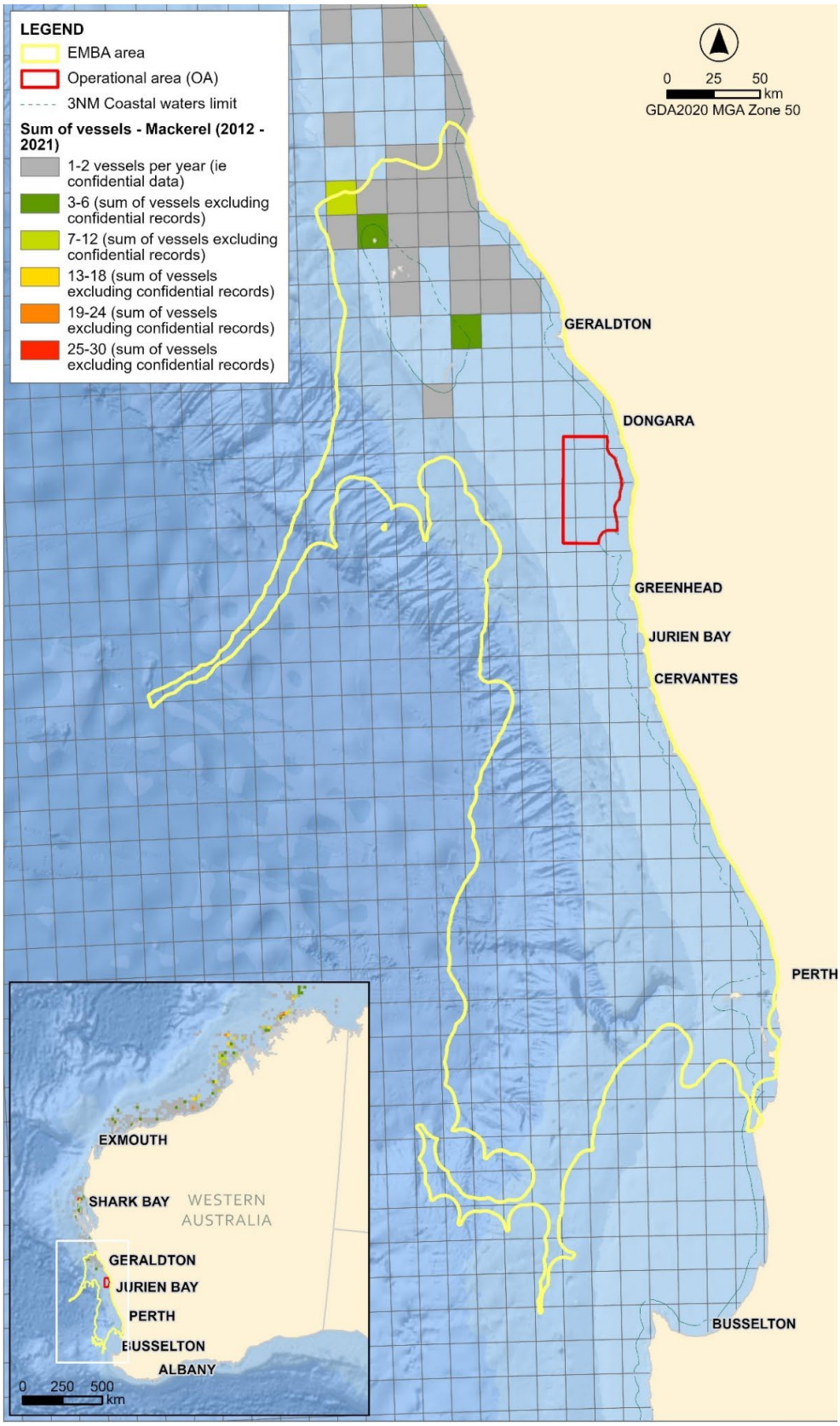


Figure 4-20: Spatial distribution and sum of annual vessel counts (excluding confidential records) in 10 × 10 nm CAES blocks recorded in the MMF for 2012–2021 combined

4.4.2.3.4 Marine Aquarium Fish Managed Fishery

The MAFMF is a low volume, high value fishery that covers all WA state waters between the NT and SA borders, and out to the extent of the AFZ. The fishery targets up to 1500 species for marine aquarium display purposes, including fish (teleost and elasmobranchs), hard and soft corals, live rock, algae, seagrass, and invertebrates (Smith et al. 2022: Newman et al. 2023). The MAFMF operates year-round, with fishers using hand collection methods that are typically limited by sea and weather conditions, which are generally more favourable in the summer months, as well as the market demand and unit prices of target species (Newman et al. 2023). The MAFMF is managed through a constant catch harvest strategy, using input and output controls including an Individually Transferable Quota (ITQ) system for certain target species (DPIRD 2018).

Analysis of CAES data shows that fishing effort (i.e., annual licence counts) over the ten-year period between 2012 and 2021 occurred in coastal waters off the north, west and south coasts of WA (Figure 4-21). On the west coast, moderate effort was recorded off the Perth coast and around the Abrolhos Islands (16–30 and 31–45 licences), followed by low level effort off Kalbarri (3–15 licences), and confidential effort running between Kalbarri and the Perth.

Catch effort is known to correlate with areas of suitable habitat for target species, typically in shallow (<30 m) waters with easy access to beaches and for divers using hand collection methods (Newman et al. 2023). Fishing activity is also restricted by practical limitations including depth, time, and tide, together with various spatial closures (Newman et al. 2023).

The OA overlaps with 149 km^2 (or 0.32%) of the total area of MAFMF fishing effort over the ten-year period (Figure 4-21). Data within this overlap are confidential due to the low level of effort. Monthly patterns in fishing effort (sum of fishing licences above confidential limits) varied over the ten-year period, as indicated by the error bars in Figure 4-22, although there was a clear peak during August. However, as 95% of monthly CAES records were confidential, the data may not accurately represent temporal fishing effort.

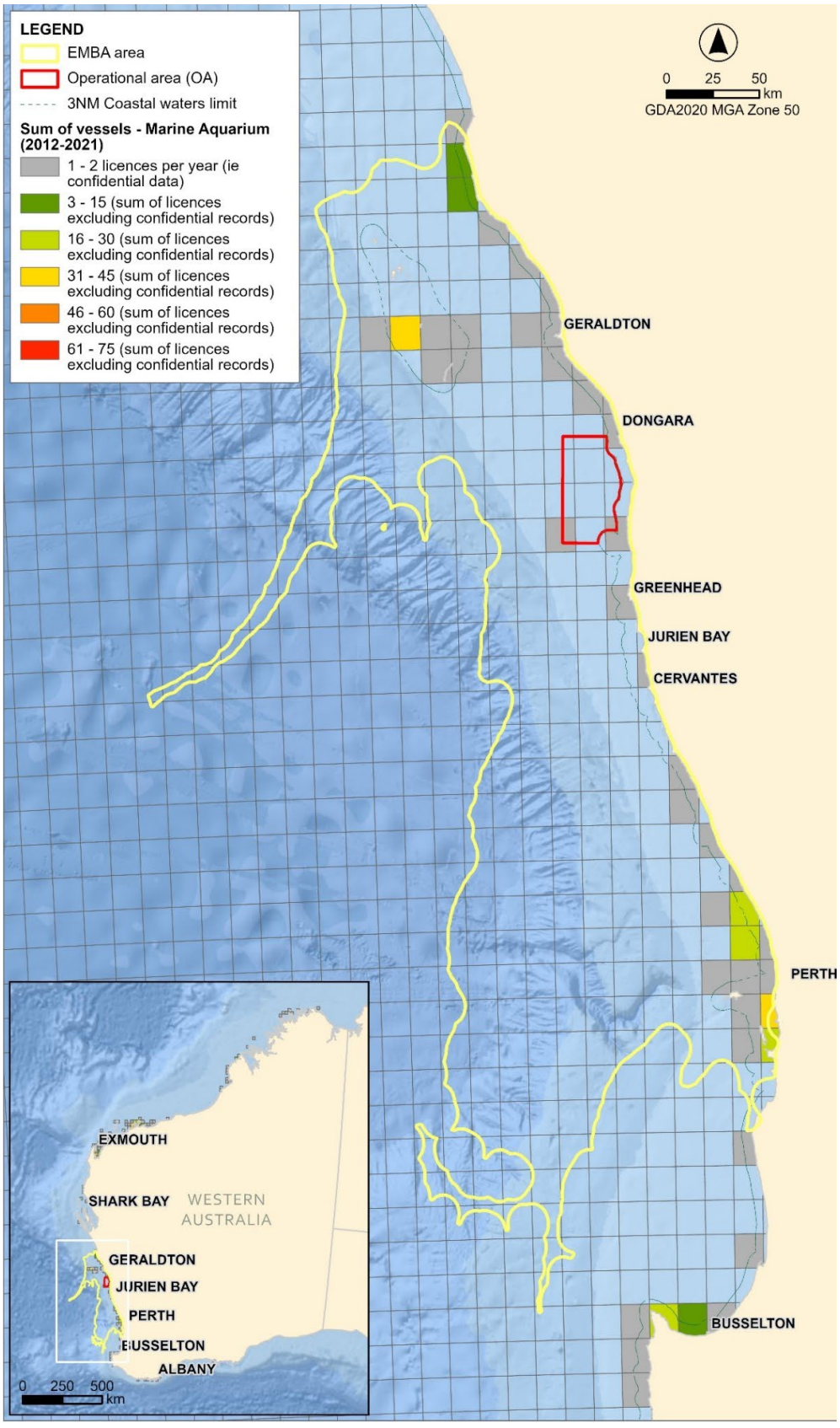


Figure 4-21: Spatial distribution and sum of annual licence counts (excluding confidential records) in 10 × 10 nm CAES blocks recorded in the MAFMF for 2012–2021 combined

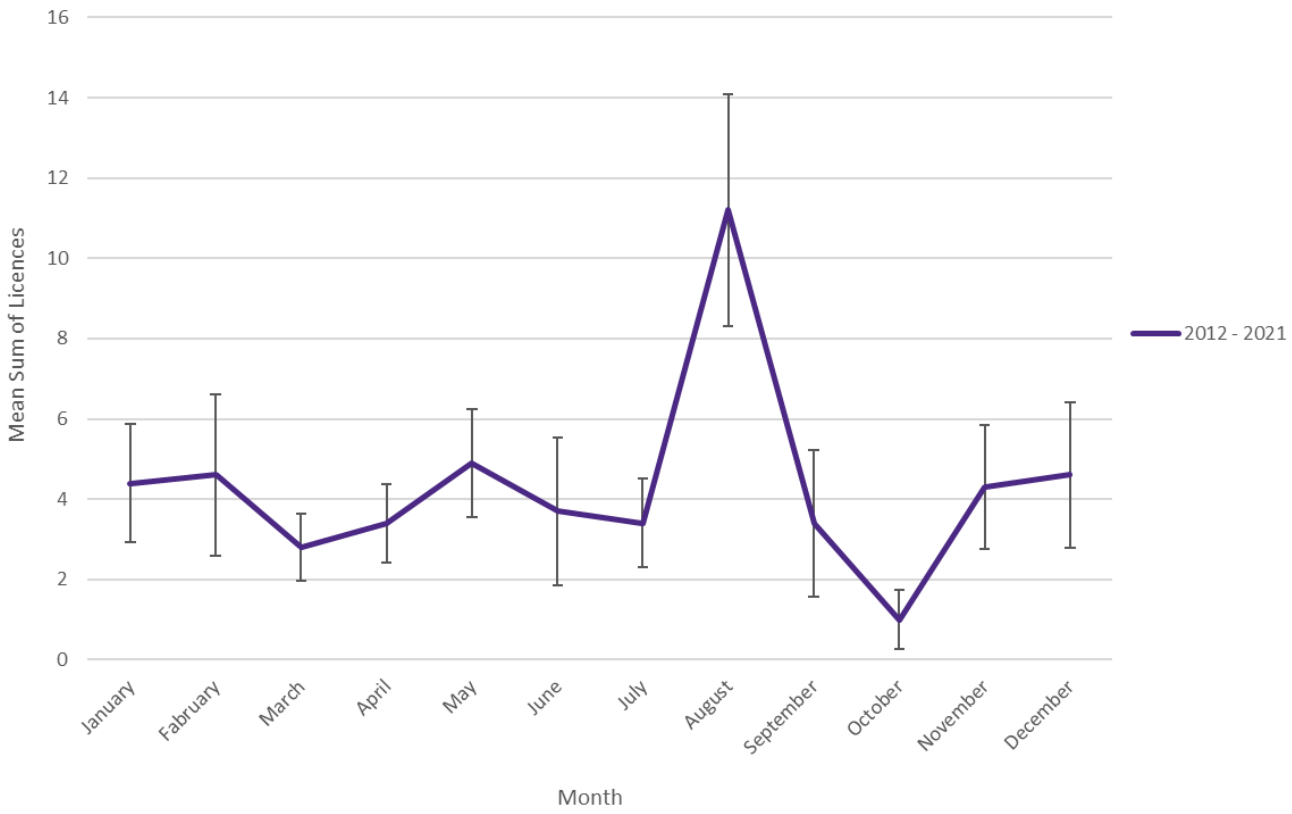


Figure 4-22: Mean monthly sum of licences (excluding confidential records) in 10 × 10 nm CAES blocks recorded in the MAFMF for 2012–2021 combined

4.4.2.3.5 Octopus Interim Managed Fishery

The OIMF covers most of the WA state waters between Kalbarri and the SA border, and out to the extent of the AFZ. The fishery operates year-round targeting western rock octopus (WRO; *Octopus djinda*, formerly *O. aff. tetricus*) in nearshore and continental shelf waters, primarily using 'trigger trap' methods (Newman et al. 2023). The OIMF accounts for most of the commercial octopus catch in WA and is divided into three spatial management areas: Zone 1, Zone 2, and Zone 3. Fishing activity is managed using input controls such as gear restrictions and spatial regulations limiting the total number of traps permitted in each zone (Hart et al. 2018; Newman et al. 2023).

Analysis of CAES data shows that fishing effort (i.e., annual vessel counts) over the ten-year period between 2012 and 2021 occurred in coastal and nearshore waters between Kalbarri and Busselton (Figure 4-23). Low and moderate effort was recorded in coastal and nearshore waters between Geraldton and Mandurah (3–6, 7–12 and 13–18 vessels), with the highest effort concentrated off Green Head (19–24 vessels), Mandurah (19–24 vessels) and Lancelin (25–30 vessels).

WRO complete their life cycle in a range of nearshore habitats in depths up to 70 m, including rocky reefs, seagrass meadows and sandy substrates, typically using limestone reefs around 20 m deep (Hart et al. 2018). Spatial fishing intensity likely follows areas of suitable habitat and depth for traps with a greater catchability of WRO and proximity to ports at Green Head, Jurien Bay, and Lancelin.

Fishing effort also reflects the spatial management of the OIMF. Zone 2 off the west and south-west coast of WA (between 30°30' S and 34°24' S) is allocated the most fishing licences and consequently accounts for approximately 82% of annual catches (Hart et al. 2018), as shown in Figure 4-23.

The OA overlaps with 1,482 km^2 (or 3.24 %) of the area of OIMF fishing effort over the ten-year period (Figure 4-23). CAES blocks within the OA recorded between three and 24 vessels.

Whilst most monthly records were confidential, monthly patterns in fishing effort (the sum of fishing vessels above confidential limits) varied over the ten-year period, as indicated by the error bars in Figure 4-24. Average effort was greater from April to June and October to November, and lower in January, February, July, and August.

WRO is short-lived (up to 1.5 years), with early maturity and year-round spawning (Hart et al. 2018). The consistent fishing effort is likely due to the consistent catchability of WRO, together with the 12-month season in the OIMF, giving fishers the flexibility to operate year-round. Fishers are typically limited by sea and weather conditions, which are generally more favourable in the summer months, as well as market demand and unit prices of octopus (Newman et al. 2023). External factors may also influence monthly fishing effort. For example, catch in the OIMF increased by 86% from 262 t in 2020 to 487 t in 2021, due to a recovery from COVID-19 related supply and trade limitations (Newman et al. 2023).

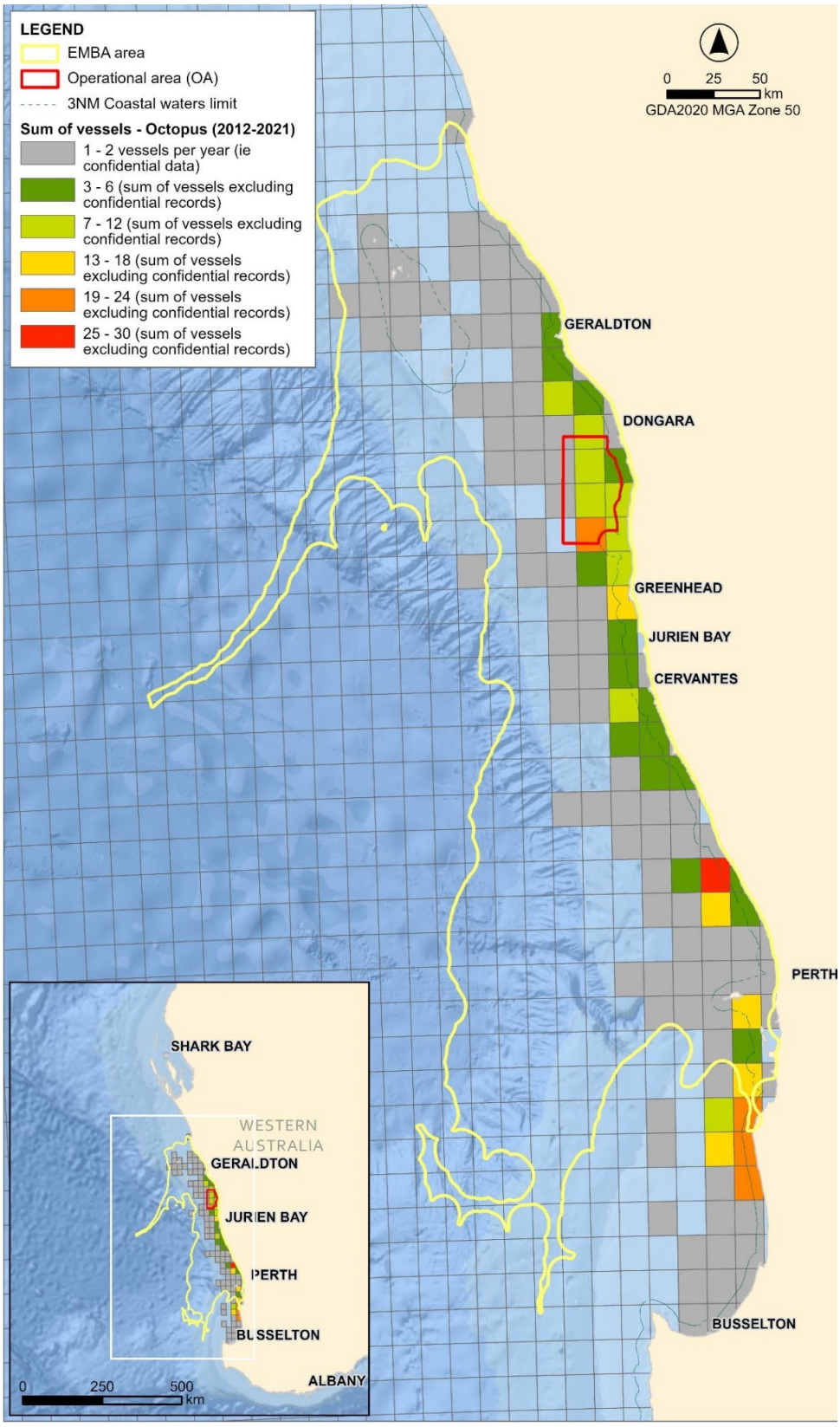


Figure 4-23: Spatial distribution and sum of annual vessel counts (excluding confidential records) in 10 × 10 nm CAES blocks recorded in the OIMF for 2012–2021 combined

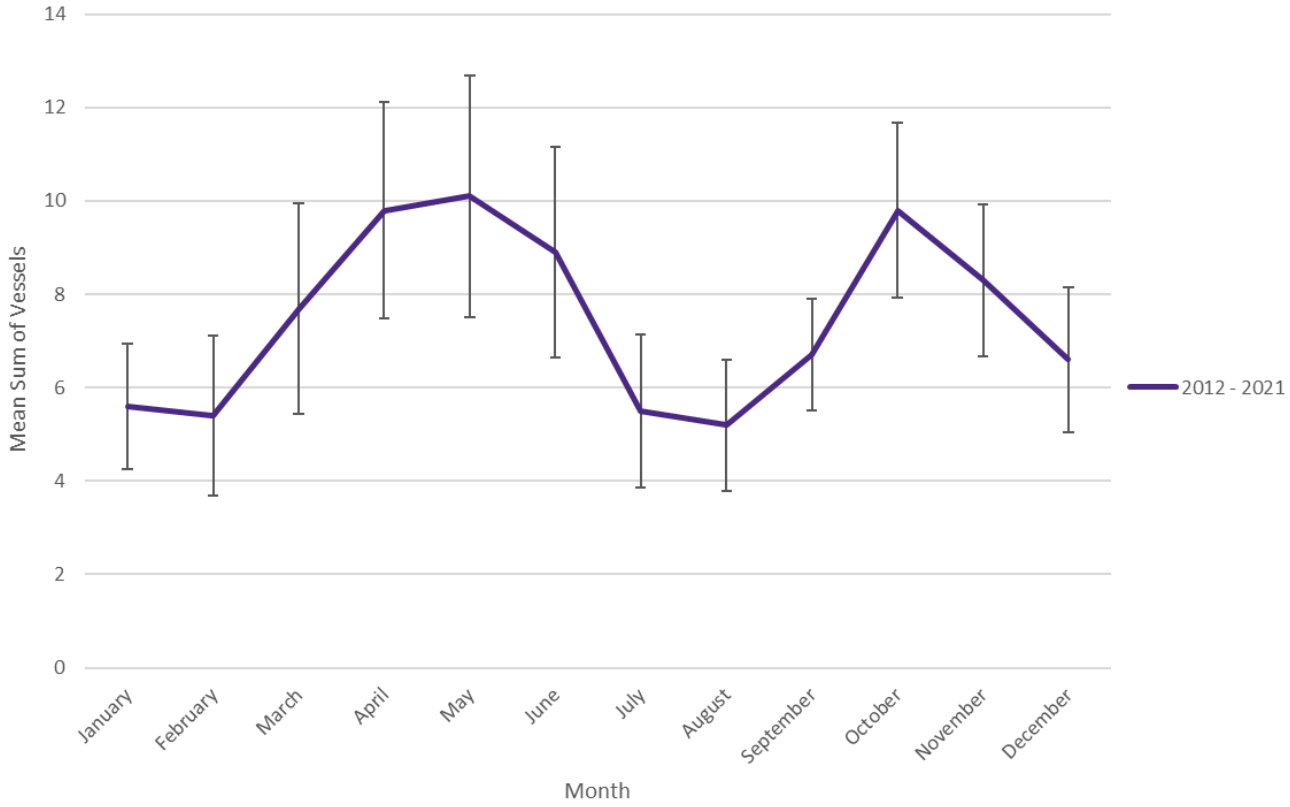


Figure 4-24: Mean monthly sum of vessels (excluding confidential records) in 10 × 10 nm CAES blocks recorded in the OIMF for 2012–2021 combined

4.4.2.3.6 Open Access Fishery

The OAF covers a range of fish resources. In the West Coast Bioregion (WCB), the fishery primarily targets the West Coast Estuarine and Nearshore Finfish Resource (WCENFR), which comprises approximately 15 species in coastal and nearshore waters from Kalbarri to the Capes region (DPIRD 2020c, Newman et al. 2023). Indicator species in the WCENFR include sea mullet (*Mugil cephalus*), Australian herring (*Arripis georgianus*), yellowfin whiting (*Sillago schombergkii*), and Western Australian salmon (*Arripis truttaceus*). The fishery operates year-round in coastal and nearshore waters using haul nets and gillnets (DPIRD 2020c). Fishers are typically limited by sea and weather conditions, which are generally more favourable in the summer months, as well as the market demand and unit prices of target species (Newman et al. 2023).

Fisheries data for the OAF was only available in course 60 × 60 nm CAES blocks. Consequently, the area of fishing activity may be overestimated, as effort is likely spatially limited to discrete locations within the 60 × 60 nm blocks. Data for the OAF includes the North Coast, Gascoyne Coast and West Coast bioregions combined.

Analysis of CAES data shows that fishing effort (i.e., annual vessel counts) over the ten-year period between 2012 and 2021 occurred in coastal waters off the north, west and south coasts of WA (Figure 4-25). The greatest effort was recorded in coastal waters south of Jurien Bay (31–40 vessels) and Perth (41–50 vessels), followed by moderate effort between Geraldton and Jurien Bay (11–20 vessels), and north of Perth (21–30 vessels). Spatial fishing intensity is known to correlate with areas of suitable habitat for target species in coastal and estuarine waters, with proximity to ports at Perth and Jurien Bay.

The OA overlaps with 1,575 km^2 (or 0.76 %) of the total area of OAF fishing effort over the ten-year period (Figure 4-25). CAES blocks within the OA recorded 11–20 vessels.

Monthly patterns in fishing effort (sum of fishing vessels above confidential limits) varied over the ten-year period, as indicated by the error bars in Figure 4-26. Average monthly effort was greatest in the first half of the year from January to a peak in May, and lowest in the second half of the year from June to December.

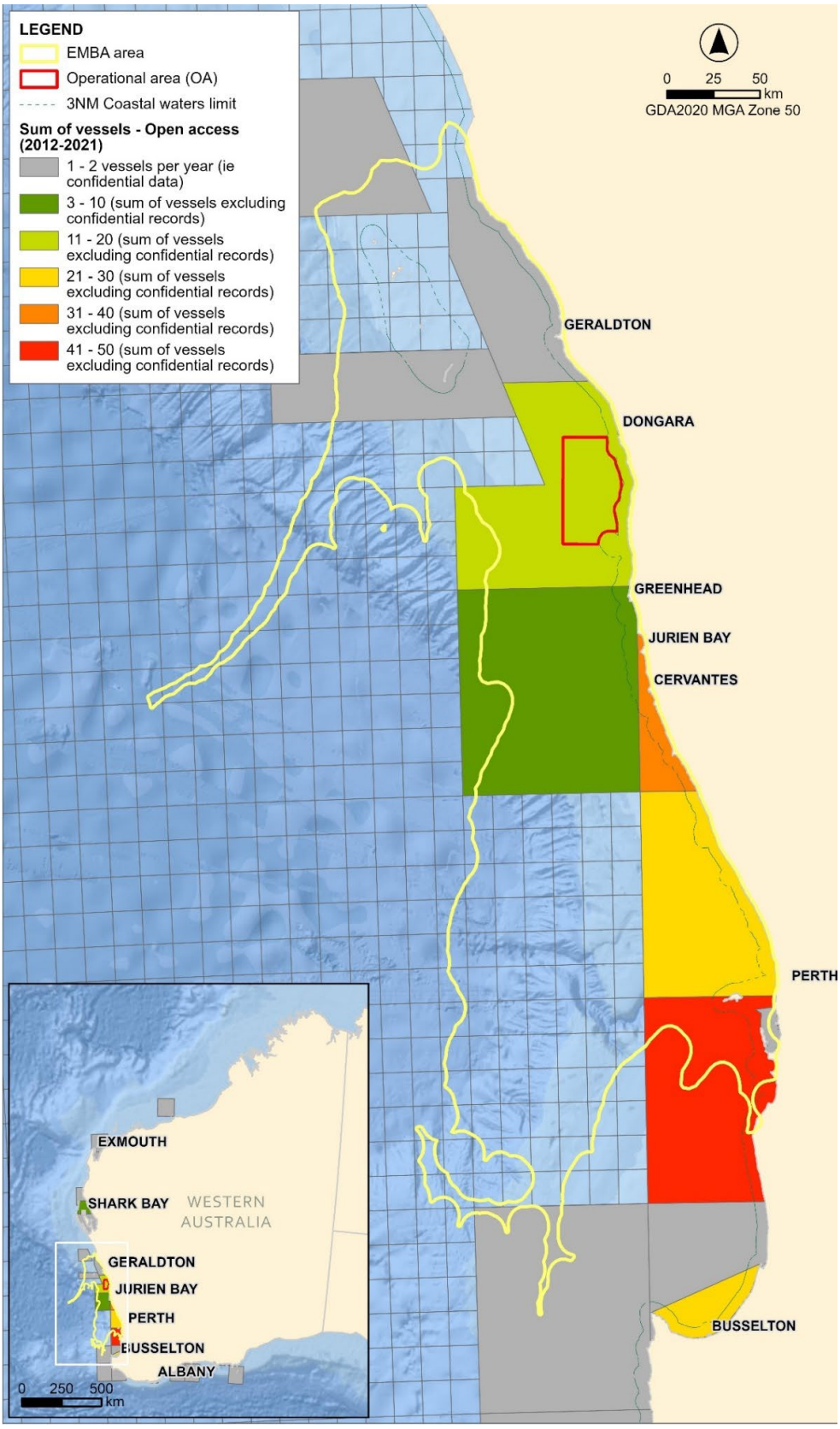


Figure 4-25: Spatial distribution and sum of annual vessel counts (excluding confidential records) in 60 × 60 nm CAES blocks recorded in the OAF for 2012–2021 combined

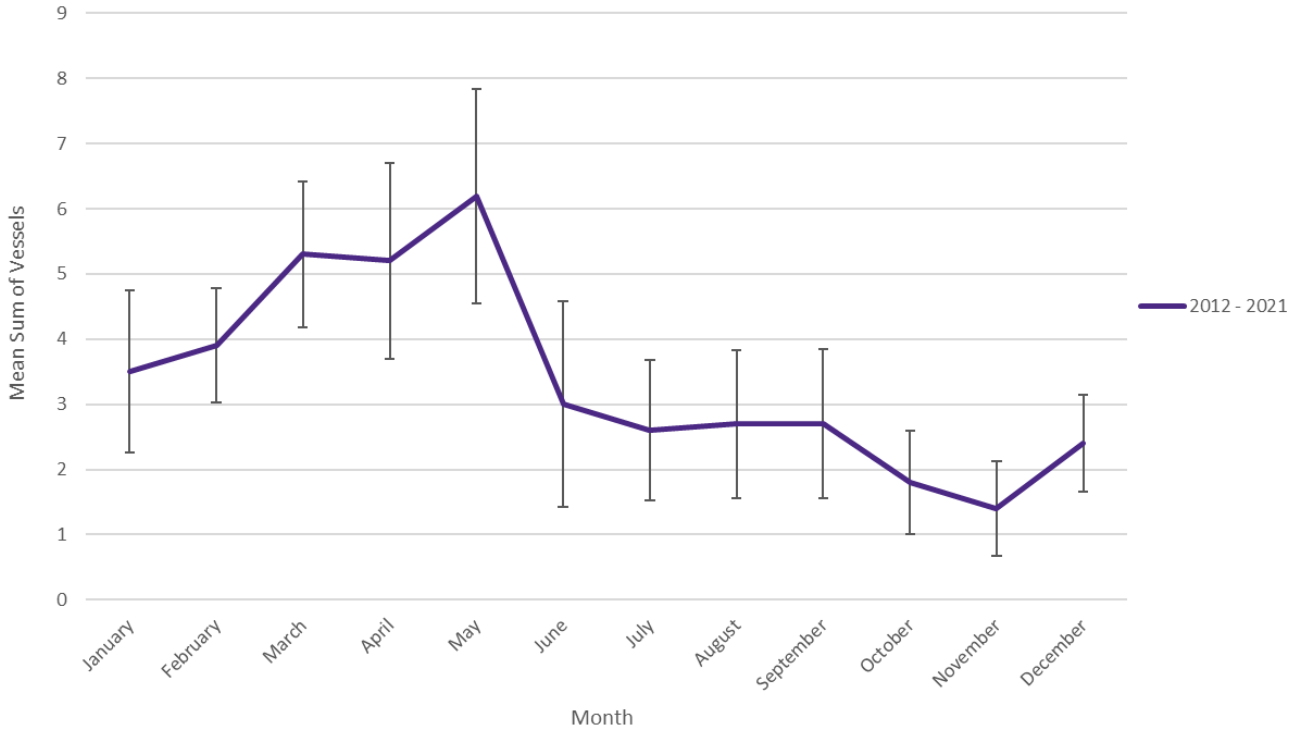


Figure 4-26: Mean monthly sum of vessels (excluding confidential records) in 60 × 60 nm CAES blocks recorded in the OAF for 2012–2021 combined

4.4.2.3.7 South West Coast Salmon Managed Fishery

The SWCSMF covers WA state waters between Geographe Bay and the NT border, and out to the extent of the AFZ. The fishery targets Western Australian salmon (*Arripis truttaceus*) in the south-west coast region of WA, using haul, beach seine and gill net methods (Newman et al. 2023). The range of western Australian salmon extends across multiple jurisdictions, with most of the catch taken off the south coast of Australia. In the west coast region, fishing activity typically occurs in nearshore waters south of the Perth metropolitan area in March–April when large schools form and move around the coast to their spawning area on the lower west coast (DPIRD 2022c). The SWCSMF is managed through a constant exploitation policy, using input controls restricting gear and entry together with area closures (Newman et al. 2023).

The OA does not overlap with the area of SWCSMF fishing effort over the ten-year period (Figure 4-27). Monthly CAES data shows fishing effort (the sum of fishing vessels above confidential limits) occurred in April and May. However, as 95% of monthly CAES records were confidential, the data may not accurately represent temporal fishing effort.

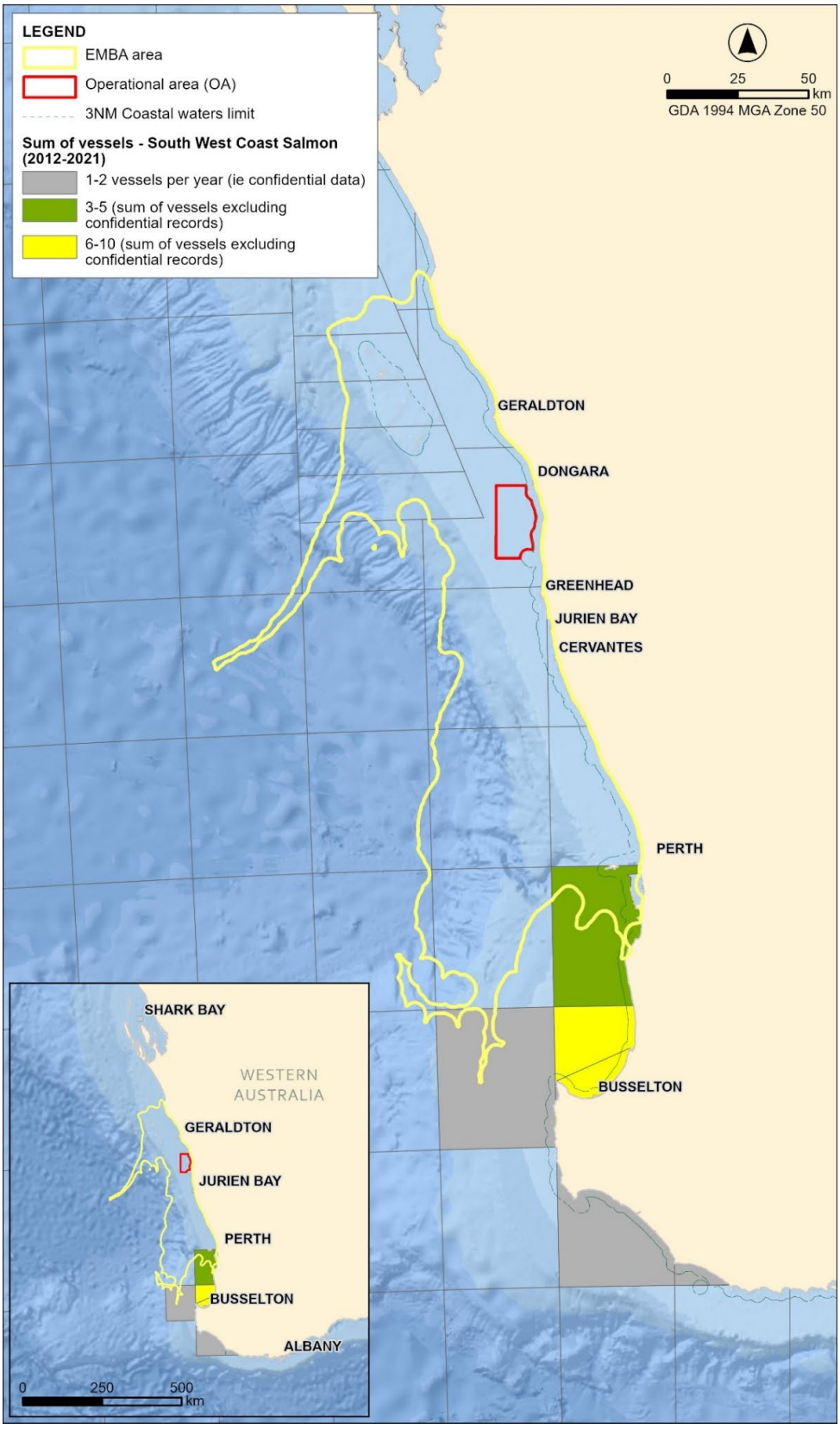


Figure 4-27: Spatial distribution and sum of annual vessel counts (excluding confidential records) in 60 × 60 nm CAES blocks recorded in the SWCSMF for 2012–2021 combined

4.4.2.3.8 Southern Demersal Gillnet and Demersal Longline Managed Fishery

The Southern Demersal Gillnet and Demersal Longline Managed Fishery (SDGDLMF) covers WA state waters between the Capes region (below 33° S) and the SA border, and out to the extent of the AFZ. The fishery transitioned from joint Commonwealth/WA state management to state-only management in December 2018 (Newman et al. 2023). The fishery primarily operates in continental shelf waters up to 200 m deep, using demersal gillnets and occasional demersal longlines to target sharks, with scalefish as a legitimate by-product (Newman et al. 2023). Several indicator species are used to represent the overall stock of temperate sharks, which comprise approximately 80% of the shark catch (Newman et al. 2023). The primary indicator species are dusky (*Carcharhinus obscurus*), sandbar (*Carcharhinus plumbeus*), gummy (*Mustelus antarcticus*) and whiskery (*Furgaleus macki*) sharks (Newman et al. 2023). The SDGDLMF is managed through a constant catch harvest strategy, using input controls in the form of transferable time units (i.e., hours of fishing entitlement) and restrictions on gear such as mesh, hook, and net sizes (DoAFF 2021, Newman et al. 2023).

Analysis of CAES data shows that fishing effort (i.e., annual vessel counts) over the ten-year period between 2012 and 2021 occurred in inshore (20–250 m deep) and offshore (>250 m deep) waters off the south and south-west coasts of WA (Figure 4-28). Most effort was recorded between Busselton and the SA border, with the greatest effort concentrated between Albany and Esperance.

The OA does not overlap with the area of SDGDLMF fishing effort over the ten-year period (Figure 4-28). Monthly CAES data showed fishing effort (the sum of fishing vessels above confidential limits) varied over the period and was greatest between March and May, peaking in April. However, as 97% of CAES records were confidential, the data may not accurately represent temporal fishing effort.

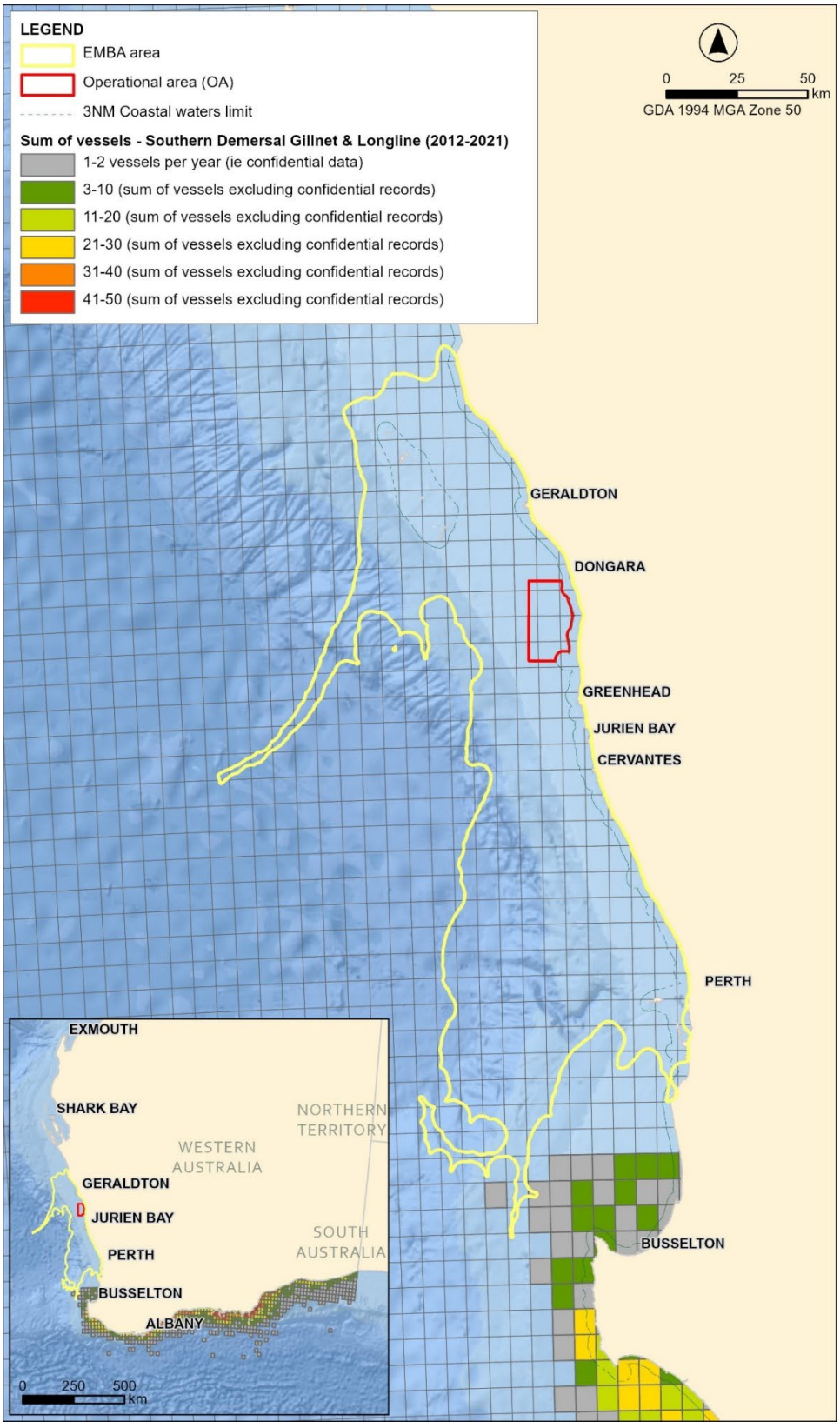


Figure 4-28: Spatial distribution and sum of annual vessel counts (excluding confidential records) in 10 × 10 nm CAES blocks recorded in the SDGDLMF for 2012–2021 combined

4.4.2.3.9 Specimen Shell Managed Fishery

The SSMF covers the entire WA coastline between the NT and SA borders and is based upon the collection of shells for the purposes of display, collection, cataloguing, classification, and sale (Newman et al. 2023). Approximately 200 species of specimen shell are collected each year through a variety of methods including shallow water diving, wading along coastal beaches, and using remotely operated vehicles (Newman et al. 2023).

The SSMF operates year-round and is managed using input controls restricting gear and entry, together with permanently closed areas (Newman et al. 2023). Fishers using hand collection methods are typically limited by sea and weather conditions, which are generally more favourable in the summer months, as well as the market demand and unit prices of target species (Newman et al. 2023).

Analysis of CAES data shows that fishing effort (i.e., annual licence counts) over the ten-year period between 2012 and 2021 occurred in coastal waters off the north, west and south coasts of WA (Figure 4-29). On the west coast, the greatest effort was recorded south of Cape Naturaliste (21–30 licences) and off Busselton (11–20 licences), followed by moderate effort off Perth (3–10 licences), with low level, confidential effort running between Shark Bay and the Capes region. Catch effort is typically concentrated in shallow (<30 m) waters around population centres, with easy access to beaches and for divers using hand collection methods (Newman et al. 2023). Fishing activity is also restricted by practical limitations including depth, time, and tide, together with various spatial closures (Newman et al. 2023).

The OA overlaps with 171 km^2 (or 0.19%) of the total area of SSMF fishing effort over the ten-year period (Figure 4-29). Data within this overlap are confidential due to the low level of effort. Monthly CAES data showed patterns in fishing effort (sum of fishing licences above confidential limits) varied over the ten-year period. However, as 95% of monthly CAES records were confidential, the data may not accurately represent temporal fishing effort.

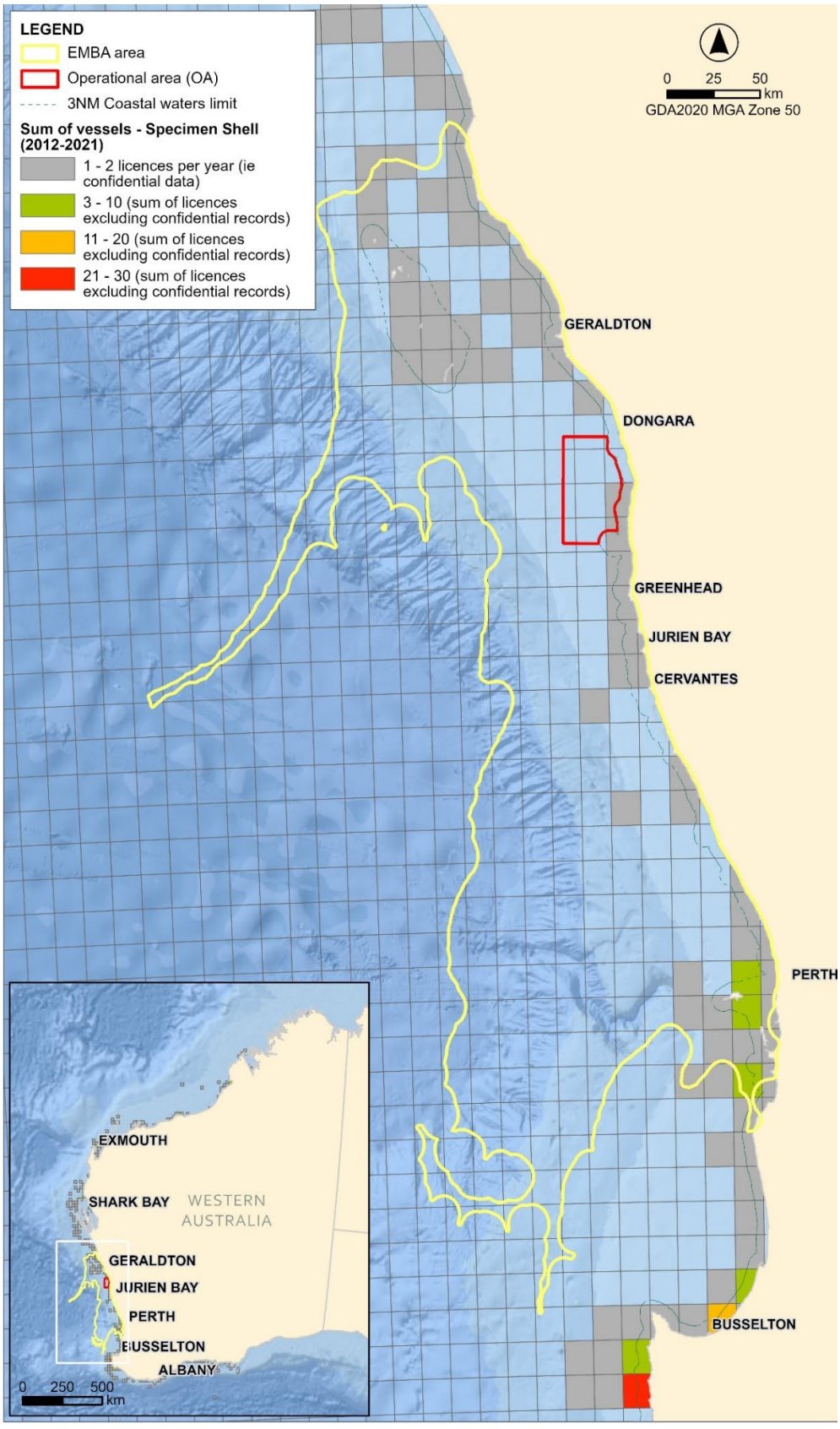


Figure 4-29: Spatial distribution and sum of annual licence counts (excluding confidential records) in 10 × 10 nm CAES blocks recorded in the SSMF for 2012–2021 combined

4.4.2.3.10 West Coast Deep Sea Crustacean Managed Fishery

The WCDSCMF covers all WA state waters north of the Capes region to the NT border, on the seaward side of the 150 m isobath (DPIRD 2020d). The fishery primarily targets crystal crabs (*Chaceon albus*), as well as champagne crabs (*Hypothalassia acerba*) and giant crabs (*Pseudocarcinus gigas*), using baited pots or traps operated in a long-line formation in shelf edge waters 500–800 m deep (DPIRD 2020d; Newman et al. 2023). The WCDSCMF operates year-round and is primarily a quota-managed fishery using a TACC for each target species (Newman et al. 2023). Fishers are typically limited by sea and weather conditions, which are generally more favourable in the summer, as well as export market demand and unit prices of target species, for example around Chinese New Year (How et al. 2015).

Fisheries data for the WCDSCMF in 10 × 10 nm CAES blocks was only available between 2017 and 2021. Fishing effort (i.e., annual vessel counts) over the five-year period between 2017 and 2021 occurred on the seaward side of the 150 m isobath between Exmouth and the Capes region (Figure 4-30). Most fishing activity was confidential due to the low level of effort. Moderate effort was recorded off Perth (3–4 vessels), with both moderate and relatively high effort (3-4 and 5–6 vessels) recorded south of Shark Bay.

The OA does not overlap with the area of WCDSCMF fishing effort over the five-year period (Figure 4-30). Monthly CAES data was 100% confidential and may not accurately represent temporal fishing effort.

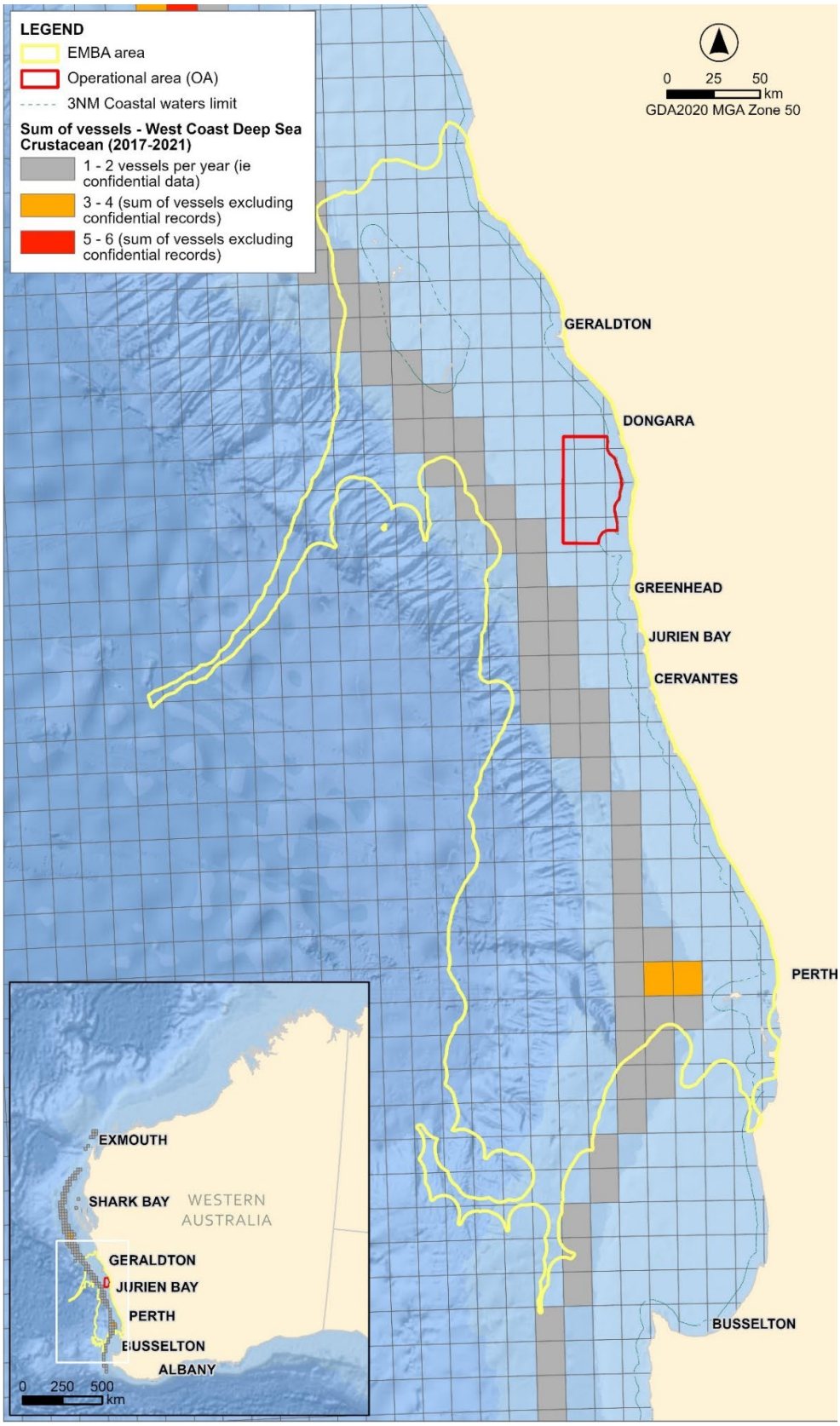


Figure 4-30: Spatial distribution and sum of annual vessel counts (excluding confidential records) in 10 × 10 nm CAES blocks recorded in the WCDSCMF for 2012–2021 combined

4.4.2.3.11 West Coast Demersal Gillnet and Demersal Longline Managed Fishery

The WCDGDLMF covers WA state waters between Shark Bay and the Capes region (above 33° S), and out to the extent of the AFZ. The fishery primarily operates in continental shelf waters up to 200 m deep, using demersal gillnets and occasional demersal longlines to target sharks, with scalefish as a legitimate by-product (Newman et al. 2023). Several indicator species are used to represent the overall stock of temperate sharks, which comprise approximately 80% of the shark catch (Newman et al. 2023). The primary indicator species are dusky (*Carcharhinus obscurus*) and sandbar (*Carcharhinus plumbeus*) sharks, which are typically targeted along the west coast (WAFIC 2022), as well as gummy (*Mustelus antarcticus*) and whiskery (*Furgaleus macki*) sharks (Newman et al. 2023). The WCDGDLMF is managed through a constant catch harvest strategy, using input controls in the form of transferable fishing time units (i.e., hours of fishing entitlement) and restrictions on gear such as mesh, hook, and net sizes (Newman et al. 2023).

Analysis of CAES data shows that fishing effort (i.e., annual vessel counts) over the ten-year period between 2012 and 2021 occurred in inshore (20–250 m deep) and offshore (>250 m deep) waters between Shark Bay and Mandurah (Figure 4-31). The greatest effort was recorded in coastal waters off Green Head at the southern extent of the OA (9–11 vessels), followed by moderate effort in coastal and inshore waters between Geraldton and Lancelin (3–5 and 6–8 vessels).

Spatial fishing intensity is known to correlate with areas of suitable habitat for target shark species, together with proximity to ports along the coastline between Geraldton and Jurien Bay. In WA, adult dusky and sandbar sharks are most abundant in continental shelf waters north of the Abrolhos Islands, while juveniles inhabit in more temperate, south-west waters (Braccini et al. 2018). Adult dusky and sandbar sharks also have high mobility across WA and make regular seasonal migrations from the northwest to temperate waters for pupping (Braccini et al. 2018). The southward movement of target species may contribute to the concentrated fishing effort in more temperate waters, as shown in Figure 4-31.

Fishing activity is also restricted by the current closure of the Abrolhos Islands Fish Habitat Protection Area (FHPA) and the metropolitan management area off the Perth coast (inshore <250 m), as shown by the low vessel counts recorded in these areas in Figure 4-31

The OA overlaps with 1,575 km^2 (or 4.21%) of the area of WCDGDLMF fishing effort over the ten-year period (Figure 4-31). CAES blocks within the OA recorded between three and 11 vessels, as well as some low-level, confidential effort.

Monthly CAES data was over 99% confidential and may not accurately represent temporal fishing effort. The WCDGDLMF season runs for 12-months, giving fishers with individually transferable time units an incentive to increase efficiency and the flexibility to fish year-round. Fishers are typically limited by sea and weather conditions, which are typically more favourable in the summer months, as well as the catchability and market demand for sharks and scalefish. The seasonal migrations of target species may also influence temporal fishing effort.

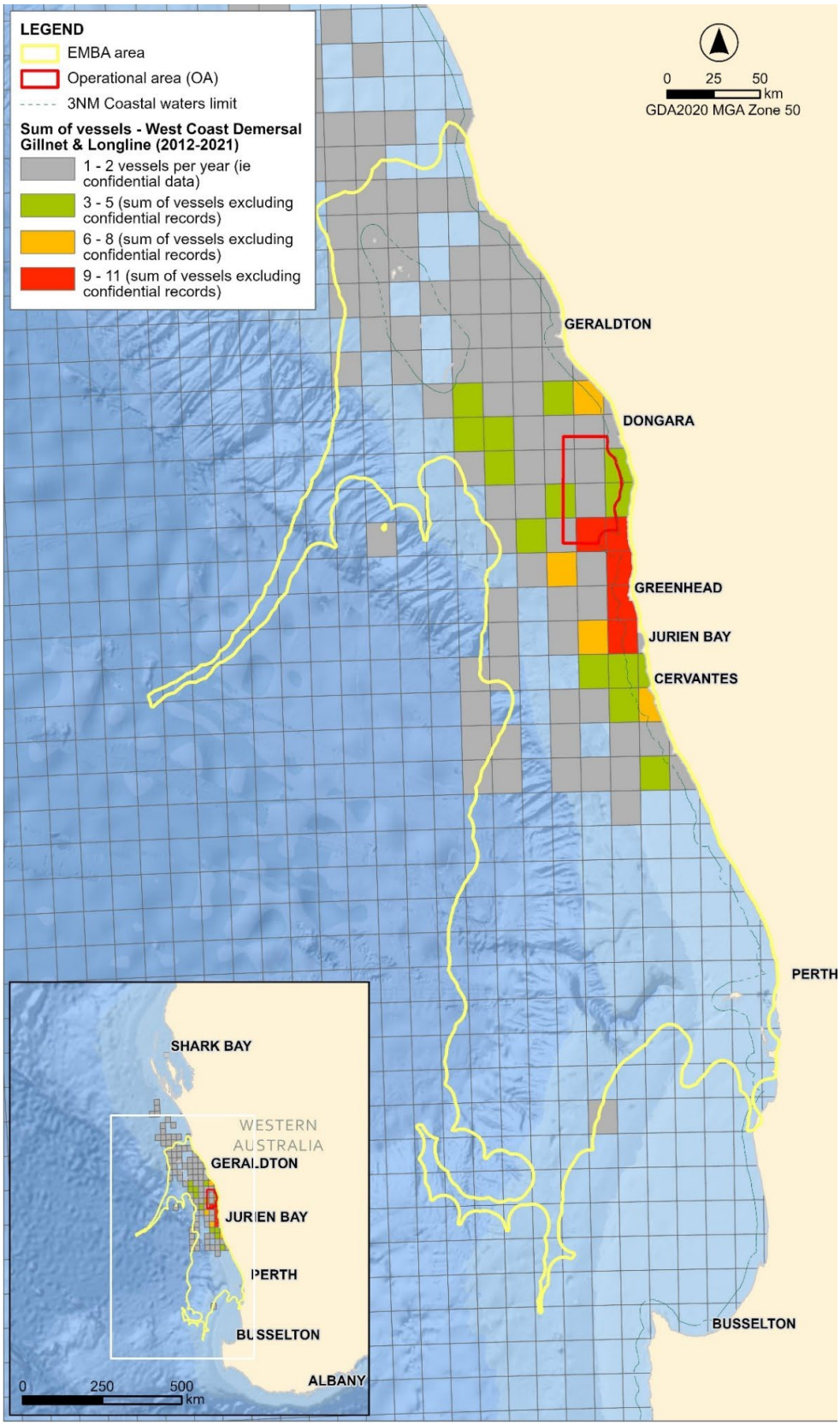


Figure 4-31: Spatial distribution and sum of annual vessel counts (excluding confidential records) in 10 × 10 nm CAES blocks recorded in the WCDGDLMF for 2012–2021 combined

4.4.2.3.12 West Coast Demersal Scalefish Interim Managed Fishery

The WCDSIMF covers WA state waters between north of Kalbarri and south-east of Augusta, and out to the extent of the AFZ. The fishery targets approximately 100 demersal species in inshore (20–250 m deep) and offshore (>250 m deep) habitats, using boat-based line methods (Newman et al. 2023).

The WCDSIMF is divided into four management zones: Kalbarri, Mid-West, Metropolitan and South-West, with approximately 64% of the west coast demersal scalefish (WCDS) resource allocated to the commercial sector (Newman et al. 2023). Several indicator species are used to represent the overall stock of WCDS, which comprise approximately 75% of the total catch (DPIRD 2021). Inshore indicator species include West Australian dhufish (*Glaucosoma hebraicum*), pink snapper (*Chrysophrys auratus*) and baldchin groper (*Choerodon rubescens*) (Fairclough et al. 2021a; Newman et al. 2023).

The WCDS resource is currently undergoing a long-term recovery phase (Fairclough et al. 2021a; Newman et al. 2023). Management arrangements to recover the resource have been in place since 2010, limiting annual catches in the West Coast Bioregion (Kalbarri to Augusta) to 50% of 2005–2006 levels through permits allocating annual fishing hours. Annual entitlement to fish in the Mid-West area has since ranged from 53–69% of maximum (45% in 2021), with a corresponding decrease in catch below the stock recovery benchmark (Newman et al. 2021, 2023). In January 2023, DPIRD further reduced fishing hours to achieve a 50% cut in TACC to 240 t (DPIRD 2023d). The effort reduction is likely to reduce the number of days fished per commercial line boat to an average of 20 days per year (DPIRD 2023d).

Analysis of CAES data shows that fishing effort (i.e., annual vessel counts) over the ten-year period between 2012 and 2021 ranged between Shark Bay and the Capes region, with most vessels recorded within approximately 100 km offshore (Figure 4-32). The greatest effort was concentrated to the west and south-west of the OA and around the Abrolhos Islands (41–60 and 61–80 vessels), followed by moderate effort in inshore waters running adjacent to the coastline between Shark Bay and Jurien Bay (21–40 vessels).

Spatial fishing intensity is known to correlate with areas of suitable habitat for target species such as dhufish and snapper, together with proximity to ports along the coastline and at the Abrolhos Islands. The movement of target species may also influence fishing effort, for example, pink snapper may be targeted by fishers as they migrate to spawning areas in Shark Bay and Cockburn Sound every year. Fishing activity is also restricted by the current closure of the Metropolitan management area (since 2007), as shown by the low vessel counts recorded between Lancelin and south of Mandurah in Figure 4-32.

The OA overlaps with 1,575 km^2 (or 2.02 %) of the area of WCDSMF fishing effort over the ten-year period (Figure 4-32). CAES blocks within the OA recorded between three and 60 vessels, as well as some low-level, confidential effort.

Monthly patterns in fishing effort (the sum of fishing vessels above confidential limits) followed a consistent seasonal trend. Average monthly effort over the ten-year period was greatest in summer from November to May, peaking in December, with a corresponding reduction in winter from June to September (Figure 4-33).

The WCDSMF season runs for 12-months, giving fishers with individual permits (i.e., hours of fishing entitlement) an incentive to increase efficiency and the flexibility to fish year-round. Fishers are typically limited by sea and weather conditions, as well as the market demand for scalefish (Newman et al. 2023). The greater vessel numbers recorded between November and May likely reflects more favourable conditions for line fishing and the greater catchability and unit prices of target species in the summer months (Figure 4-33).

External factors may also influence monthly fishing effort. For example, catch in the Mid-West management area increased from 76 t in 2018 to 100 t in 2020, partly due to an increase in fishing effort in February and March following western rock lobster market changes caused by COVID-19 (Newman et al. 2021, 2023).

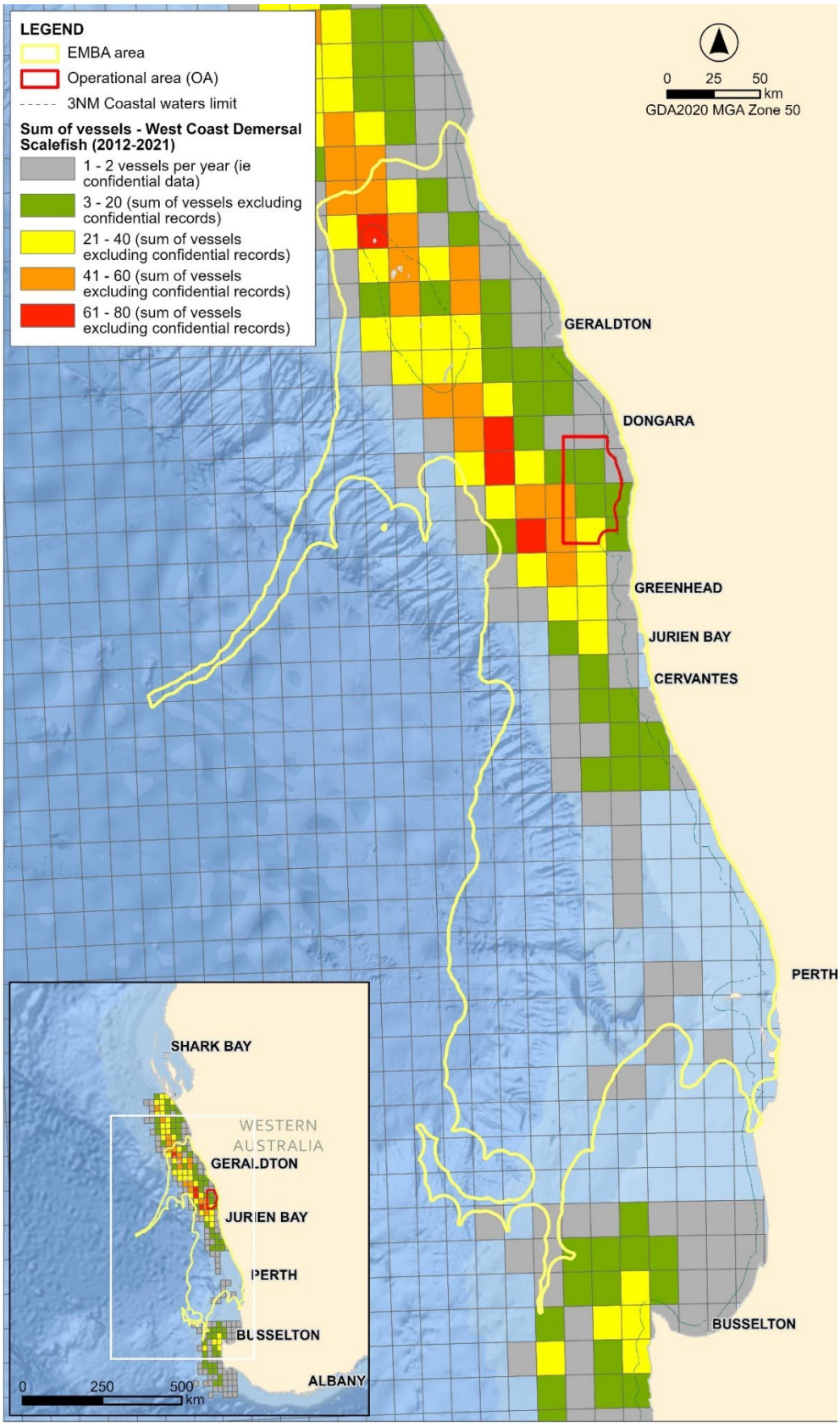


Figure 4-32: Spatial distribution and sum of annual vessel counts (excluding confidential records) in 10 × 10 nm CAES blocks recorded in the WCDSIMF for 2012–2021 combined

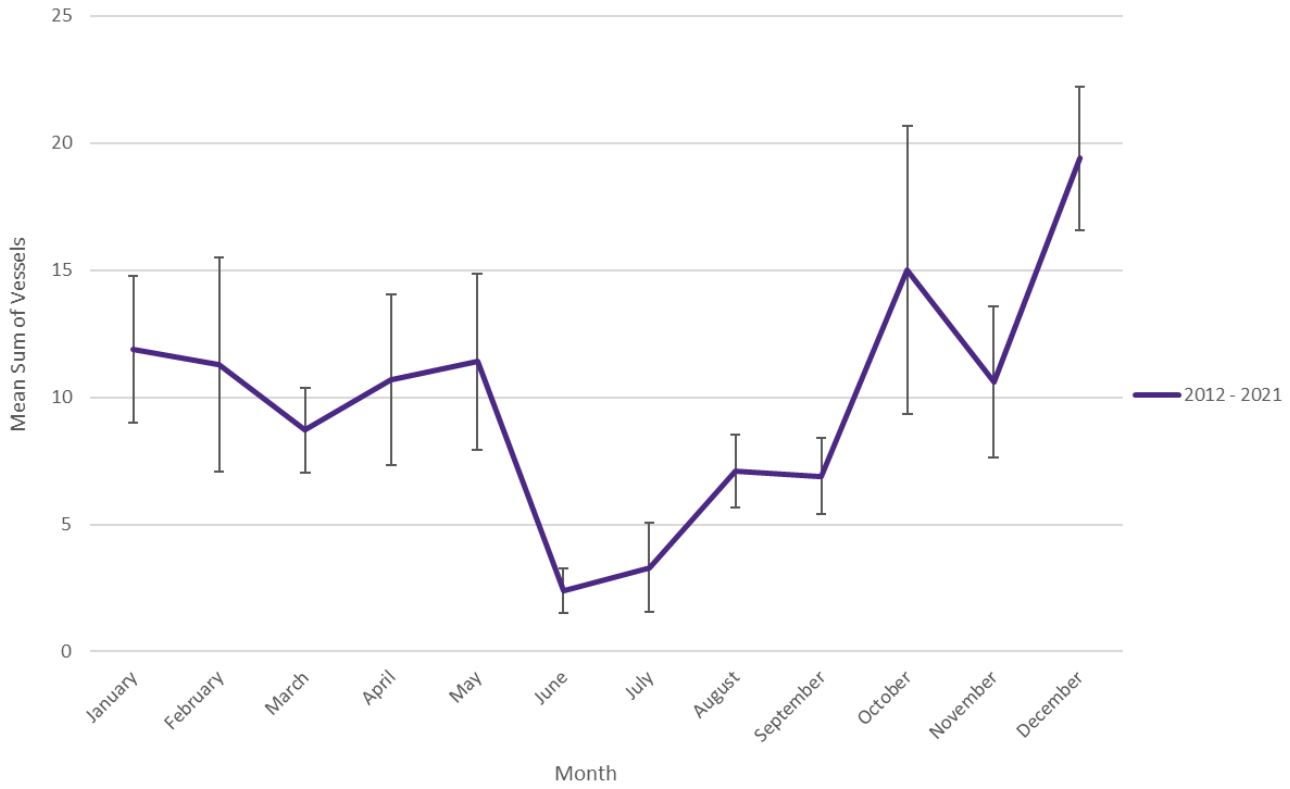


Figure 4-33:Mean monthly sum of vessels (excluding confidential records) in 10 × 10 nm CAES blocks recorded in the WCDSIMF for 2012–2021 combined

4.4.2.3.13 West Coast Purse Seine Managed Fishery

The WCPSMF covers WA state waters from Geraldton to Geographe Bay. The fishery targets small pelagic scalefish using purse seine methods. Scaly mackerel (*Sardinella lemuru*) and Australian sardine (*Sardinops sagax*) are the indicator species and dominate the catch (Newman et al. 2023). The WCPSMF operates year-round and is managed through input controls limiting entry and gear type, as well as notional TACC limits for Australian sardines and separately for other small pelagic species (Blazeski et al. 2021; Newman et al. 2023). Fishers are typically limited by sea and weather conditions, which are generally more favourable in the summer months, as well as the market demand and unit prices of target species.

Fisheries data for the WCPSMF was only available in coarse 60 × 60 nm CAES blocks. Consequently, the area of fishing activity may be overestimated, as effort is likely spatially limited to discrete locations within the 60 × 60 nm blocks.

Analysis of CAES data shows that fishing effort (i.e., annual vessel counts) over the ten-year period between 2012 and 2021 ranged from the Abrolhos Islands to Busselton (Figure 4-34). The highest effort was concentrated in Cockburn Sound south of Perth (22–28 vessels), followed by moderate effort off the Busselton coast (8–14 vessels) and low effort north of Perth (3–7 vessels). Spatial fishing intensity is known to correlate with areas of suitable habitat for pelagic target species, typically in coastal waters around the Perth metropolitan area such as Cockburn Sound (Newman et al. 2023).

The OA does not overlap with the area of WCPSMF fishing effort over the ten-year period (Figure 4-34). Monthly CAES data is 96% confidential and may not accurately represent temporal fishing effort.

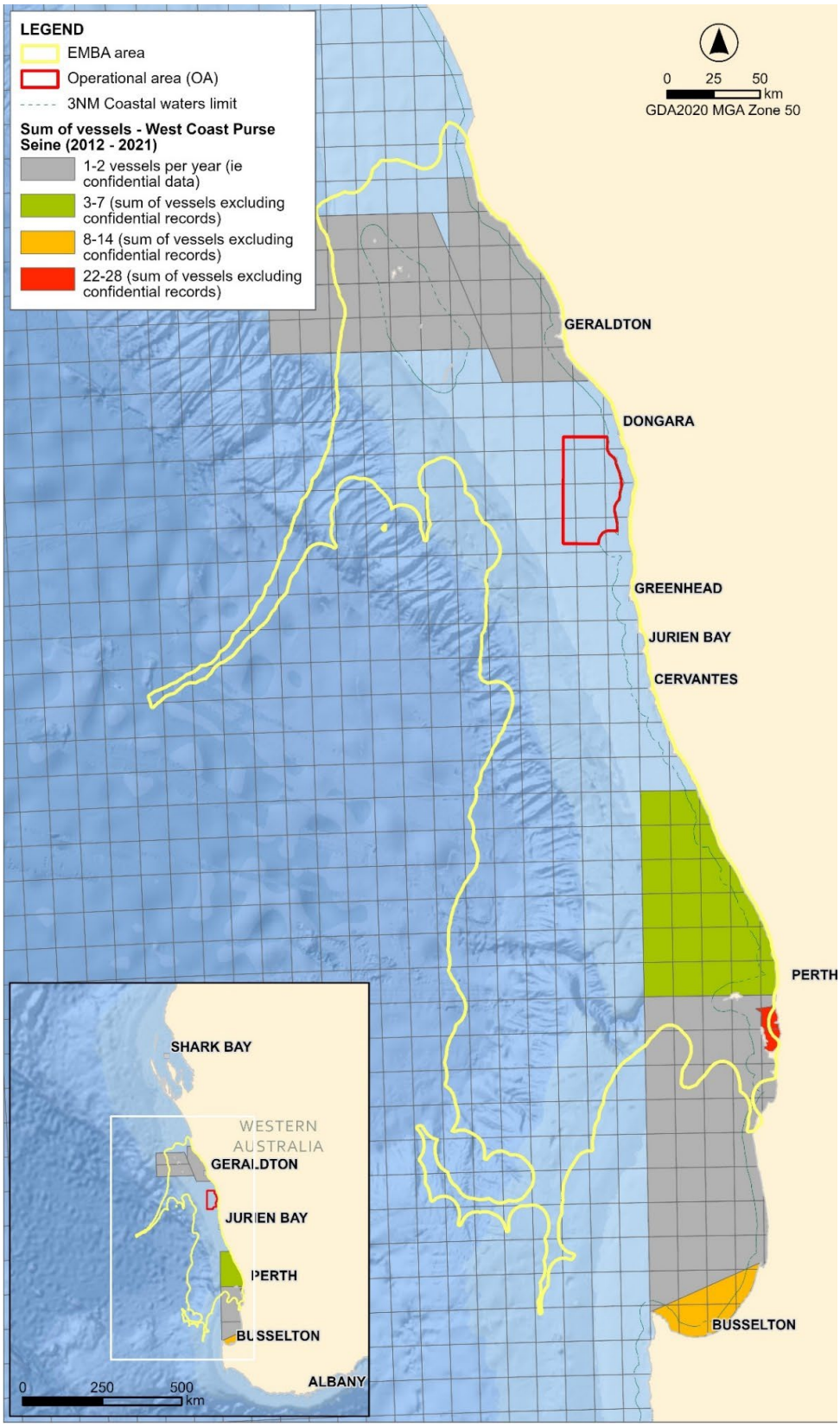


Figure 4-34: Spatial distribution and sum of annual vessel counts (excluding confidential records) in 60 × 60 nm CAES blocks recorded in the WCPSMF for 2012–2021 combined

4.4.2.3.14 West Coast Rock Lobster Managed Fishery

The WCRLMF covers WA state waters between Exmouth and Cape Leeuwin, and out to the extent of the AFZ. The fishery targets the western rock lobster (*Panulirus cygnus*) throughout their geographic range along the lower west coast of WA, using baited traps/pots (Newman et al. 2023). Historically, the WCRLMF has been Australia's largest and most valuable single species wild capture fishery (de Lestang et al. 2016).

The WCRLMF is managed in three spatial areas: Zone A (Abrolhos Islands area), Zone B (north of 30°S) and Zone C (south of 30°S). In 2010–2011, the fishery transitioned to an output-based system in response to a downturn in recruitment (Caputi et al. 2014), implementing a transferable quota system to control the annual TACC in each zone while maximising economic yield (DPIRD 2014; Newman et al. 2023).

Analysis of CAES data shows that fishing effort (i.e., annual vessel counts) over the ten-year period between 2012 and 2021 ranged between Shark Bay and the Capes region, with most vessels recorded in nearshore waters between Geraldton and Perth, as well as around the Abrolhos Islands (Figure 4-35). Vessel counts were greatest off the Geraldton coast (226–300 and 301–375 vessels), followed by the Abrolhos Islands (226–300 vessels) and Perth coast (151–225 vessels).

Spatial fishing intensity is known to correlate with areas of suitable limestone reef habitat, with proximity to ports along the coastline and at the Abrolhos Islands. Additionally, since the implementation of a 50% catch share between management Zones A and B to combine with Zone C in 2015, spatial catch variability has reduced by dispersing effort across the fishery (de Lestang et al. 2016).

The movement of WCRL may also influence fishing effort. Juvenile, newly moulted WRL (or 'whites') migrate west from coastal reefs across sandy habitats to deeper offshore breeding grounds (Bellchambers et al. 2017), while a smaller number migrate north following the continental shelf (de Lestang et al. 2016). While there is substantial inter-annual variability in north-ward movement between latitudes 27°S and 30°S (de Lestang et al. 2016), this may contribute to the concentrated fishing effort in the northern areas of the fishery.

The OA overlaps with 1,575 km^2 (or 1.94%) of the area of WCRLMF fishing effort over the ten-year period (Figure 4-35). CAES blocks within the OA recorded between three and 300 vessels.

Monthly patterns in fishing effort (the sum of fishing vessels above confidential limits) followed a consistent seasonal trend. Average monthly effort over the ten-year period was greatest in the summer from December to May, peaking in February, with a corresponding reduction in winter from June to November (Figure 4-36). The 2020 season was excluded from the average due to trade limitations and disruptions caused by COVID-19.

The WCRLMF management structure enables export market demand to drive temporal fishing effort. Since 2013, the commercial season has run for 12 months beginning 15 January, giving fishers with individual catch limits (i.e., transferable quotas) an incentive to increase economic efficiency and the flexibility to fish when the market price for lobsters is high. Asia is the primary export market for WRL, with almost all catch exported to China, together with Hong Kong, Taiwan, and Japan (Newman et al. 2023). Fishing effort reflects export prices and typically peaks shortly after the annual quota is renewed around Chinese New Year in January–February (Figure 4-36).

External economic factors may also influence monthly fishing effort. For example, in 2020 catch effort was substantially reduced during the peak seasonal fishing period in January and February, reflecting a Chinese ban on Australian imports and a crash in export demand due to COVID-19.

Catches of WRL are also limited by sea and weather conditions (Newman et al. 2023), which are generally more favourable in the summer, as shown in Figure 4-36. Historically, seasonal catches of WRL have also been greater in December–January due to the higher catchability of the 'whites' phase, as well as in March–April when undersize WRL moult into legal size (de Lestang et al. 2016). Fishing effort and catch are typically lower in winter, due to more rough weather days, lower catchability, and many females starting to mate and therefore becoming illegal for capture (de Lestang et al. 2016).

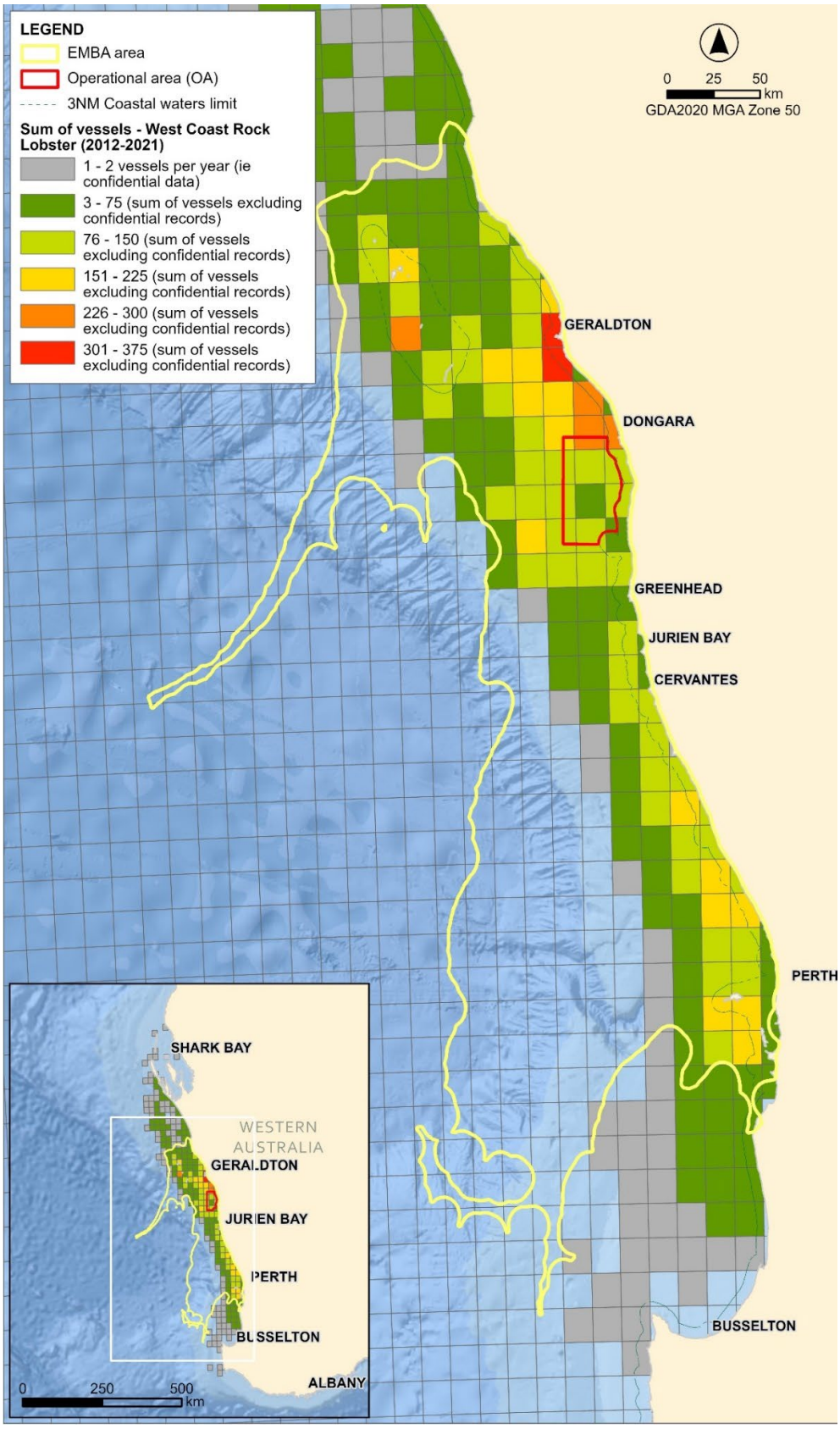


Figure 4-35: Spatial distribution and sum of annual vessel counts (excluding confidential records) in 10 × 10 nm CAES blocks recorded in the WCRLMF for 2012–2021 combined

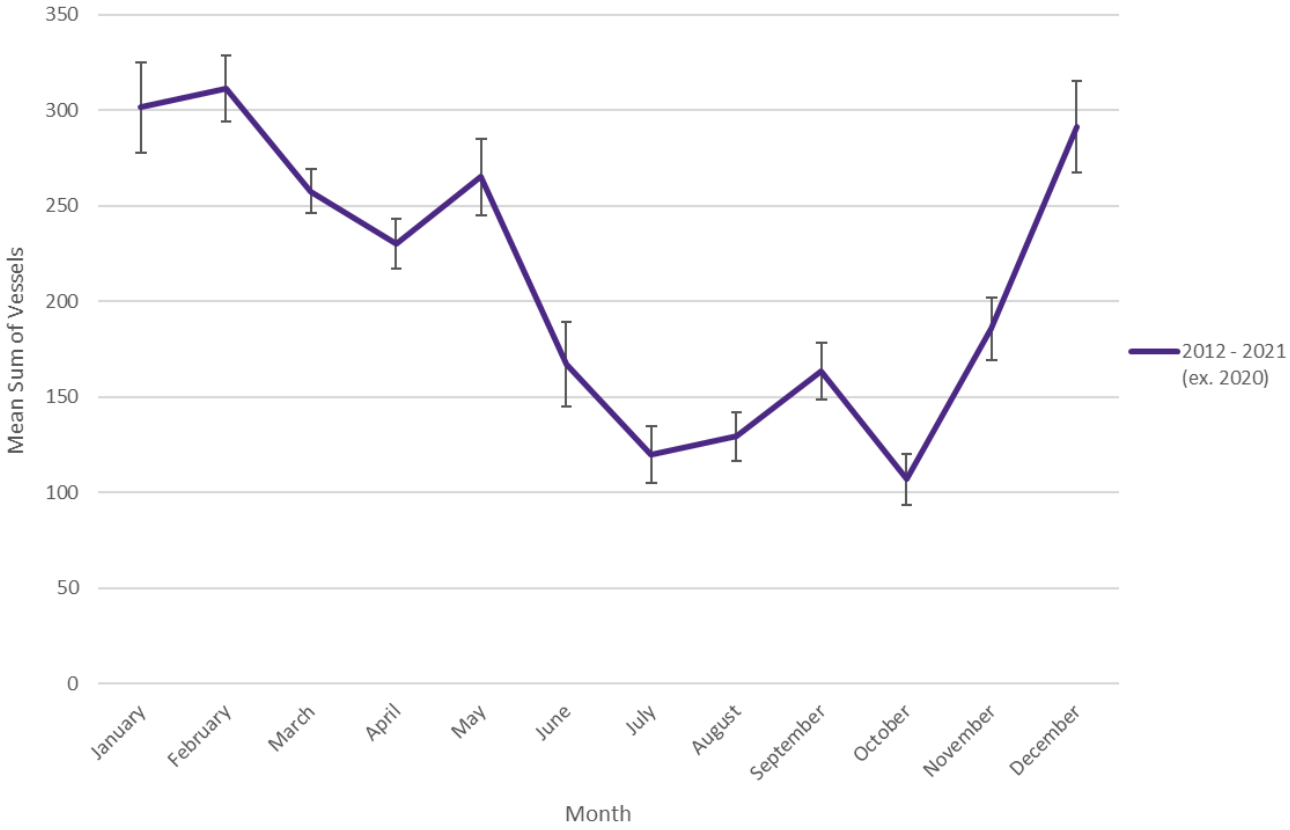


Figure 4-36: Mean monthly sum of vessels (excluding confidential records) in 10 × 10 nm CAES blocks recorded in the WCRLMF for 2012–2021 combined, excluding 2020

4.4.3 Tourism

No tourism activities are known to take place within the OA; however, tourism activities do occur in the EMBA and surrounding region. The primary tourism activities surrounding the OA are recreational fishing, water sports and scenic/wildlife tours. Further details on local tourism are covered in Section 0.

4.4.4 Recreational fishing

Recreational fishing is a popular activity in the WCB. Port Denison (6 km east of the OA) is a common recreating fishing hot spot, and recreational vessels may occur within the OA and/or EMBA. Recreational fishing charters also operate in the region (see Section 4.4.4.1).

4.4.4.1 Tour Operator Fishery West Coast

The TOFWC is based on recreational fishers operating from charter vessels off the WA coast and around the Abrolhos Islands. Charter fishers typically target the large pelagic and west coast demersal scalefish resources using line fishing methods (Newman et al. 2023). The WCDSIMF operates in inshore (20–200 m deep) and offshore (>250 m) habitats, targeting approximately 100 demersal species such as Western Australian dhufish and pink snapper (Newman et al. 2023). Charter fishers are included in the 36% catch allocation for the WCDSIMF recreational sector, with 61 licensed operators reported active in the WCB in 2020–2021 (Newman et al. 2023). The large pelagic resource is distributed throughout WA in offshore pelagic and inshore waters and includes a range of tropical and temperate species, such as mackerels, barracuda, billfishes, cobia, large trevallies, mahi, and tunas (Lewis 2020).

Analysis of CAES data shows that fishing effort (i.e., annual licence counts) over the ten-year period between 2012 and 2021 ranged between Shark Bay and the Capes region (Figure 4-37). The highest fishing effort was concentrated around

the Rottnest and Abrolhos islands (106–140 and 141–175 licences), followed by moderate and low effort off the Geraldton, Jurien Bay, and Perth coasts (3–35 and 36–70 licences).

Recreational charter fishing is typically limited by distance and isolation, with most catches taken between Perth and Dampier (Lewis 2020). Spatial fishing intensity is known to correlate with areas of suitable habitat for target species, with easy access for tourists and charter vessels, such as at Rottnest Island and the Abrolhos Islands. The OA overlaps with 942 km^2 (or 1.25%) of the area of TOFWC fishing effort over the ten-year period (Figure 4-37). Data within this overlap are confidential due to the low level of effort.

Monthly patterns in fishing effort (the sum of fishing vessels above confidential limits) followed a consistent seasonal trend. Average monthly effort over the ten-year period was greatest in the summer from December to June, peaking in April, with a corresponding reduction in winter from July to November (Figure 4-38). The 2020 season was excluded from the average due to disruptions caused by COVID-19.

Charter fishing is seasonal, with recreational fishers typically limited by sea and weather conditions, as well as the management controls of targeted fish resources. The greater fishing effort over the summer months likely reflects more favourable conditions for recreational line fishing and the greater catchability of target species.

External factors may also influence temporal recreational fishing effort. For example, in 2020 charter fishing was substantially reduced during the peak seasonal fishing period in April and May, likely because of a crash in charter customer demand due to COVID-19 restrictions.

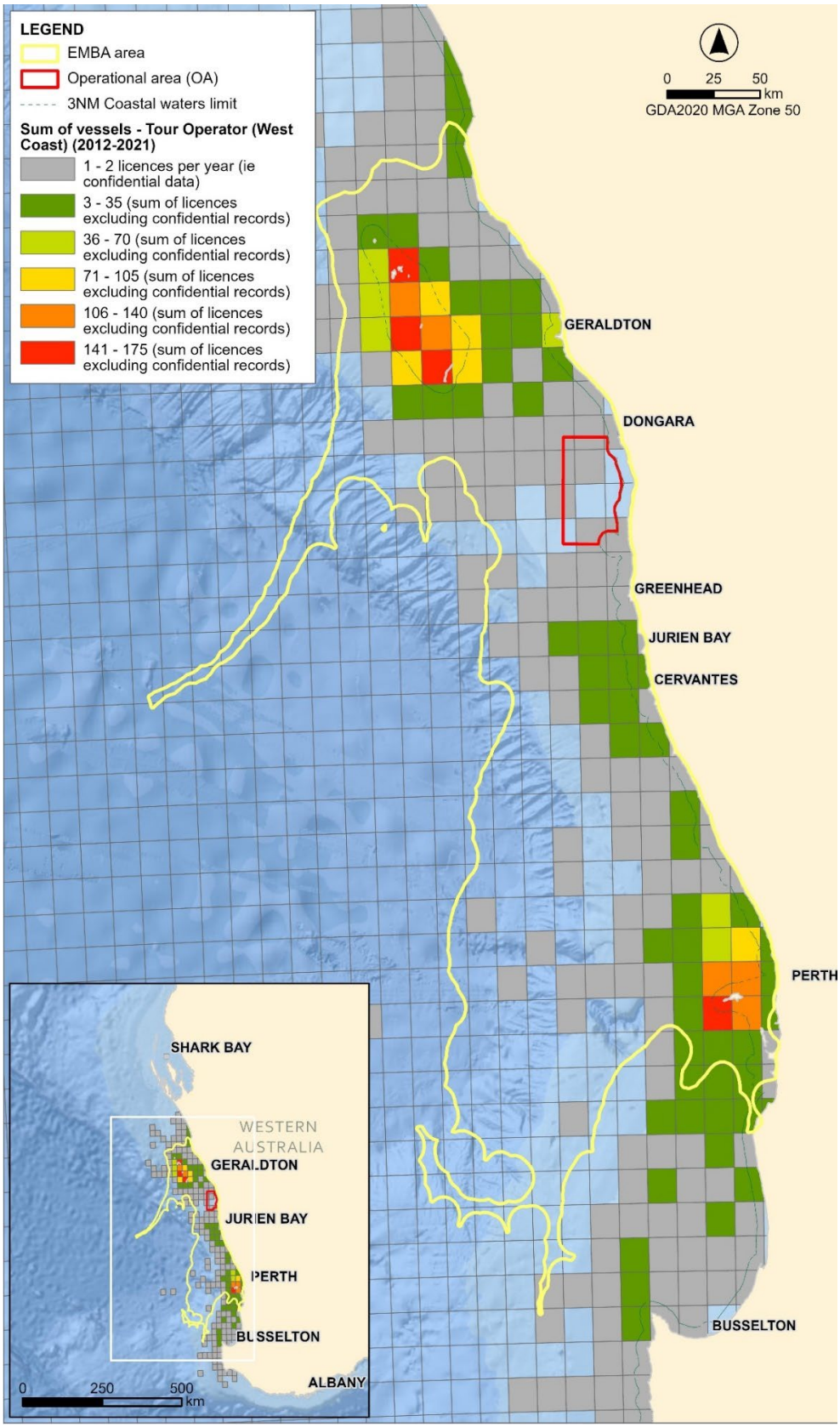


Figure 4-37: Spatial distribution and sum of annual licence counts (excluding confidential records) in 10 × 10 nm CAES blocks recorded in the TOFWC for 2012–2021 combined

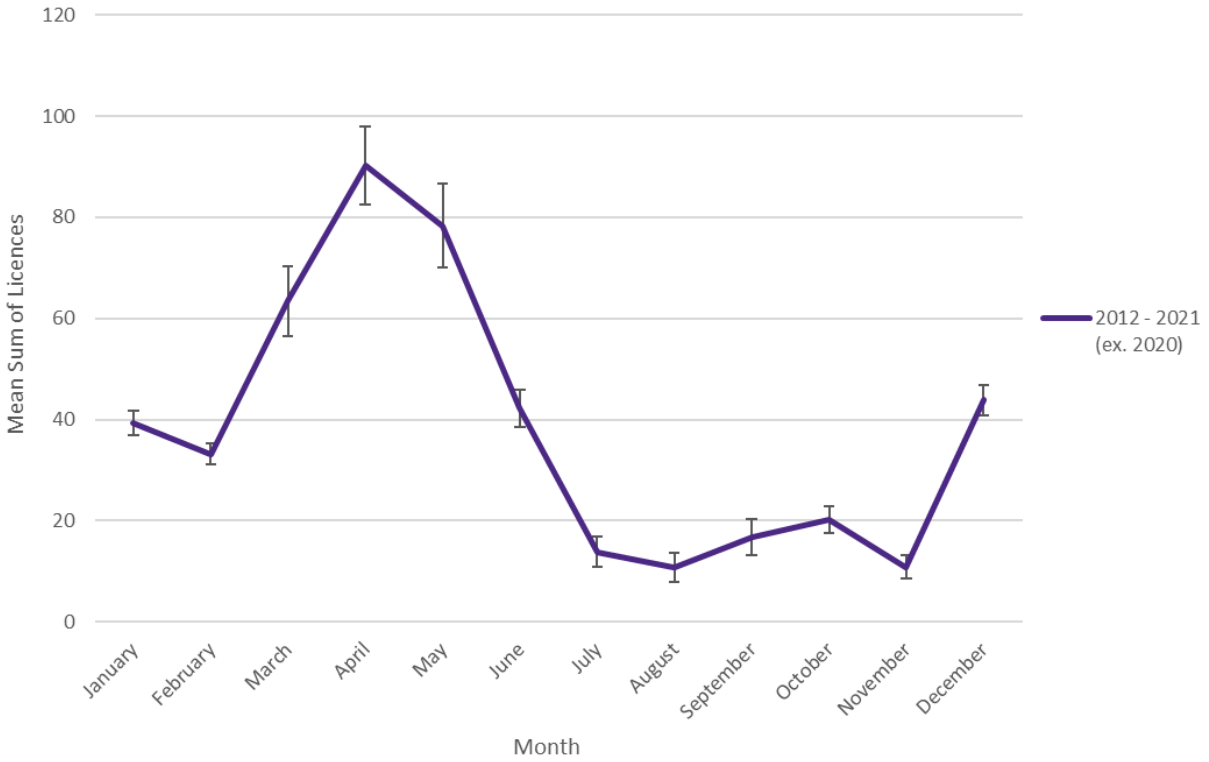


Figure 4-38: Mean monthly sum of licences (excluding confidential records) in 10 × 10 nm CAES blocks recorded in the TOFWC for 2012–2021 combined, excluding 2020

4.4.5 Oil and gas activities

The region currently only supports the Triangle Energy operated petroleum production operation (Cliff Head Development) in Production Licence WA-31-L. The Cliff Head Development wellhead platform is located within the Node Survey Area, and part of the Node Survey Area is crossed by the two pipelines (production and water injection, along with associated power cable and umbilical) that connect the platform to the Arrowsmith stabilisation plant onshore. The pipelines run ~10 km along the sea floor from the wellhead platform to the shore crossing, and are unburied, using the concrete coating weight and rock bolting to provide stability.

There is only one petroleum title adjacent to the proposed activity. WA-31-L is a production licence that partially overlaps the OA and its operator is Triangle Energy (Operations) Pty Ltd.

It is not considered feasible that other seismic surveys will take place in the region during the time of the Eureka 3D MSS. The last 3D MSS undertaken in the area was in February to May 2013 — the Geelvink 3D MSS and the Turtle Dove Ridge 3D MSS for Murphy Australia Oil (refer NOPIMS). There have been no 2D surveys acquired in the area in the region since 2013.

4.4.6 World and national heritage areas

World heritage sites are natural or manufactured sites, areas, or structures recognised as being of outstanding universal value by the United Nations Educational, Scientific and Cultural Organization (UNESCO). There are no world or national heritage sites within the OA or EMBA. The closest world heritage property (WHP) to the OA is the Shark Bay WHP, located ~300 km north of the OA.

Australia's National Heritage List contains natural, historic, and Indigenous places of significance to the nation and are protected under the EPBC Act (DoEE 2023). One marine Commonwealth heritage listed place occurs within the EMBA: the *Batavia* Shipwreck Site and Survivor Camps Area 1629 – Houtman Abrolhos. The *Batavia* Shipwreck Site was listed for

values meeting Category A, C, D and G of the Commonwealth Heritage List criterion (DoEE 2023). *Batavia* is located approximately 117 km northwest of the OA.

The *Batavia* is the oldest of the known Verenigde Oost-Indische Compagnie wrecks on the WA coast, wrecked on 4 June 1629. The wreck is relatively undisturbed and provides information on 17th century Dutch ship building techniques, while the remains of the cargo carried by the vessel have provided economic, and social evidence of the operation of the Dutch port at Batavia (now Jakarta) in the early 17th century (DoEE 2023). The wreck of the Batavia occurred after a long and arduous voyage where considerable hardship had already been experienced by the passengers and crew, the survivors reaching Beacon Island. The mutiny and massacre that followed the wreck of the vessel remain unparalleled in Australian maritime history. Archaeological evidence indicates that the two ruined 'huts' on West Wallabi Island are the oldest structure built by Europeans on the Australian continent. The mutineers Wouter Loos and Jan Pelgrom de Bye were left on the mainland and are consequently regarded as the first known European residents of the Australian continent.

4.4.7 First Nations cultural heritage

Archaeological evidence indicates that humans have occupied the Australian continent for at least 50–65,000 years, with the Kimberley region potentially the first area to be inhabited (Clarkson et al. 2017, Hayes et al. 2022). This long period of continuous occupation has allowed for the development of considerable cultural value and significance across the land and seascape. During this time First Nations peoples have experienced dramatic change in their landscape due to sea level rise at the end of the Pleistocene ice age, with sea levels stabilising at around their current levels around 9,000 years ago. Archaeological records of habitation by First Nations groups in south-west WA date back to at least 47,000 years ago (DPC 2018). There are extensive registered culturally significant sites along the coastal margins of south-west WA and cultural values in the land and Sea Country. There are also considerable intangible cultural heritage values associated with the Sea Country, in stories and songlines of creation spirits for Noongar nation groups (including Yued, Whadjuk and Gnaala Karla Boodja groups) and the Yamatji people, which have been confirmed through research and/or consultation. Undersea cultural heritage values have been the subject of some recent discoveries in the Pilbara region of WA (Benjamin et al 2023), though this is a new field of research with few sites discovered nationally. There are currently no records of inundated tangible cultural heritage values in the shallow coastal areas of southwest WA but limited research has been undertaken.

Pilot has engaged with relevant First Nations groups including Registered Native Title Bodies Corporate (RNTBC), registered Aboriginal corporations, and identified traditional owner groups to help identify relevant cultural heritage values in and adjacent to the OA and EMBA. Pilot has also conducted a search of existing registered Aboriginal Cultural Heritage sites, native title claims and Indigenous Land Use Agreements (ILUAs) in operation for the OA and EMBA. Pilot has investigated the documented cultural heritage values associated with development of management plans for Commonwealth and State Marine Parks and any Indigenous Protected Area programs within the project area. Pilot has also searched publicly available anthropological studies for evidence of intangible cultural heritage values associated with songlines and ceremonial knowledge across the Sea Country of the relevant language groups and traditional owners of the project area.

4.4.7.1 Native Title and Indigenous Land Use Agreements

The Yamatji Nation Agreement Indigenous Land Use Agreement (ILUA: WI2020/002), identifies Southern Yamatji as traditional owners of the area as represented by Yamatji Marlpa Aboriginal Corporation (YMAC). This ILUA extends seaward between 4–12 nm of the coast from just north of Leeman to over 100 km north of Geraldton and overlaps with the OA, bordering with the Yued ILUA area (WI2015/009) (Figure 4-40).

There is geographical overlap between the Operational Area and the Yamatji Nation Indigenous Land Use Agreement (ILUA) area. However, the ILUA's obligations under the Native Title Act 1993 (Cth) primarily bind the Western Australian Government and Yamatji Nation entities, and do not impose direct compliance requirements on petroleum titleholders for activities governed by the Offshore Petroleum and Greenhouse Gas Storage Act 2006 (Cth). All consultation obligations under the OPGGS (Environment) Regulations 2023 continue to be addressed through the EP's existing stakeholder engagement processes.

The Yamatji Nation claim is made up of five claimant groups – Hutt River, Southern Yamatji, Yamatji Nation, Mullewa Wadjari and Widi Mob. The Yamatji People are represented by the Bundi Yamatji Aboriginal Corporation, Yamatji Southern Regional Corporation and the Yamatji Marlpa Aboriginal Corporation. A Yamatji Proponent Standard Heritage Agreement (YPSHA) is in place between TEO and Yamatji Southern Regional Corporation as of February 2021.

The Yued ILUA is part of the South-West Native Title Agreement (SWNTA) and subsequent *Noongar Recognition Act 2016*, which has resolved the single Noongar native title claim for a package of land grants, rights and financial value This agreement extinguishes native title rights for this area. The identified Yued ILUA borders with the Southern Yamatji country near Leeman, and extends 3 nm into Sea Country, extending southward to an area immediately south of Guilderton (Figure 4-40). The EMBA also overlaps with Sea Country areas of the Whadjuk Noongar ILUA and Gnaala Karla Boodjah ILUA (Figure 4-40), both part of the SWNTA.

A search of the National Native Title Tribunal (NNTT) Register identified that the OA overlaps of 96 km^2 with the Yamatji Nation Native Title Determination. The EMBA overlaps the Yued Native Title Determination and the Whadjuk people Native Title Determination. The OA is located within the Geraldton Representative Aboriginal, Torres Strait Islander body (RATSIB) area (Yamatji Marlpa Aboriginal Corporation), while the EMBA overlaps the Geraldton and South-West (Native Title Services Goldfields) RATSIB areas.

4.4.7.2 Cultural values of Commonwealth and State Marine Parks and Indigenous protected areas

There are considerable ecological values and cultural values identified within the following National Reserve areas which all overlap with the project EMBA. The listed Australian and State Marine Parks (Section 4.4.1) document traditional owner groups and continued cultural practises of these groups for the identified Sea Country areas. The WA Government is in the process of developing Joint Management arrangements for all national parks and marine parks in WA, which identify cultural values and traditions as well as developing local Indigenous rangers as part of the management program. The Southern Yamatji people are currently consulting on the development of an Indigenous Protected Area (IPA) at the Houtman Abrolhos Islands and have commenced drafting their Sea Country Management Plan. The IPA consultation area is off Geraldton on the central west coast of Western Australia, and includes the Abrolhos Islands, an important seabird breeding site, and the Hutt Lagoon System, an ecologically significant wetland system. IPAs constitute over 50% of the National Reserve System and are designed to protect ecological and cultural values with a combination of traditional knowledge and western science conservations practises.

4.4.7.3 Cultural heritage sites

In database searches there are no known registered sites of Indigenous cultural heritage significance within the OA; however, 37 sites were determined using the Aboriginal Heritage Inquiry System. Of these 37 sites, only 18 are below the high-water mark (HWM) and therefore within the EMBA. The closest known Aboriginal sites to the OA are the Registered Aboriginal Sites 18907 (Irwin River, SC04) and 5280 (Leander Point), both approximately 6 km east of the OA (Figure 4-40). Pilot also recognises that the Beagle Islands have also been submitted as a site of cultural heritage by the Wattandee Littlewell Aboriginal Corporation (WLAC) to the Aboriginal Heritage Committee, though this is not reflected on the ACHIS website at the time of submission. A search of 'Other Heritage Places' on the ACHIS highlighted another 60 heritage places within the EMBA, 37 of which are below the HWM. The closest 'Other Heritage' places to the OA are the Other Heritage Places 5918 (Irwin River) and 5574 (Cliff Head), both approximately 6 km east of the OA. These sites include ceremonial areas, burial sites, camp sites and middens and other areas of significance. There are extensive cultural heritage values associated with the area around Rottnest Is (Wadjemup), Garden Island (Meeandip), Fremantle (Walyalup) and Carnac Is for Whadjuk and Bindjareb Noongar peoples. There are no published surveys or listed sites for undersea cultural heritage places within the OA or the project EMBA.

Sea Country values and intangible cultural heritage.

There are many anthropological studies of the extensive Sea Country knowledge and cultural values held within songlines, creation (dreamtime) stories and ceremonial practises for coastal and Sea Country First Nations groups (i.e., Bradley et al. 2010). For the area within the project OA and EMBA, Pilot discovered several publicly available texts identifying Sea

Country values, songlines, and totemic animals for the First Nations groups in question. There is also a record of Sea Country cultural values that were identified during consultations with First Nations groups (Table 4-17).

Sea Country values for Whadjuk Noongar people around Fremantle (Walyalup) were identified in the cultural mapping project, Mapping Walyalup Boodja (Collard et al. 2021 Figure 4-39). A depiction of the cultural values identified for this area shows songlines and cultural sites for the area, some of which correspond with the identified cultural sites in Figure 4-40. These include the island sites of Garden Is, Rottnest and Carnac Is, as well as songlines linking the nearshore islands with the mainland as well as routes of land bridges between Rottnest Is and current mainland from oral histories. This project highlights the strong cultural connection of Whadjuk Noongar to these areas and the continued cultural practises and stories for this area.

Discussion with members of the Kwelena Mambakort Wedge Island Aboriginal Corporation (KMAC) have identified their interests for the Sea Country around Wedge Island (within the Yued ILUA area) and within the EMBA, with the presence of both songlines and totemic species identified for the group. Discussion with members of WLAC have identified important cultural areas and heritage around the Irwin River mouth, the Beagle Islands and adjacent Sea Country. Pilot Energy acknowledges and recognises the totemic species: Sea Lion, Shark, Dolphin, Whales and their spiritual and ecological significance to WLAC peoples and Elders and the sacred sites and Dreaming tracks across the shelf and marine zones.

They have identified strong cultural connections to sea lions in Irwin River mouth and suggested that a songline regarding sea lions is shared along the coast amongst different tribes. However, there was no identification of who the knowledge holders of this songline would be for that area.

Pilot Energy understands from WLAC that it has and will continue to make submissions to have cultural heritage registered under the Aboriginal Cultural Heritage Act 1972 (WA) and produce maps of these places. As part of ongoing consultation with all relevant persons, Pilot Energy will update this EP to reflect information provided by any Traditional Owner group to ensure ongoing recognition and acknowledgement of their cultural heritage values.

There are references to totemic animals and songlines associated with various animals in publicly available literature. Whadjuk Noongar people have strong affiliations with whales, Mamong transports people who have passed, back to the spiritual world (Wadjemup Whadjuk Booja n.d). Outside of the project EMBA south coast Noongar people, Wirloman clan of the Minang Noongar people, have strong affiliations with Sea Country and documented creation stories about ASLs (*Dwoortbaalkaat*), documented in a storybook by Scott (2013). Whilst there is no evidence of the connection of this story through songlines to clans on the west coast (Whadjuk and Yued peoples), early explorers documented the customary use of seals and sea lions by First Nations groups (King 1826).

These resources and consultations have highlighted that Sea Country cultural values for First Nations groups are known throughout the project EMBA. A summary of the cultural values for First Nations groups, and potential presence within the EMBA, is in Table 4-17. Note that relevant persons have requested that information provided during consultation is not publicly shared, therefore not all information provided in consultation is included in the table below.

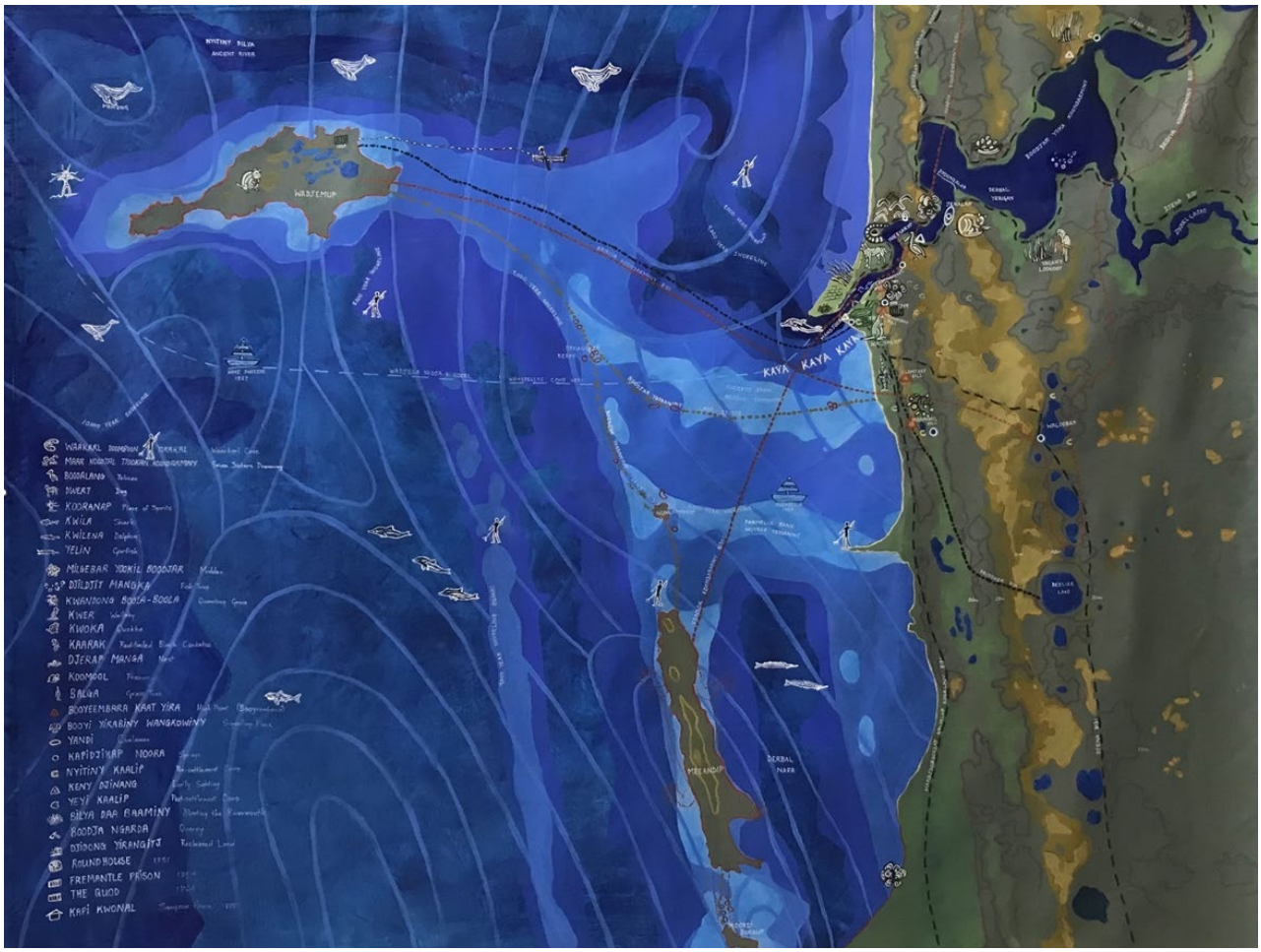


Figure 4-39: Sea Country cultural values around Sea Country of Whadjuk Noongar. Reproduced from Mapping Walyalup Boodja (Collard et al 2021)

Table 4-17: Summary of likely cultural values in the OA and project EMBA based on desktop studies, heritage inquiries

First Nations group/native title claimant group	Cultural values	Source	Present in OA	Present in EMBA
Southern Yamatji	Cultural sites along coastal areas and in freshwater sites, associated cultural heritage values in Sea Country	ACHIS Inquiry, DPLH	Possible (unspecified)	Yes, listed cultural heritage sites exist
Yued Noongar	Cultural sites along coastal areas and in freshwater sites, associated cultural heritage values in Sea Country	ACHIS Inquiry, DPLH	Possible (unspecified)	Yes, listed cultural heritage sites exist
Whadjuk Noongar	Cultural sites along coastal areas and in freshwater sites, associated cultural heritage values in Sea Country Songlines and Sea Country cultural heritage	ACHIS Inquiry, DPLH Collard et al (2021)	No	Yes, Sea Country cultural values exist
Gnaala Karla Boodja	Cultural sites along coastal areas and in freshwater sites, associated cultural heritage values in Sea Country	ACHIS Inquiry, DPLH	No	Yes, Sea Country cultural values exist
Wattandee Littlewell Aboriginal Corporation	Sea lions are a totemic species with strong cultural values connected to sites and stories of them around Irwin River mouth, Beagle Island and surrounding waters, across the shelf and throughout their Sea Country. As well as sharks and whales being a species of cultural significance.	Relevant person consultation	Yes	Yes, Sea Country cultural values exist
Kwelena Mambakort Wedge Island Aboriginal Corporation	Sea Country values and totemic species including mullet, shark, dolphin, whales and abalone around Wedge Is.	Relevant person consultation	Yes	Yes, Sea Country cultural values exist

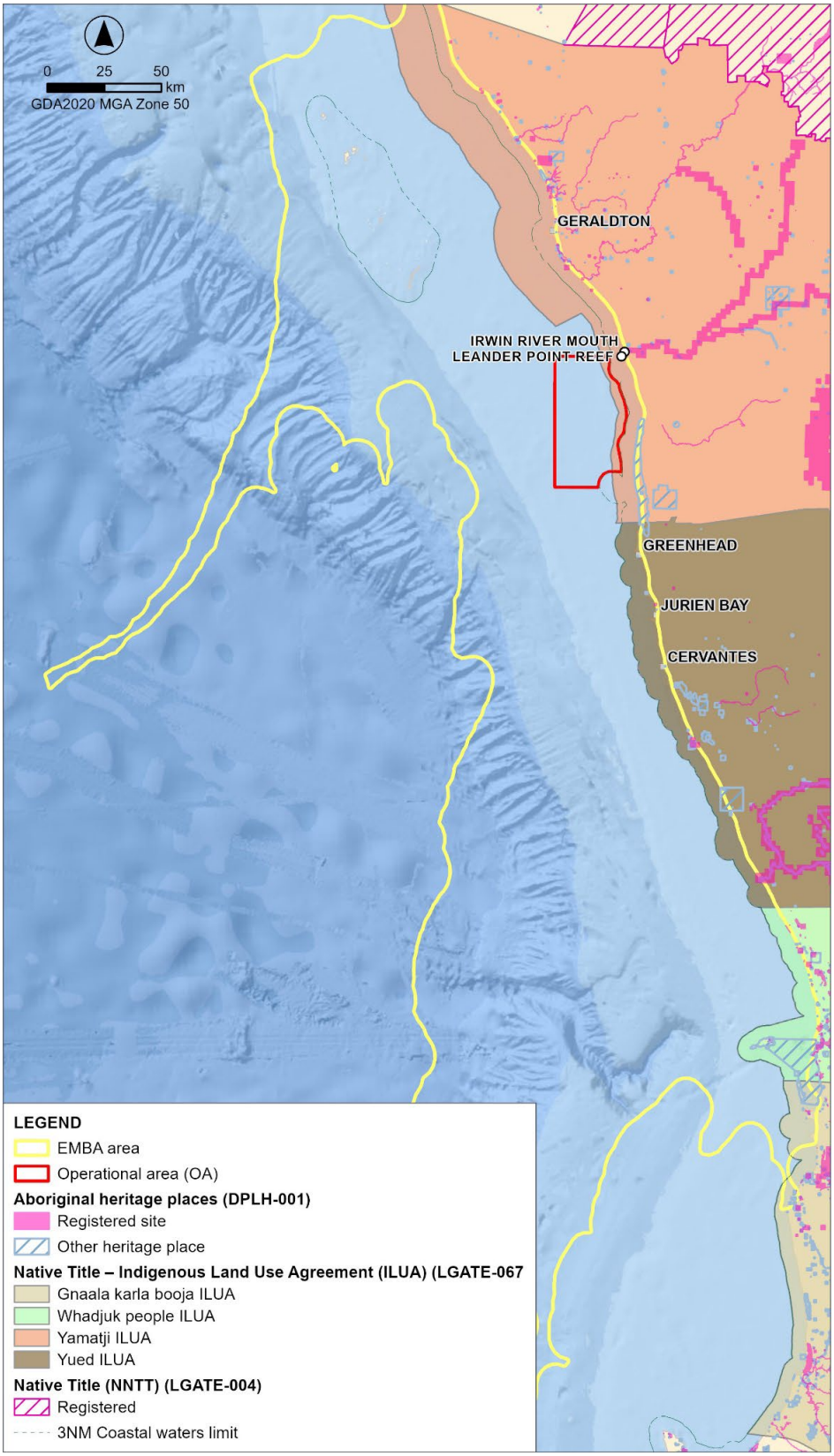


Figure 4-40: Native title and cultural heritage areas in and adjacent to the OA and EMBA

4.4.8 Ramsar wetlands

The Ramsar Convention on Wetlands is an intergovernmental treaty that aims to conserve wetlands of international importance. Ramsar wetlands are recognised as a matter of national environmental significance under the EPBC Act (DoEE 2021a). No Ramsar wetlands occur within the OA or EMBA. The closest Ramsar wetlands is the Peel-Yalgorup System, approximately 400 km south of the OA and beyond the EMBA.

4.4.9 Marine archaeology

All shipwrecks more than 75 years old are protected under the *Underwater Cultural Heritage (Consequential and Transitional Provisions) Act 2018* (DAWE 2022). A search of the Australian Underwater Cultural Heritage Database (AUCHD) indicated that two known historic shipwrecks potentially occur within the OA: the *Leander* and the *Era* near Dongara (Table 4-18). The Western Australian Museum (2024) advise that the Leander's exact location has never been found but approximate co-ordinates are provided in the Australian Underwater Cultural Heritage Database (AUCHD). Discussion in a gazette in 1853 (WAM, 2024) implies that the location may be closer to shore than the AUCHD co-ordinates indicate. The Era shipwreck is just the mast and bowsprit which blew off the ship in a storm in 1934 but ship itself was not sunk until 1958 in Shark Bay. Neither are listed as a Protected Place under the EPBC Act. A further eight known historic shipwrecks were identified near the OA: the *Swan, Sea prince, Saint Mary, Gussie, Stanford, Carlton, Jessie Edwards, Cambewarra* and two unidentified vessels (Table 4-18). A search using the AUCHD (2021) indicates a further 227 known historic shipwrecks within the EMBA (Figure 4-41).

Table 4-18: Recorded shipwrecks within and near the OA

Vessel name	Year wrecked	Wreck location	Distance from OA
Leander	1853	Dongara	Within OA
Era	1934	Dongara	Within OA
Swan	1869	Dongara	5 km east
"Unidentified whaler"	1867	Dongara	5 km east
Sea prince	1932	Dongara	5 km east
Saint Mary	1905	Leeman	10 km south
Gussie	1909	Dongara	10 km north
Stanford	1936	Geraldton	20 km northwest
"Unidentified ship"	1851	Geraldton	20 km northwest

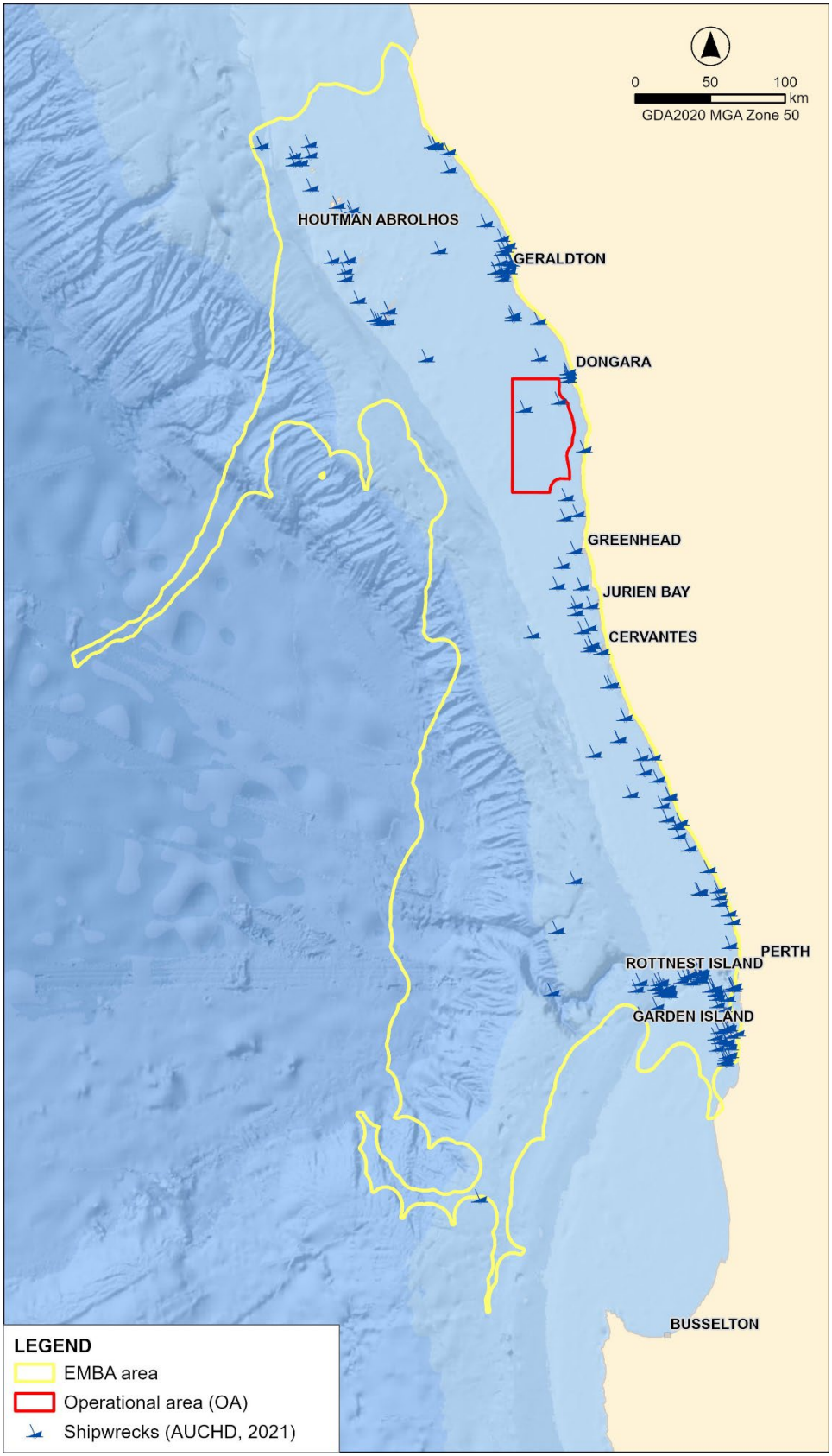


Figure 4-41: Recorded shipwrecks within the OA and EMBA (AUCHD, 2021 database)

4.4.10 Commercial shipping

The Southwest offshore region facilitates several major port facilities, including the state's busiest general cargo port (Fremantle), a potential land backed port (Westport) in Kwinana, as well as the Royal Australian Navy's largest base (HMAS Stirling) on Garden Island (Newman et al. 2023). Geraldton is the closest major port to the OA (approximately 50 km north); however, shipping also occurs from Dongara/Port Denison (approximately 6 km east of the OA). Vessels transiting the region during the proposed survey will primarily include bulk carrier ships (e.g., iron ore, grain, mineral sands, and alumina) and general cargo ships. The western side of the OA intersects with a shipping fairway; however, there is limited traffic through the OA (Figure 4-42). There are many smaller ports and public boat ranges along the coast within the EMBA, with those located at Dongara being close to the OA (approximately 6 km east). The impacts from vessels and ships tend to be concentrated around ports and favoured anchorage areas. The activity is limited to the months of February and March, so analysis of the craft tracking system is narrowed to this period.

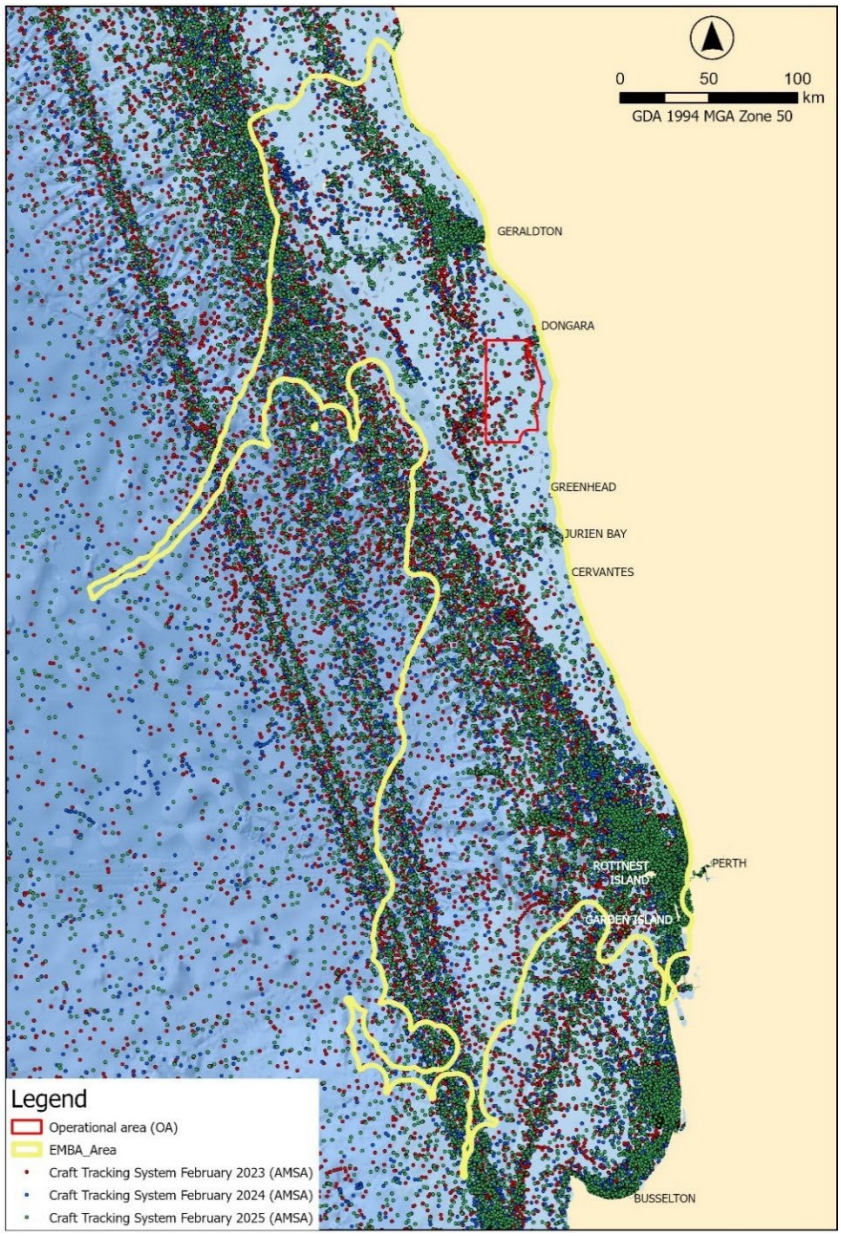


Figure 4-42: Commercial shipping tracks within and adjacent to the OA and EMBA

4.4.11 Communication

There are no telecommunication cables that run through the OA. The EMBA overlaps multiple telecommunication cables that run out of Perth, including telecom cables (2018), telecommunications submarine cables (Fusion) and global submarine cables (Figure 4-43). The closest telecommunications cable to the OA is the ≤900 global submarine cable (approximately 100 km south-west of the OA).

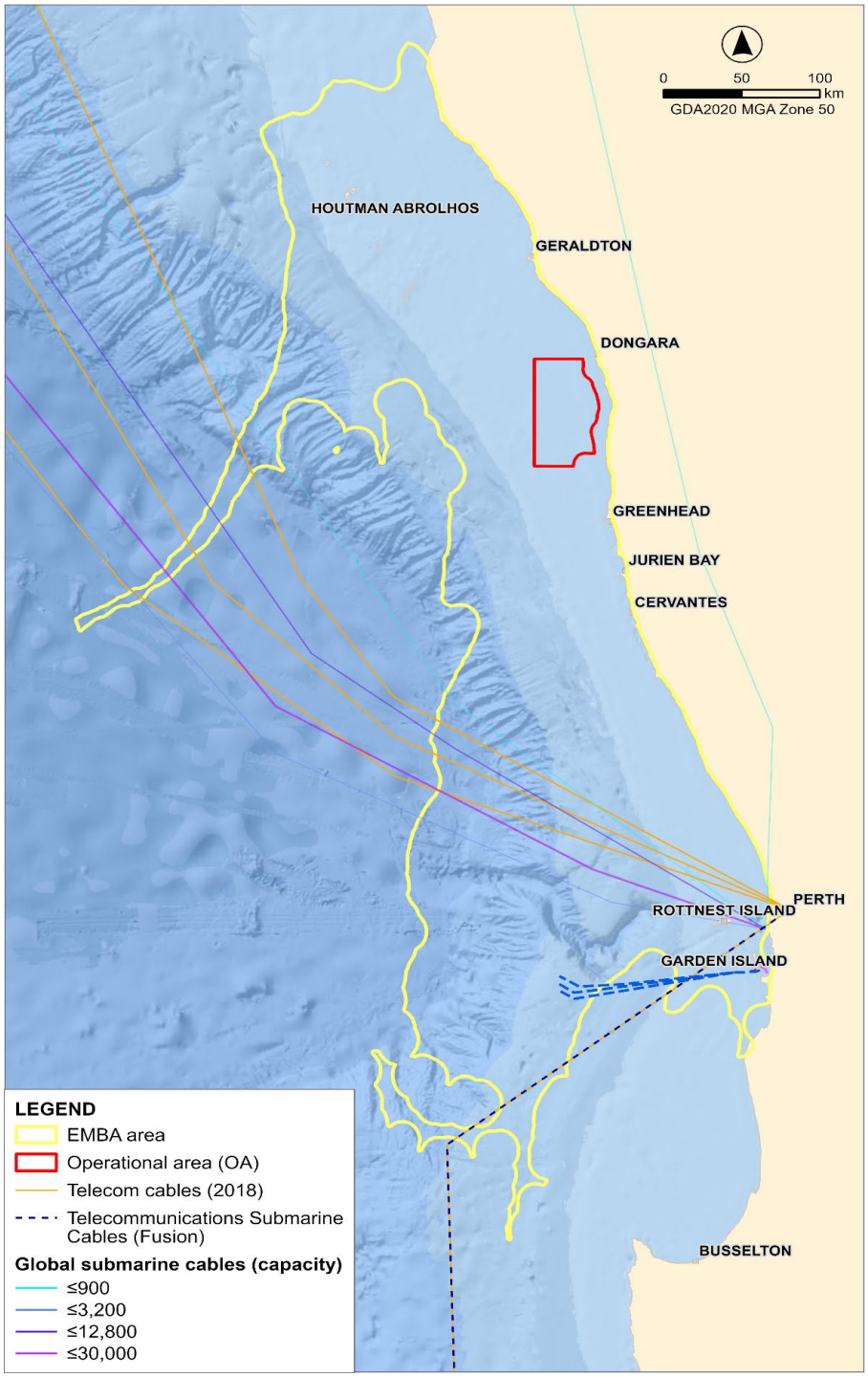


Figure 4-43: Communication lines overlapping the EMBA

4.4.12 Defence activities

The Department of Defence (DoD) operates military firing practice and exercise areas at several locations around Australia. There are no designated defence practice areas within the OA. The closest designated Defence activity area to the OA is the Western Australia Exercise Area (WAXA) approximately 40 km south-west of the OA. The onshore Lancelin Defence Training and Practice areas are located within the EMBA approximately 160 km south of the OA (Figure 4-44).

A search of the Department of Defence's unexploded ordnance (UXO) map indicated no UXO areas within the OA; however, four potential sites within the EMBA. The closest potential UXO area to the OA is located at Geraldton Seaward (50 km north of the OA: "Other"). The other potential sites include Jurien Bay Bombing Range ("Other"), RAN Gunnery Range Lancelin (approximately 160 km south of the OA; "Substantial Potential"), Moore River RAAF Armament Range ("Other") and Rottnest Seaward Firing (approximately 250 km south of the OA; "Slight Potential") (Figure 4-44) (AGDD 2023).

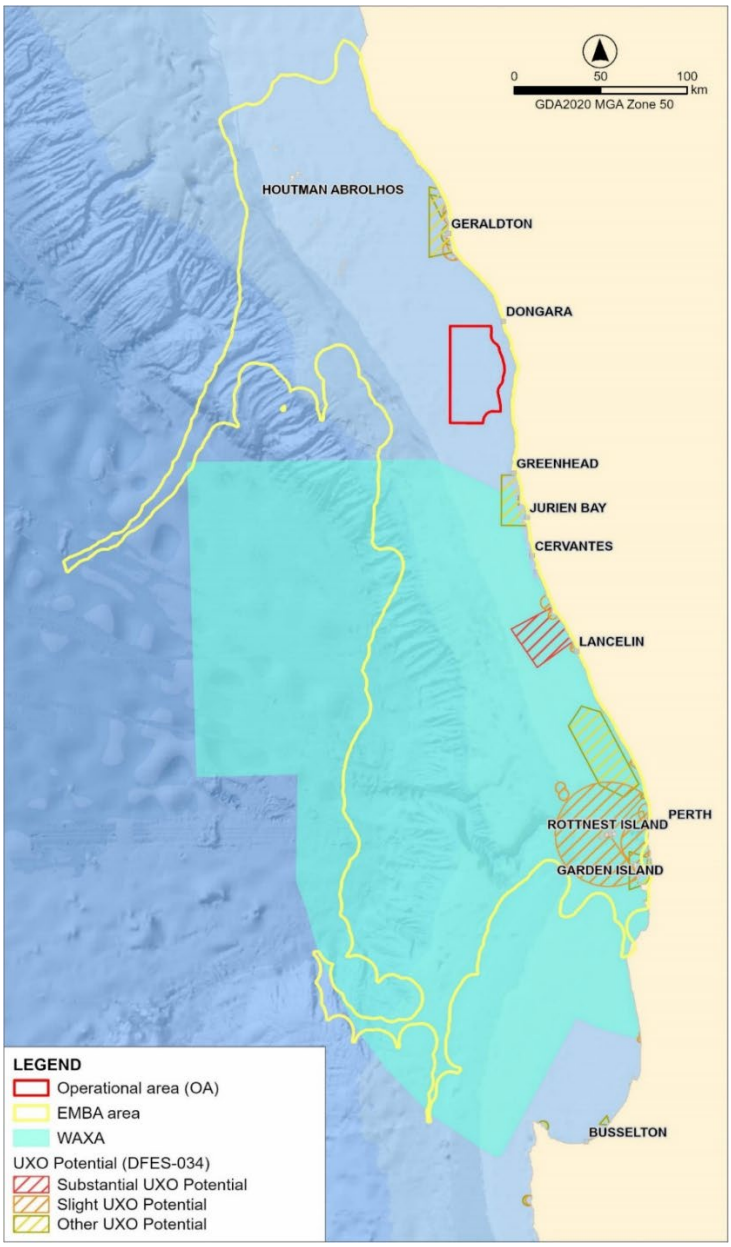


Figure 4-44: Defence areas adjacent to the OA and overlapping the EMBA