# Data layers and metadata to assist in the selection of candidate marine protected areas in the South-east Marine Region

**Prepared by:**

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# Contents

# 1. Introduction

This is the second edition of supplementary information to assist in the identification of options for candidate marine protected areas (MPAs) in the South-east Marine Region (SEMR) (see Figure 1). The primary document guiding this process is '*Australia's South-east Marine Region: A user's guide to identifying candidate areas for a regional representative system of marine protected areas'* http://www.deh.gov.au/coasts/mpa/southeast/index.html

In updating this supplementary information, the South-east MPA Scientific Reference Panel[1], stakeholders and other interested parties were invited to comment on the first edition and to nominate any other information they considered useful to the MPA design process. The Reference Panel will have an ongoing role in interpreting and assessing the validity of existing and new information available to the MPA design process over time.

The data has come from a range of sources and is presented as maps with accompanying metadata. The metadata describes the data's origins and known limitations. It is important to consider the metadata to ensure the data is being used in an appropriate way. **These data are not comprehensive** and there are resources that have not been accessed due to time constraints.

This supplementary information shows the potential spatial distribution of some pelagic and seabird species that are known to occur in the region as listed in the 'additional factors flora and fauna conservation' column in Appendix E of the User Guide. It also shows geomorphic features (Map 34) and seascapes (Map 35) for the shelf area that were not previously available in the IMCRA regionalisation.

In using this information, it is important to bear in mind that its key role will be to help refine the regional system of MPAs following the identification of MPA options largely on the basis of the primary specification (specification 1) – that is, to represent a sample of the unique features or bioregions as described in the geomorphic maps and listed in the descriptions of the bioregions and geomorphic characteristics in Appendix E of the User Guide. These bioregions are based on the best scientific understanding of surrogates for broad scale ecosystems and habitats based on bioregional assessments (nutrients, temperatures, depth, ocean currents, water properties, geological and geomorphologic data) and provide some basic understanding of the type of biological assemblages that might occur in a given area[2]. It is also important to consider other actions other than MPAs such as species-specific conservation measures that may help protect migratory and or highly mobile species that are not specifically associated with the site in question.

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[1] The South-east MPA Scientific Reference Panel is chaired by Dr Alan Butler of CSIRO Marine Research. Other members include Dr Peter Harris (Geoscience Australia); Dr Scott Condie, Dr Alan Williams, Dr Peter Last (CSIRO Marine Research); Dr Tim O'Hara (Museum Victoria); James Larcombe (Bureau of Rural Sciencies); Dr Colin Buxton (University of Tasmania).

[2] For further information on the use of surrogates for biodiversity please refer to page 7 of the User Guide.

The unpublished data currently held by CSIRO Marine Research (CMR), Hobart will at all times remain the property of the appropriate researchers (identified in the metadata) and has been provided in this document on the understanding that it will be only used for the process described above.

## 1.1 Format of maps

Most of the maps contained in this document are based on the map shown in Figure 1 which shows the broad areas of interest (BAOI), the EEZ, coastal waters boundary (3 nm), the edge of the continental shelf (200m isobath) and the continental shelf outside Australia's EEZ.

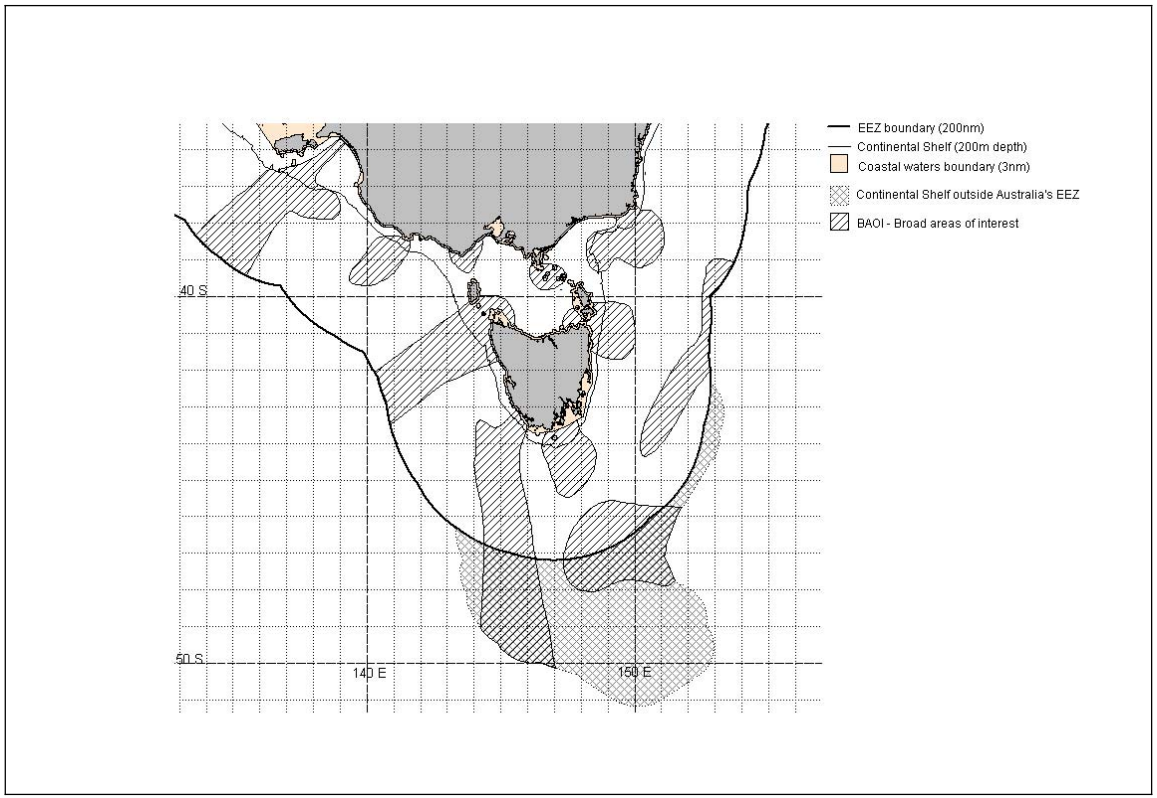



**Figure 1 Base map for the SEMR. The symbols used for the BAOI, EEZ and state jurisdictions are used throughout this report.**

# 2. Maps

## 2.1 Sea birds

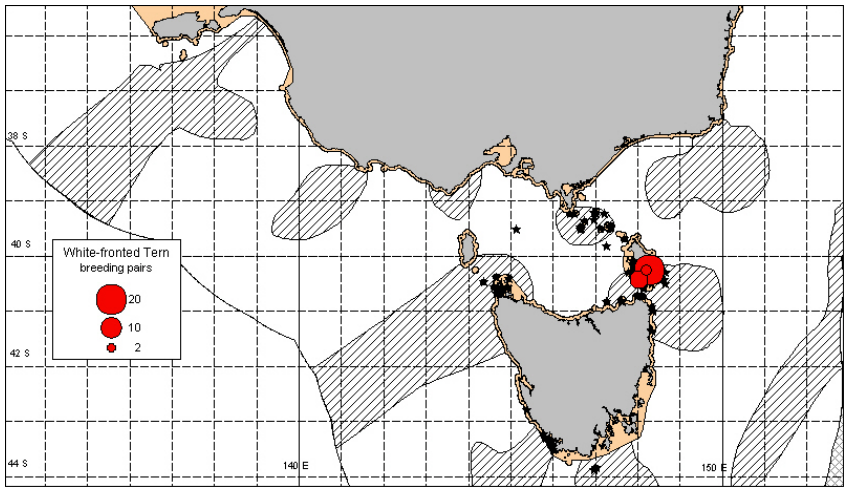
There has not been a comprehensive review of birds in the SEMR. The following maps were put together by CSIRO Marine Research to give some assistance in the process of selecting candidate MPAs in the SEMR generally considering only the regions in or near the BAOI. These maps are unpublished and hence have not been reviewed.

**Regions of high bird density**

Regions of high primary productivity appear to also be areas of high bird concentrations and likely feeding. These are regions such as the South Tasman Rise and St Helens Rise and along the shelf-break (leading to upwelling) (Reid *et al*. 2002). Other important regions for birds are the seasonally variable positions of the East Australian current, Leeuwin current and the subtropical front (see Figure 5).

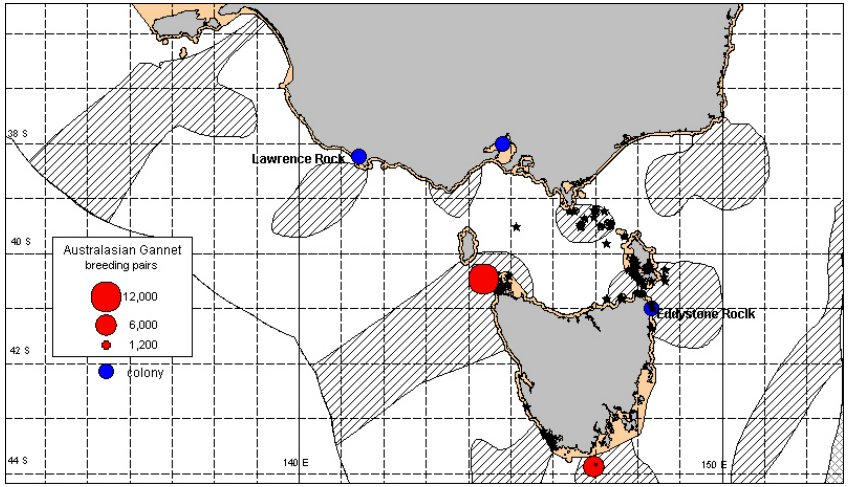
**Bird breeding sites**

Breeding sites located in or near the SEMR BAOI have been included for selected species. The islands considered for this exercise are indicated as black stars on the maps. The species were chosen based on the number of breeding pairs (≥ 1000) in the area, and/ or on the basis of their conservation status. The only exception is the white-fronted tern (see below). Data used for the Tasmanian offshore region was obtained from Brothers *et al.* (2001) (red circles on maps 1 through 11). Victorian and South Australian breeding sites for these birds were included where mentioned in the Seabird Atlas of South-eastern Australian Waters (Reid *et al*.2002), and other breeding sites where mentioned in the BAOI descriptions
http://www.deh.gov.au/coasts/mpa/southeast/index.html
(shown as blue circles on maps 1 through 11). Generally, little numeric data for seabird species is available.



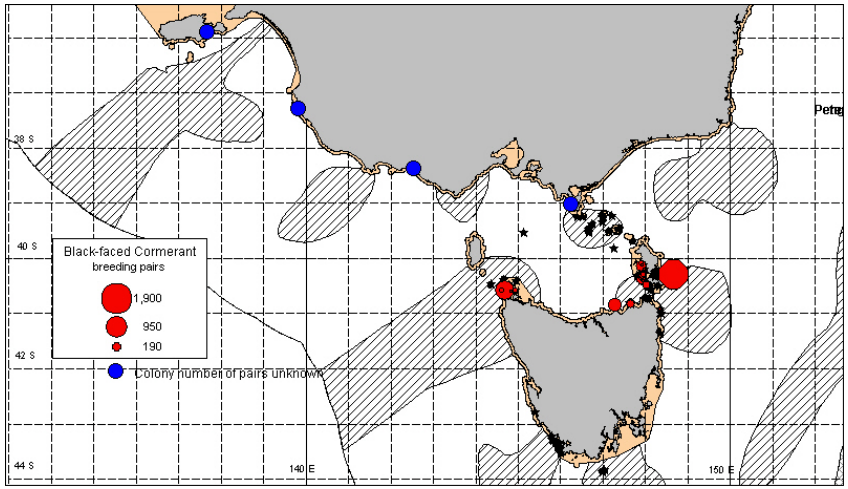

**MAP 1 White Fronted Tern**

The white fronted tern is included as it has only one breeding area within Tasmania.



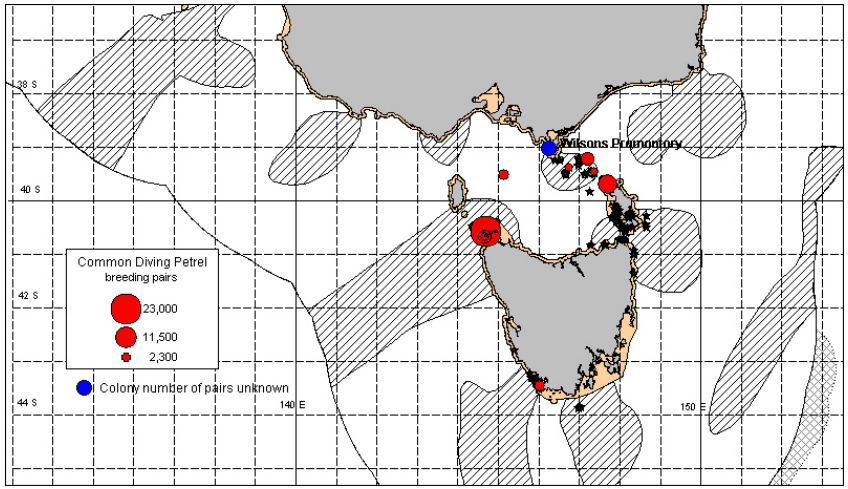

**MAP 2 Australian Gannet**

≥ 1000 breeding pairs



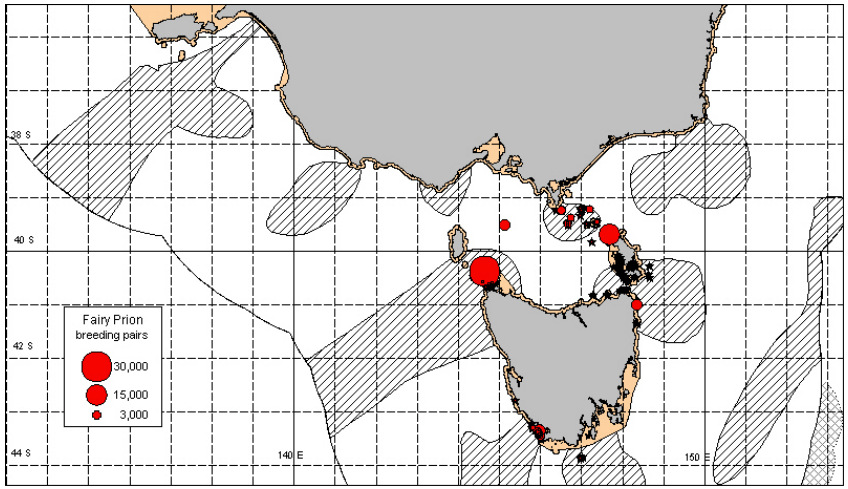

**MAP 3 Black-faced Cormorant**

≥ 1000 breeding pairs



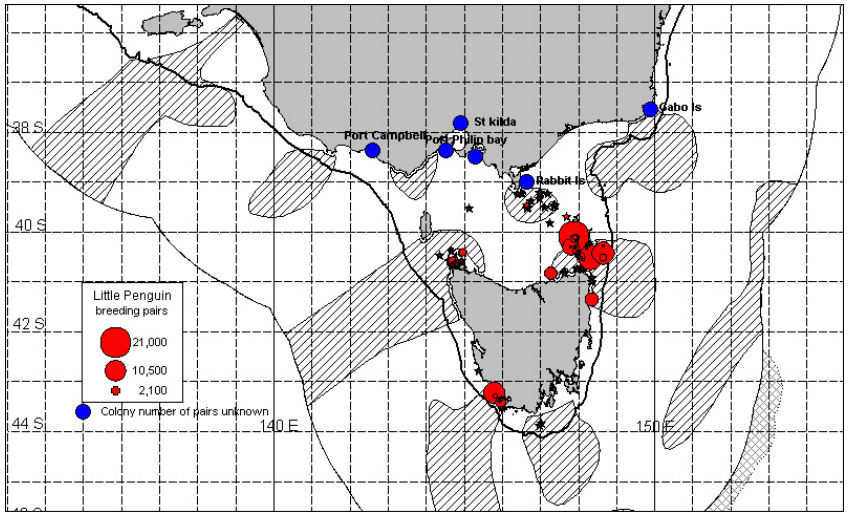

**MAP 4 Common Diving Petrel**

≥ 1000 breeding pairs



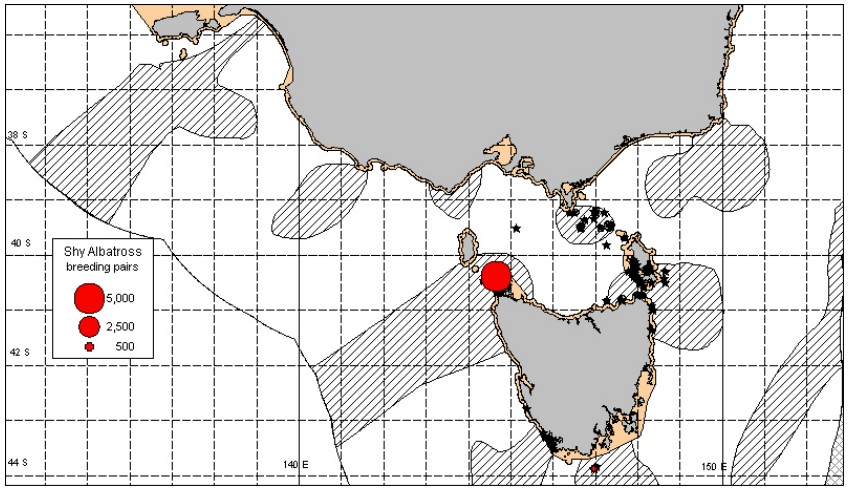

**MAP 5 Fairy Prion**

Endangered



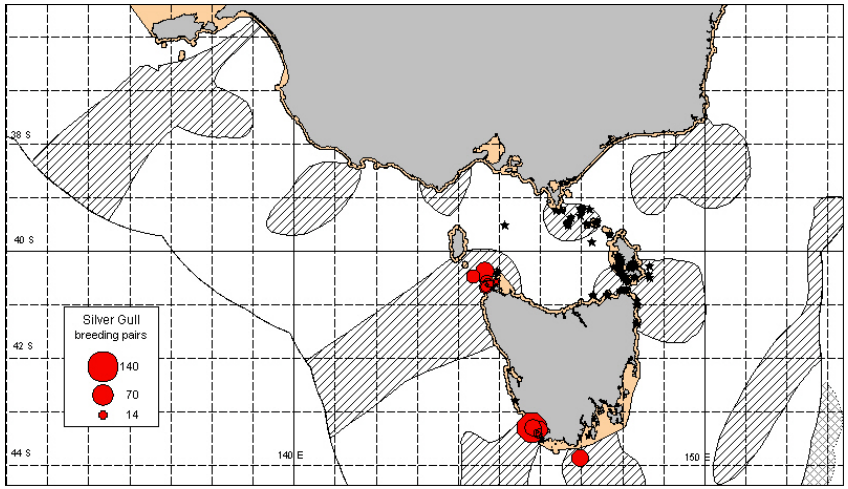

**MAP 6 Little Penguin**

≥ 1000 breeding pairs



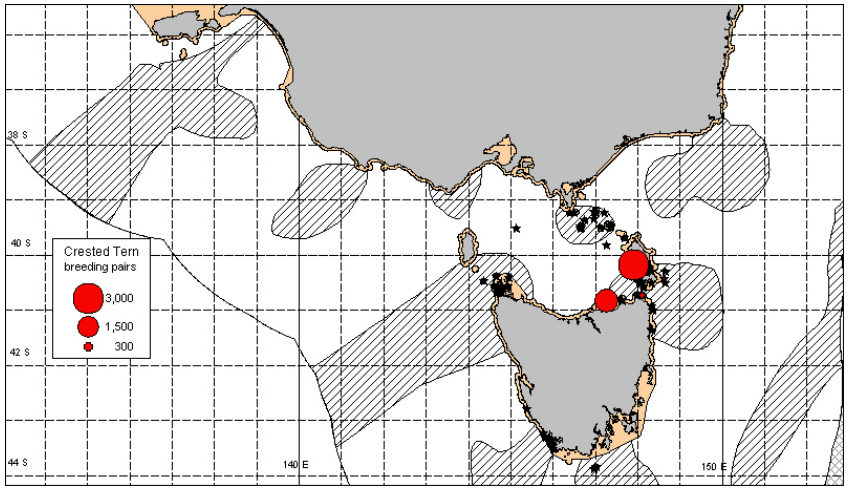

**MAP 7 Shy Albatross**

≥ 1000 breeding pairs



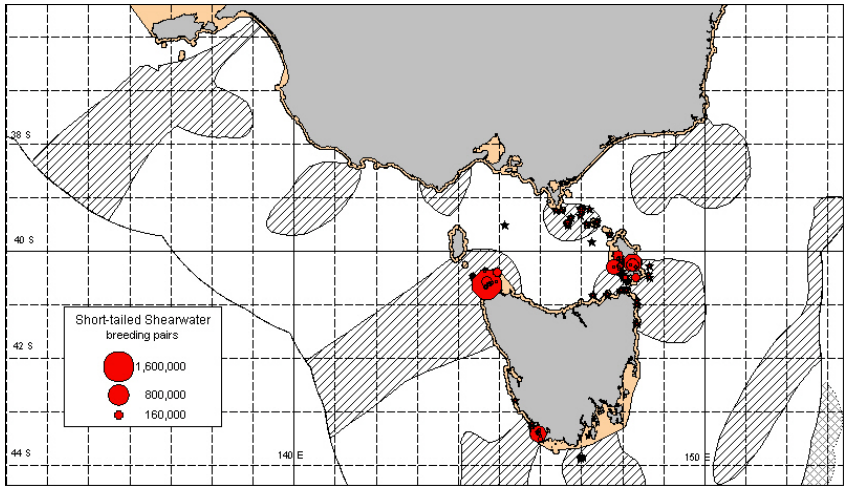

**MAP 8 Silver Gull**

≥ 1000 breeding pairs



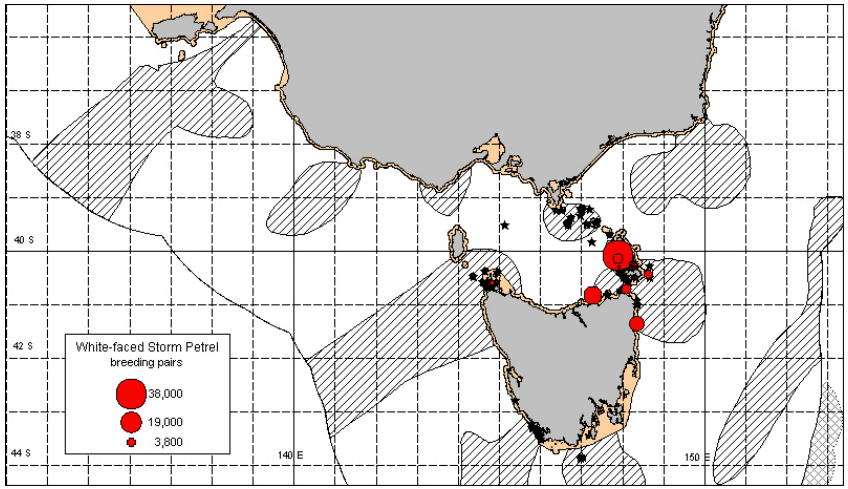

**MAP 9 Crested Tern**

≥ 1000 breeding pairs




**MAP 10 Short-tailed Shearwater**

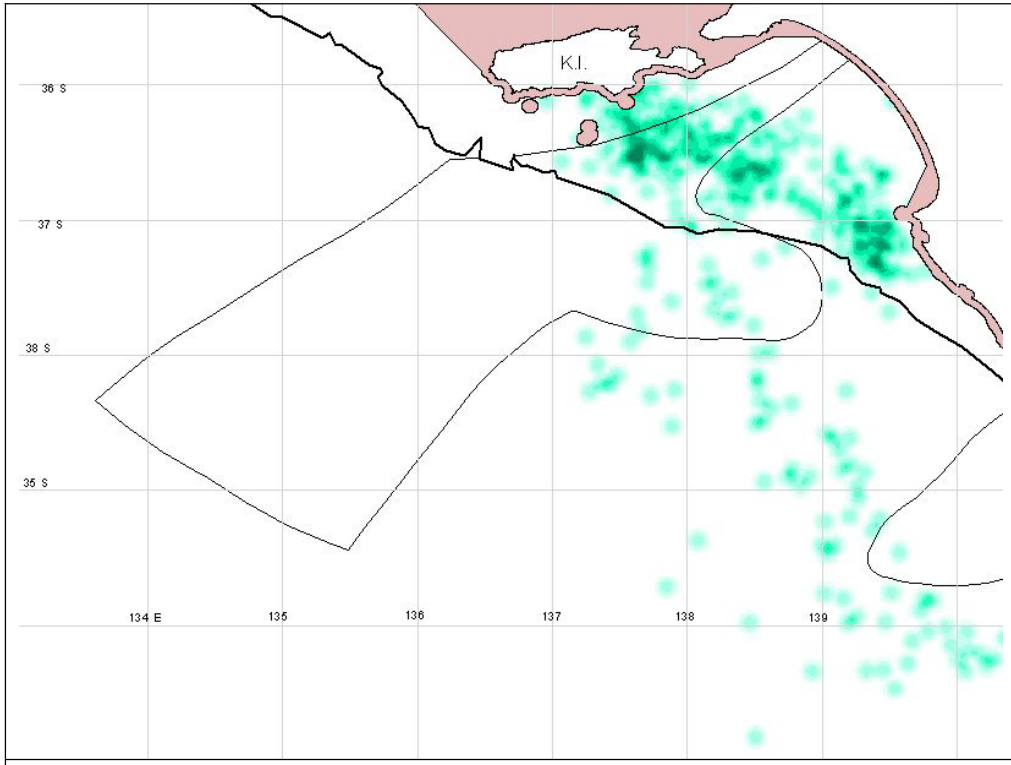
≥ 1000 breeding pairs




**MAP 11 White-faced Storm Petrel**

≥ 1000 breeding pairs

## 2.2 Australian sea lions




**MAP 12 Australian Sea Lions**
Interpolation map of records from satellite tracking of Australian sea lions, indicate their range and areas of higher activity (light green to dark green according to increasing density of recordings).

Sea lions feed benthically 40 –150 km S-SE of Kangaroo Island.

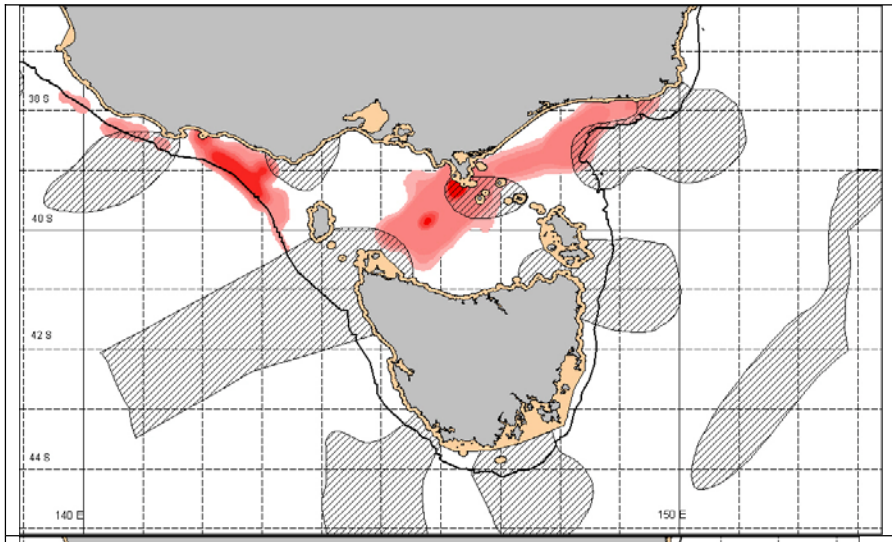
Most frequented regions……..least frequented
dark green……..…light green

Interpolation map produced by CSIRO from data provided by Brad Page, LaTrobe University, (pers. comm.).

## 2.3 Australian fur seals

Maps 13 and 14 are based on the preliminary analysis of data showing the foraging regions for female Australian fur seals for one season in one year. This data gives a reasonable guide to where Australian fur seals (females) from Victorian colonies are foraging. There are 5 other colonies in Tasmania but they account for <30% of the population. (John Arnould pers. com.)

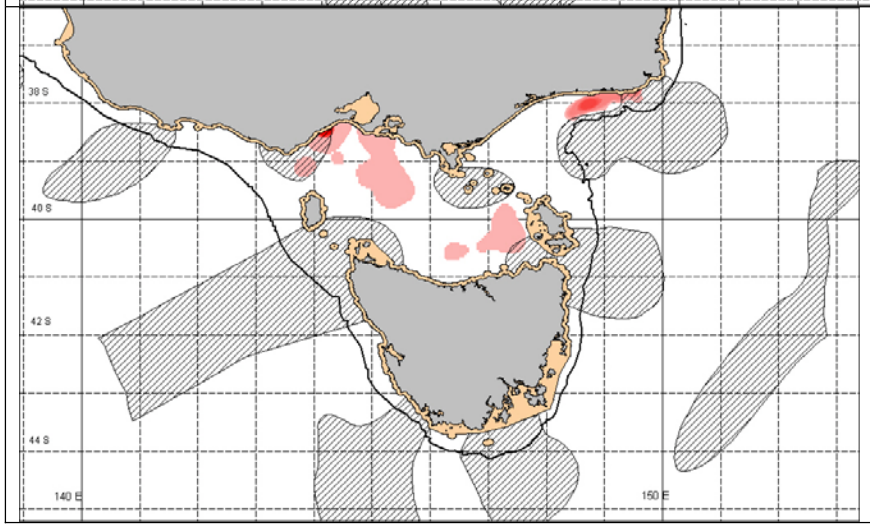
Data was provided to CSIRO Marine Research as shapefiles. Data belongs to John Arnould (University of Melbourne) and Roger Kirkwood (Phillip Island Conservation Park).




**MAP 13 Australian Fur Seals from Lady Julia Percy Island and Kanowna Island in winter 2002.**

Satellite telemetry for lactating female Australian fur seals from Lady Julia Percy Island and Kanowna Island. Highest density of locations indicated in dark red. The 200m isobath is shown.

Data belongs to John Arnould (University of Melbourne) and Roger Kirkwood (Phillip Island Conservation Park).

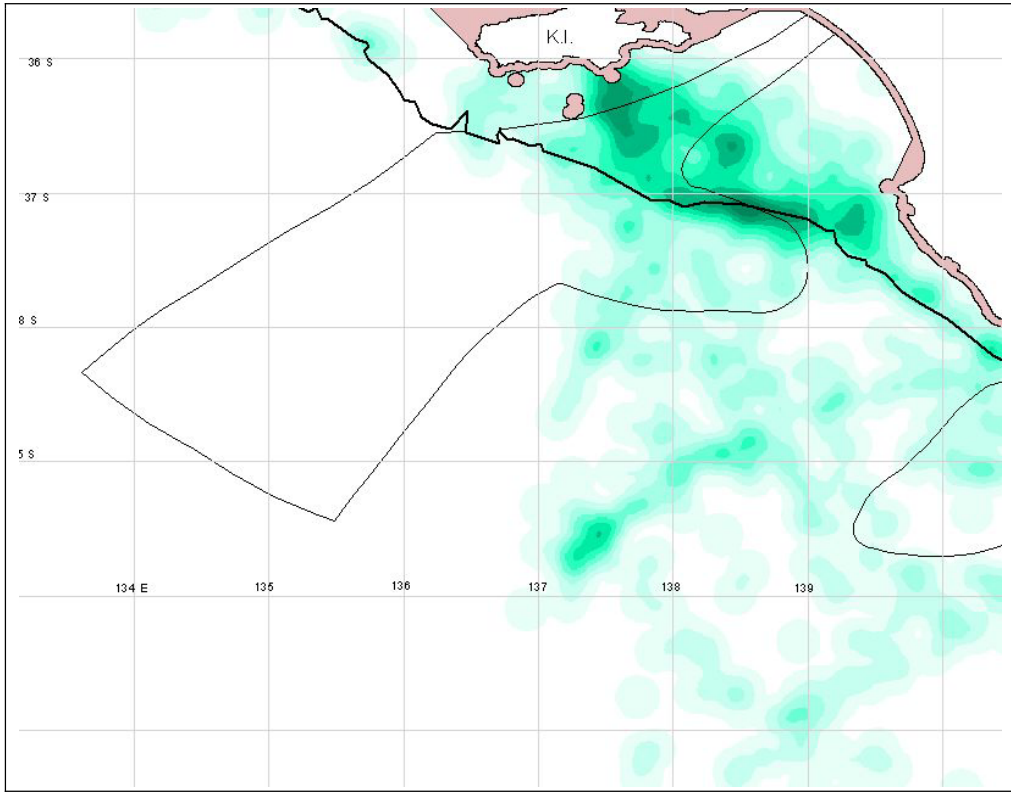



**MAP 14 Australian Fur Seals from Seal Rocks and the Skerries in winter 2002.**

Satellite telemetry for lactating female Australian fur seals from Seal Rocks and The Skerries. Highest density of locations indicated in dark red. The 200m isobath is shown.

Data belongs to John Arnould (University of Melbourne) and Roger Kirkwood (Phillip Island Conservation Park).

## 2.4 New Zealand fur seals




**MAP 15 Adult female New Zealand Fur Seals**

Interpolation map of records from satellite tracking of New Zealand fur seals, indication their range and areas of higher activity (Light green to dark green according to increasing density of recordings).

The important region for adult female New Zealand fur seals is 40 – 150 km S-SE of Kangaroo Island (shown in orange in Map 15).

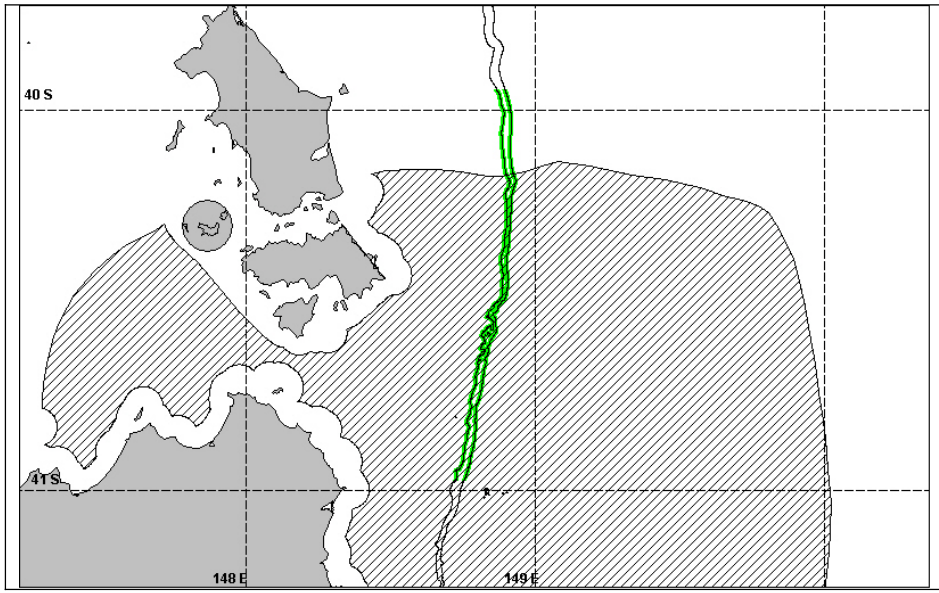
Most frequented regions……..least frequented
dark green……light green

Interpolation map produced by CSIRO Marine Research from data provided by Brad Page, LaTrobe University, (pers. comm.)

## 2.5 Sharks

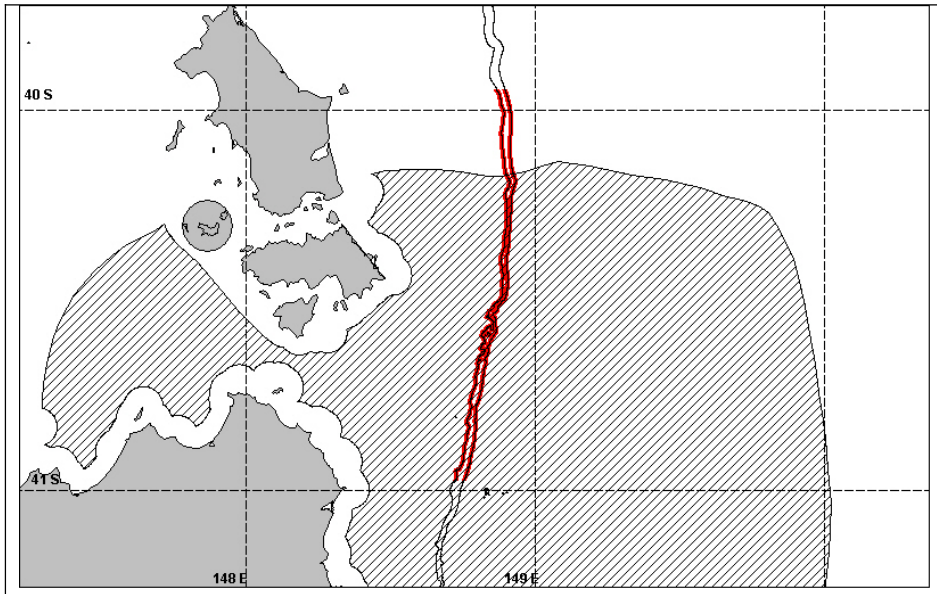
A number of shark species are protected under the EPBC (Environment Protection and Biodiversity Conservation) Act off south-eastern Australia (Daley *et al*. 2002). These include the grey nurse shark (*Carcharias taurus*), white shark *Carcharodon carcharias*) and basking shark (*Cetorhinus maximus*). However, Marine Protected Areas in Commonwealth waters are unlikely to be the most effective measure for conserving these species. Critical habitat for the grey nurse shark lies mainly within State waters and is protected by NSW laws. Basking sharks and white sharks are highly migratory species with widespread distributions. Juvenile white sharks are common in some inshore areas, some of which have been closed to fishing under Victorian State law.

Several species of deepwater dogfish (*Centrophorus* spp.) are considered to be at risk due to overfishing and, although not yet protected, have been nominated under the EPBC Act. These species have restricted distributions within Australian waters (pers. comm. Ross Daley and Grant West CSIRO Marine Research.).



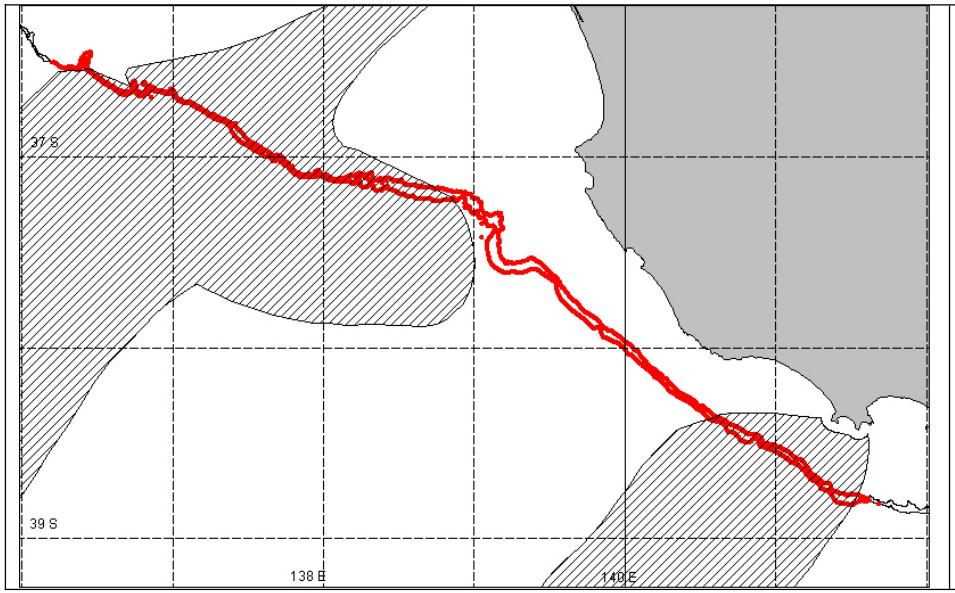

**MAP 16 Harrison's Dogfish**

Harrison dogfish has been nominated. Important regions for this species are between the 400 – 600 m isobath between Babel Island and Eddystone Point (unpublished data CSIRO FRDC project 2003/033). The 400 and 600 m isobaths are shown and the important region for the dogfish is shown in green on MAP 16.



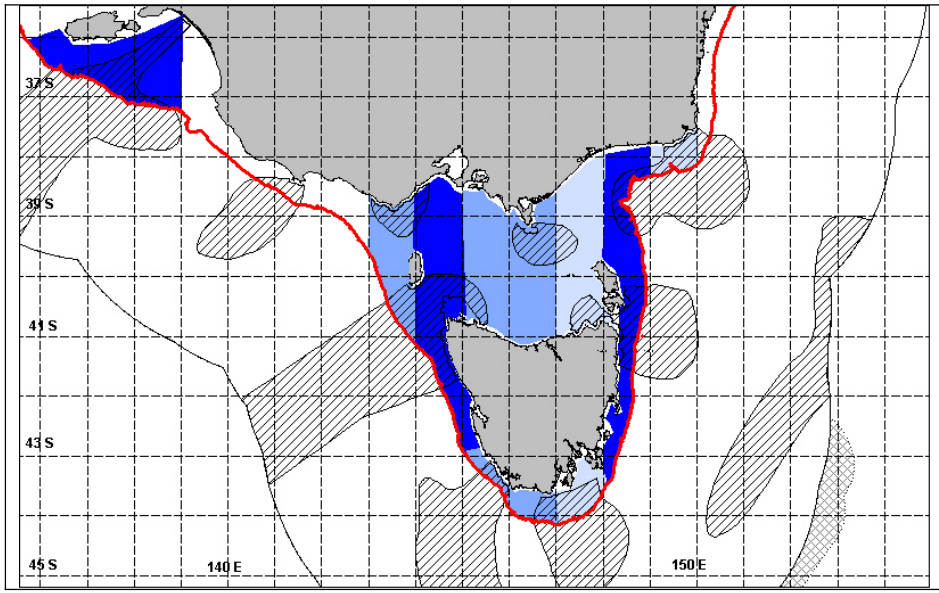

**MAP 17 Southern Dogfish (Banks Strait BAOI)**

The southern dogfish has been nominated for listing as a threatened species. Important regions for this species are between the 400 – 600 m isobath between Babel Island and Eddystone Point (unpublished data CSIRO FRDC project 2003/033). The 400 and 600 m isobaths are shown on Map 17 and the important habitat region is shown in red.




**MAP 18 Southern Dogfish (Murray and Nelson BAOI)**

The southern dogfish has been nominated for listing as a threatened species. Important regions for this species are between the 400 – 600 m isobath between Portland and Kangaroo Island. The region off Port McDonald is of particular importance (unpublished data CSIRO FRDC project 2003/033). The 400 and 600m isobaths are shown and the important habitat region is shown in red on MAP 18.




**MAP 19 Residence areas for School Shark**

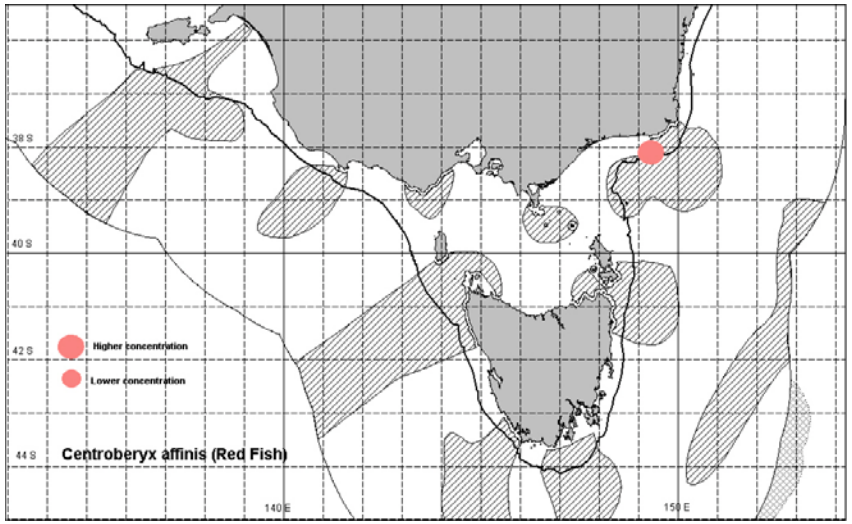
The following map was produced from data described in West and Stevens (2001) and in consultation with Grant West (CMR).
The dark blue areas are the most important areas with the lightest blue the least important. The 500m isobath is shown in red.

## 2.6 Spawning areas for fish considered at risk

The following schematic maps are designed to provide an indication of important regions for larvae of some species in relation to the BAOI in the SEMR. The information was read from the larval fish database (Bruce and Bradford 2002). Species were selected based on whether the species was considered to be at risk as assessed by the South-east Fishery Assessment Group (Smith and Wayte 2002).

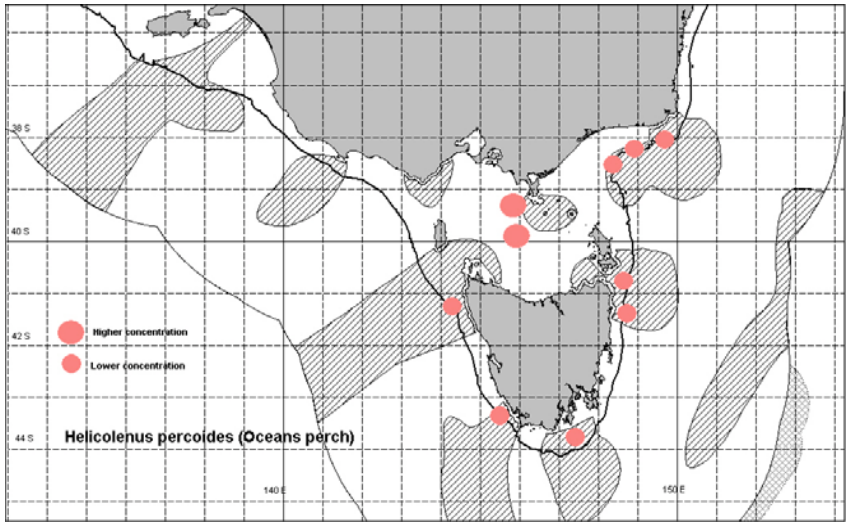
More precise information on the regional distribution of larvae is available on the larval fish database that will be available at the workshops. The larval database also includes information on species distribution, spawning, stock structure, larval vertical distribution and, for some, species age data. The presence of age data allows the user to run the larval dispersal model, which provides an estimate of the spawning sites (for further information see the data base).

Any queries relating to the larval fish database should be directed to Barry Bruce or Russ Bradford CSIRO Marine Research.



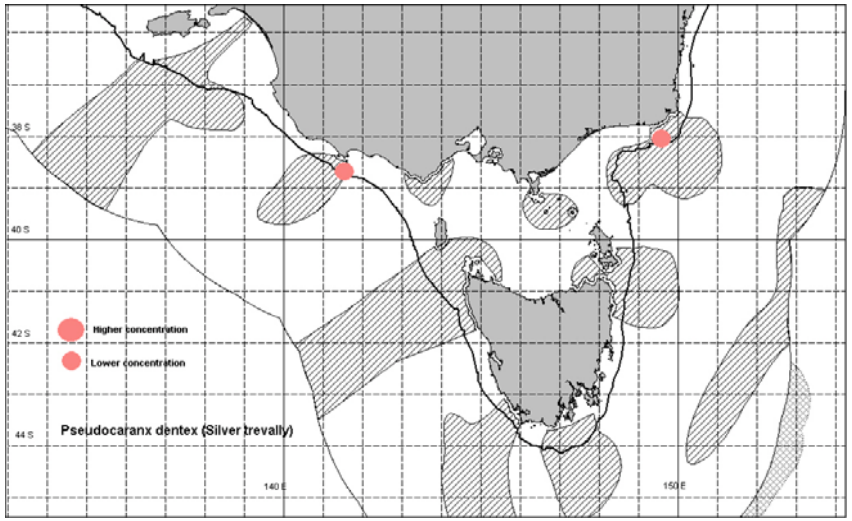

**MAP 20 *Centroberyx affinis* (Redfish)**
is considered to be close to biomass limit (Smith and Wayte 2002) and hence at high risk. The highest concentrations of larvae (14.9 to 38.7 larvae per 1000 $m^3$) for this species were sampled off the NSW coast (not shown). In the East Gippsland BAOI concentrations were sampled between 0.5 and 14.9 larvae per 1000$m^3$.

There is no larval age data available for this species.



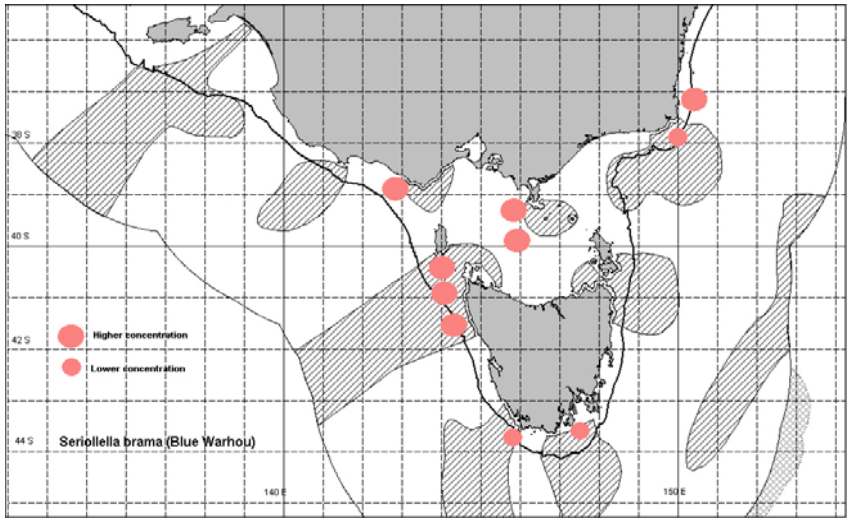

**MAP 21 *Helicolenus percoides* (Ocean Perch)**
is considered to be at medium risk (Smith and Wayte 2002) and was sampled all around Tasmania and up the east coast of Australia. The highest concentrations of larvae (22.4 to 81.7 larvae per 1000$m^3$) were sampled in Bass Straight and off the NSW coast (not shown). Concentrations of larvae between 0 and 22.4 larvae per 1000 $m^3$ were sampled in the shelf regions of the Zeehan, Tasman Fracture, Huon, Banks Strait and East Gippsland BAOIs.

Larval age data is available for this species.



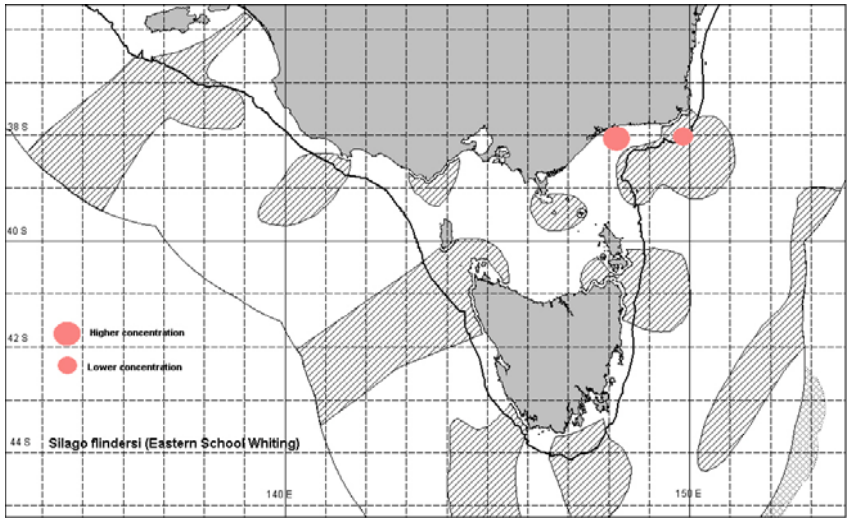

**MAP 22 *Pseudocaranx dentex* (Silver Trevally)**
is well below biomass limit and hence at risk (Smith and Wayte 2002). The highest concentrations of larvae (1250 to 4240 larvae per 1000 $m^3$) were sampled off the NSW coast (not shown). Lower concentrations (20 to 150 larvae per 1000 $m^3$) were sampled in the Nelson and East Gippsland BAOIs.

There is no larval age data available for this species.




**MAP 23 *Seriola brama* (Blue Warehou)**
is well below biomass limit and is in serious and significant decline thus at risk (Smith and Wayte 2002). The highest concentrations of larvae (39.1 to 98.2 larvae per 1000 $m^3$) were sampled in the Apollo, and Zeehan BAOIs and off the NSW coast. Lower concentrations were sampled (5.2 to 39.1 larvae per 1000 $m^3$) in the Tasman Fracture, Huon and East Gippsland BAOIs.

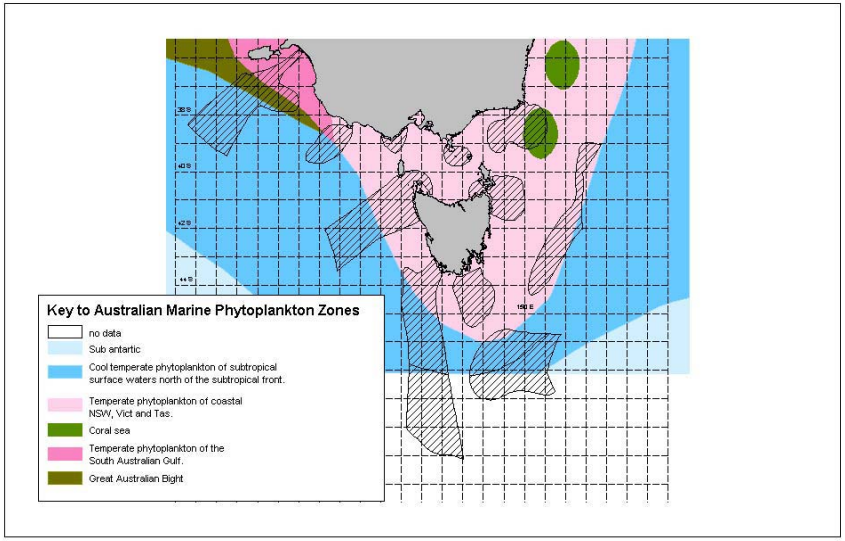
Larval age data is available for this species.




**MAP 24 *Sillago flindersi* (Eastern School Whiting)**
is a low risk species (Smith and Wayte 2002). High concentrations of larvae (72 to 734 larvae per 1000 $m^3$) were recorded off the NSW coast and near the East Gippsland BAOI. Concentrations of 5 to 72 larvae per 1000 $m^3$ were sampled in the East Gippsland BAOI.

There is no larval age data available for this species.

## 2.7 Phytoplankton




**MAP 25 Phytoplankton regionalisation in the SEMR.**

This phytoplankton regionalisation was provided by Geoscience Australia as a JPEG (pers. comm. Peter Harris Geoscience Australia).and was digitised by CSIRO Marine Research.

The data belongs to Geoscience Australia.
The shape files are held by CSIRO Marine Research.

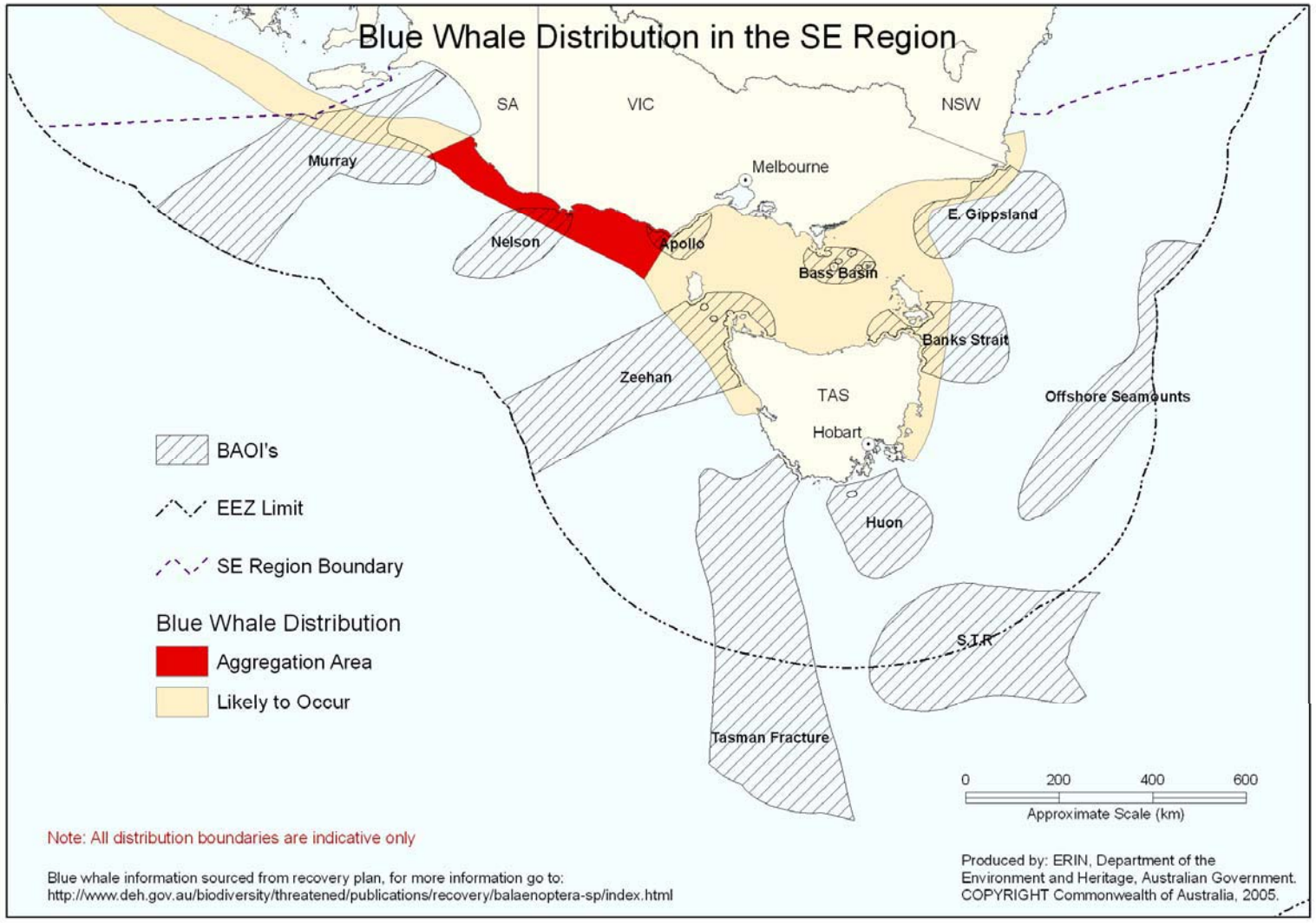
## 2.8 Whales

The following maps depict areas of significance for three common whale species - blue whale (*Balaenoptera musculus*), humpback whale (*Megaptera novaeangliae*) and southern right whale (*Eubalaena australis*) in the SEMR. Each of these animals is listed by the Australian Government Department of the Environment and Heritage as a threatened species. The information contained in these maps is sourced from the following Recovery Plans:

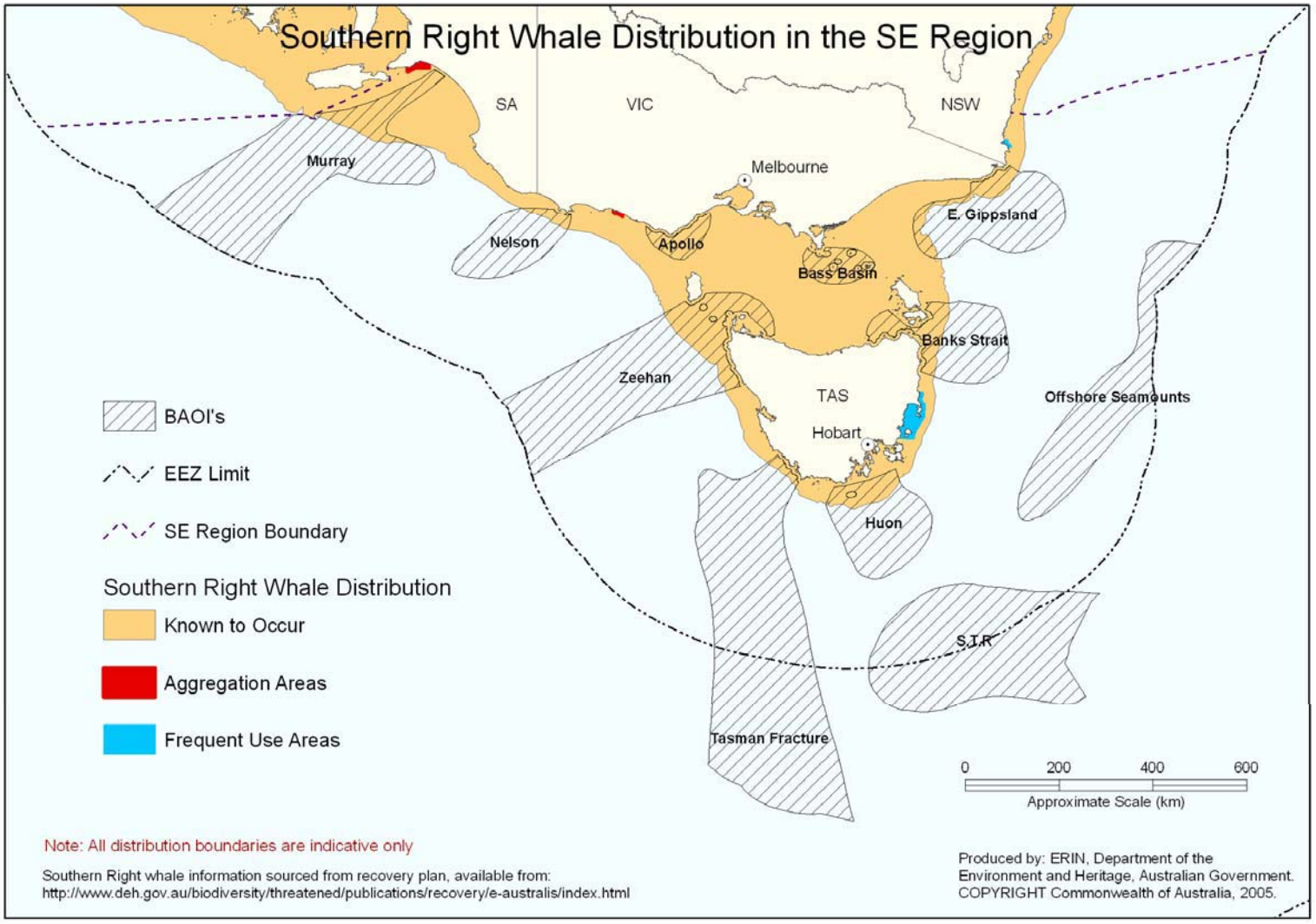
Blue, fin and sei whales:
http://www.deh.gov.au/biodiversity/threatened/publications/recovery/balaenoptera-sp/index.html

Southern right whales:
http://www.deh.gov.au/biodiversity/threatened/publications/recovery/e-australis/index.html

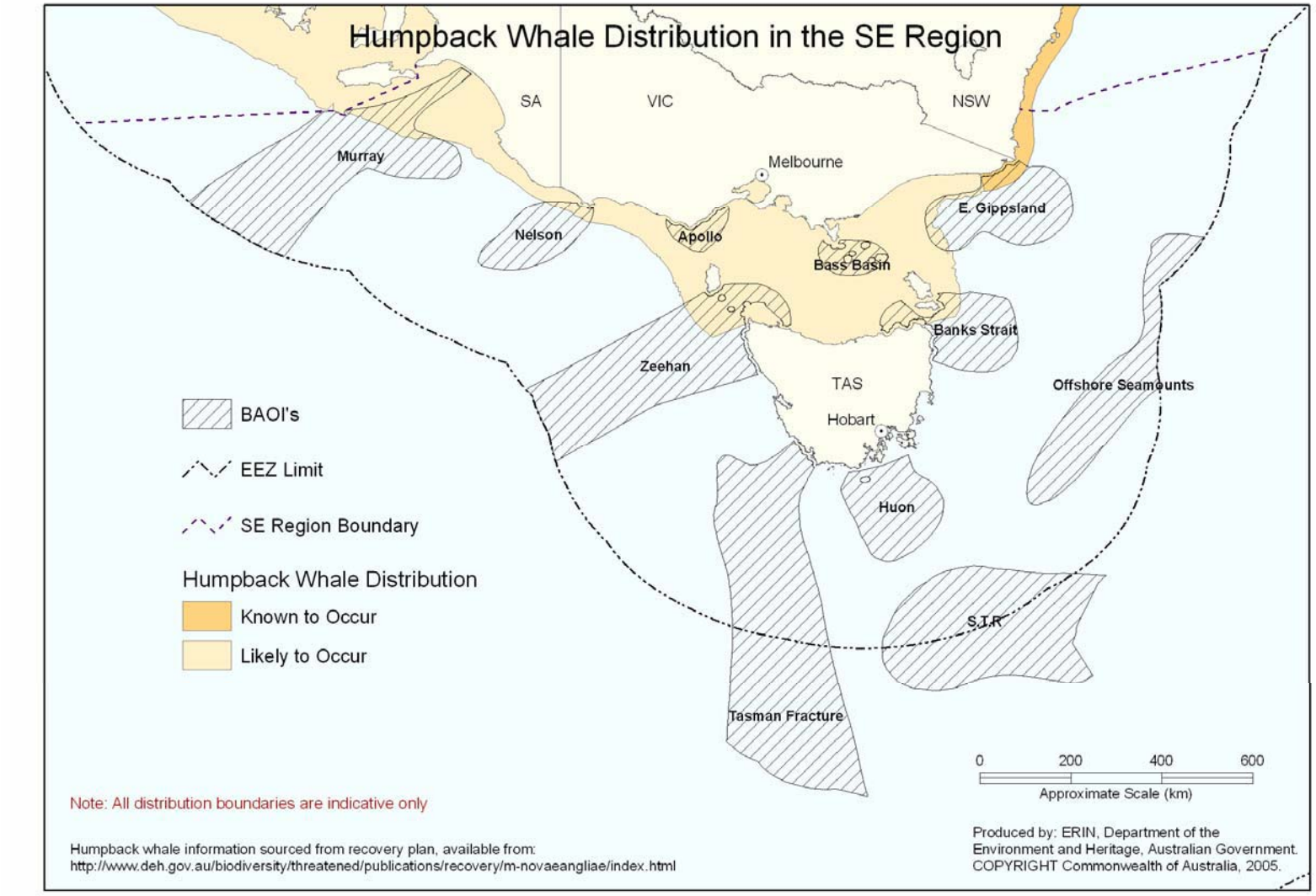
Humpback whales:
http://www.deh.gov.au/biodiversity/threatened/publications/recovery/m-novaeangliae/index.html




**MAP 26 Blue Whale aggregation areas**




**MAP 27**
**Southern Right Whales aggregation areas**




**MAP 28**
**Humpback Whales aggregation areas**

# 3. Currents, geomorphic features, canyon classification and seascapes

## 3.1 Large-scale current patterns

Figure 2 provides an indication of the distribution of major currents, fronts, eddies, and coastal upwelling sites within Australia's Ocean Territory. Quantitative information for specific time periods and regions is available from hydrodynamic model results and satellite altimetry.

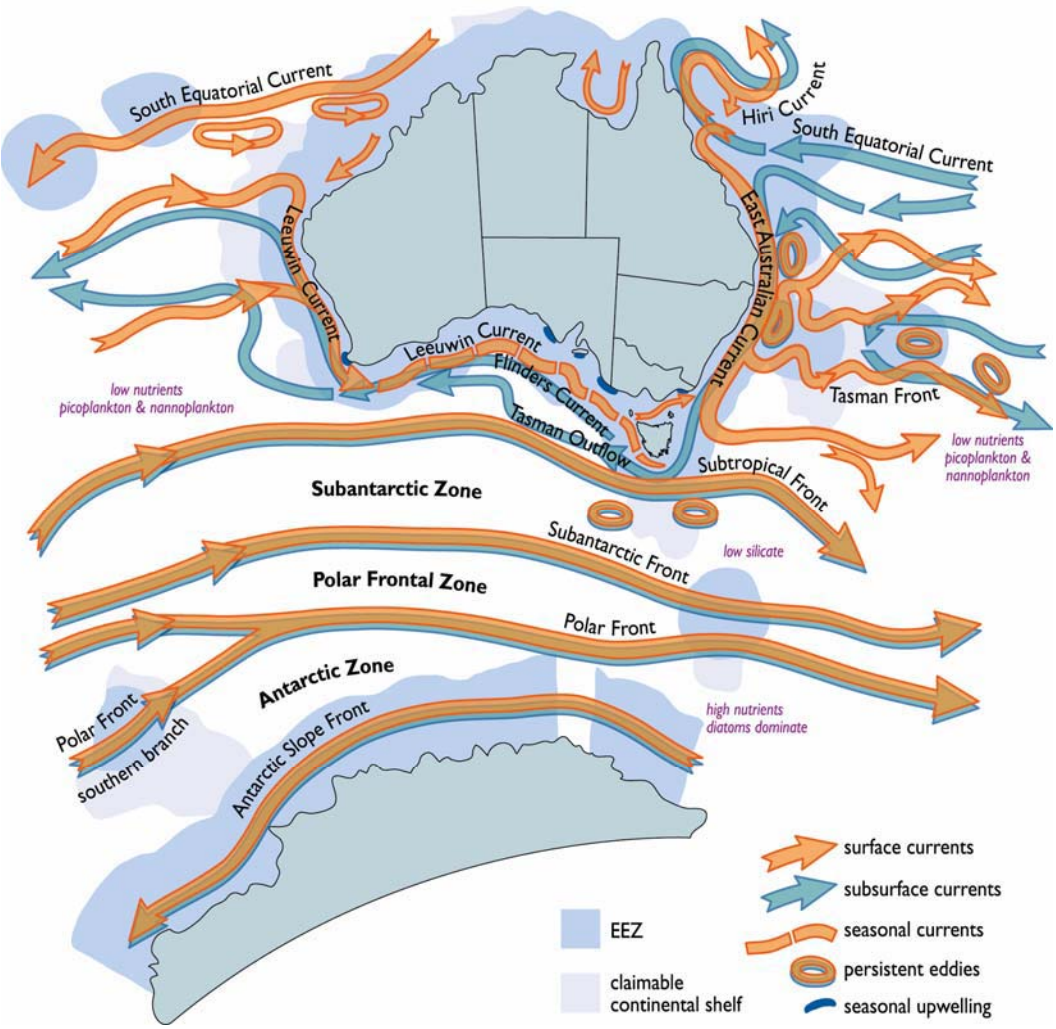


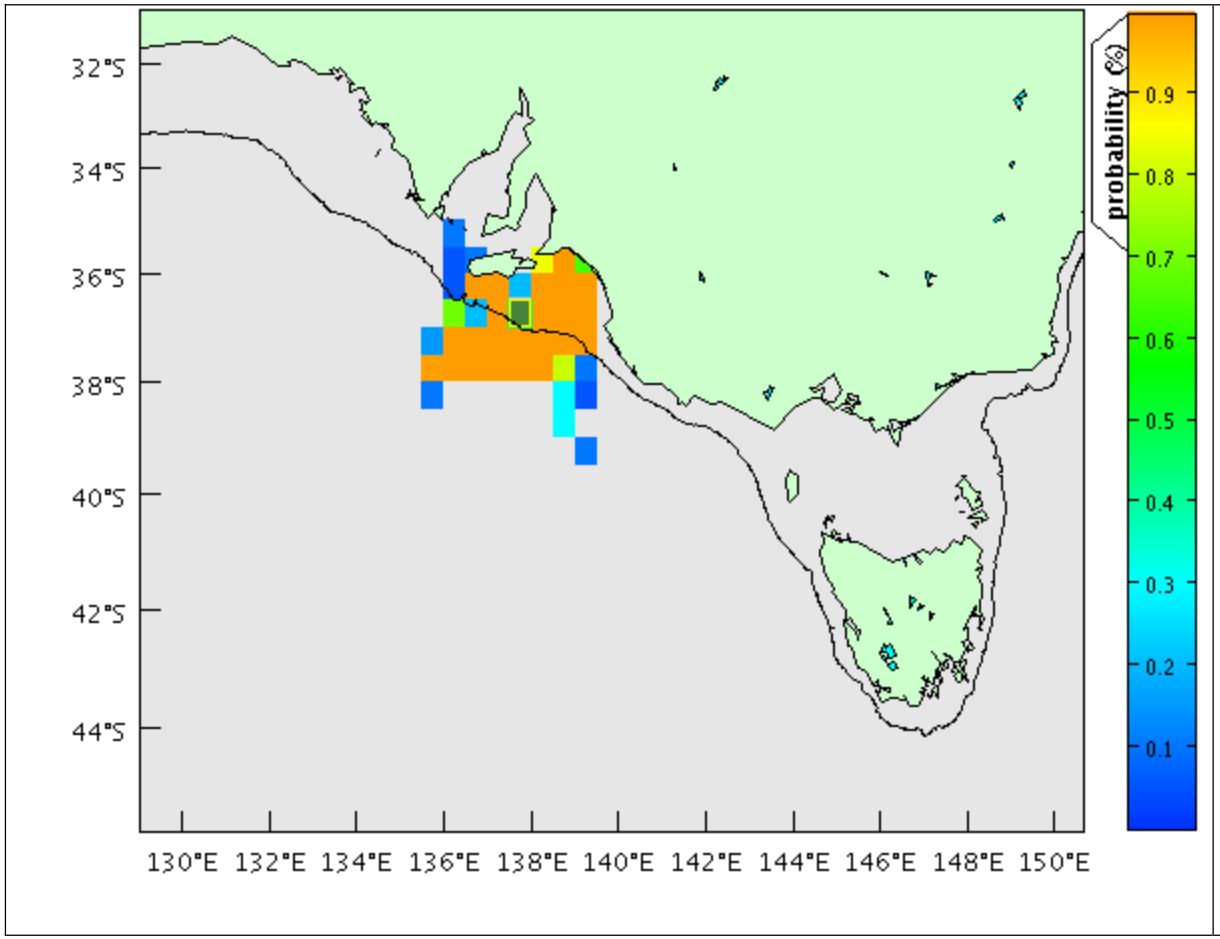

**Figure 2 Schematic diagram of the distribution of major currents, fronts, eddies, and coastal upwelling sites within Australia's Ocean Territory**

## 3.2 Connectivity in the SEMR

Marine organisms have dispersal stages, sometimes as adult but more frequently larval. Some spend a very short time in the dispersive stage, in the order of minutes to hours (the extreme being zero for direct developers where the offspring stay very close to their parents) – examples include some (but not all) ascidians, bryozoans, corals. Some spend periods of days as larvae that can be transported by currents. Others (e.g. some bivalves) spend weeks, and can be transported much further (although they may not travel far, depending on the patterns of ocean currents). Finally, some (certain fish and crustaceans) may spend months in their dispersive phases. Given that we are dealing here with "the whole of the biodiversity", and that our target organisms have not been studied but that it is a reasonable assumption that they will span the spectrum of dispersal types, we have here the opportunity to maximise the effectiveness of the proposed MPAs by considering spatial guidelines described by Warner and Cowen (2002) and Lubchenco *et al*. (2003). These spatial guidelines are: (i) to make the highly protected core of each individual MPA large enough to enclose the dispersal distances of organisms with hours to days larval duration; and (ii) to establish a network of MPAs with spacings between MPAs that are commensurate with the dispersal distances of larvae of several weeks duration.

Dispersion depends on both ocean currents and larval swimming behaviour, although in pelagic environments the latter is often a secondary influence. The time-varying nature of ocean currents suggests that a statistical description of spatial connectivity patterns is required to properly address guidelines (i) and (ii). Examples of such a description are shown for the Murray BAOI (Maps 29 through 32). They are derived from current fields based on satellite altimetry and are most relevant to large length scales (> 10 km) and long time scales (> week). Larvae are assumed to move passively with the ocean currents.

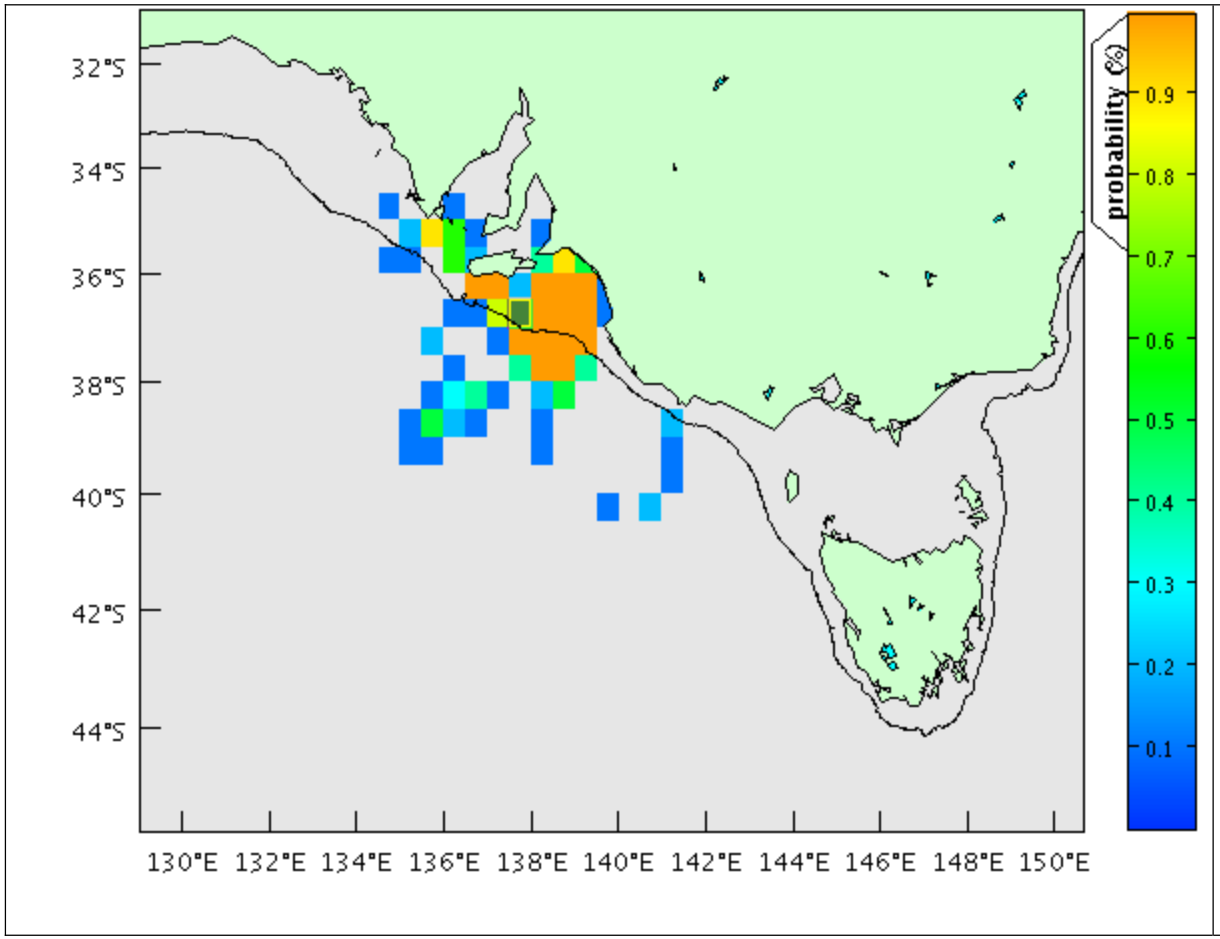
Related analyses can be used to determine the potential for candidate MPAs to be seeded from other regions (Map 33). This approach also has potential applications in estimating the risks to candidate MPAs associated with invasive species or other contaminants.




**MAP 29 Source Murray BAOI – 10 days**

Average distribution (%) of larvae 10 days after a July 1999 spawning within a 0.5-degree square in the Murray BAOI south of Kangaroo Island (highlighted cell).

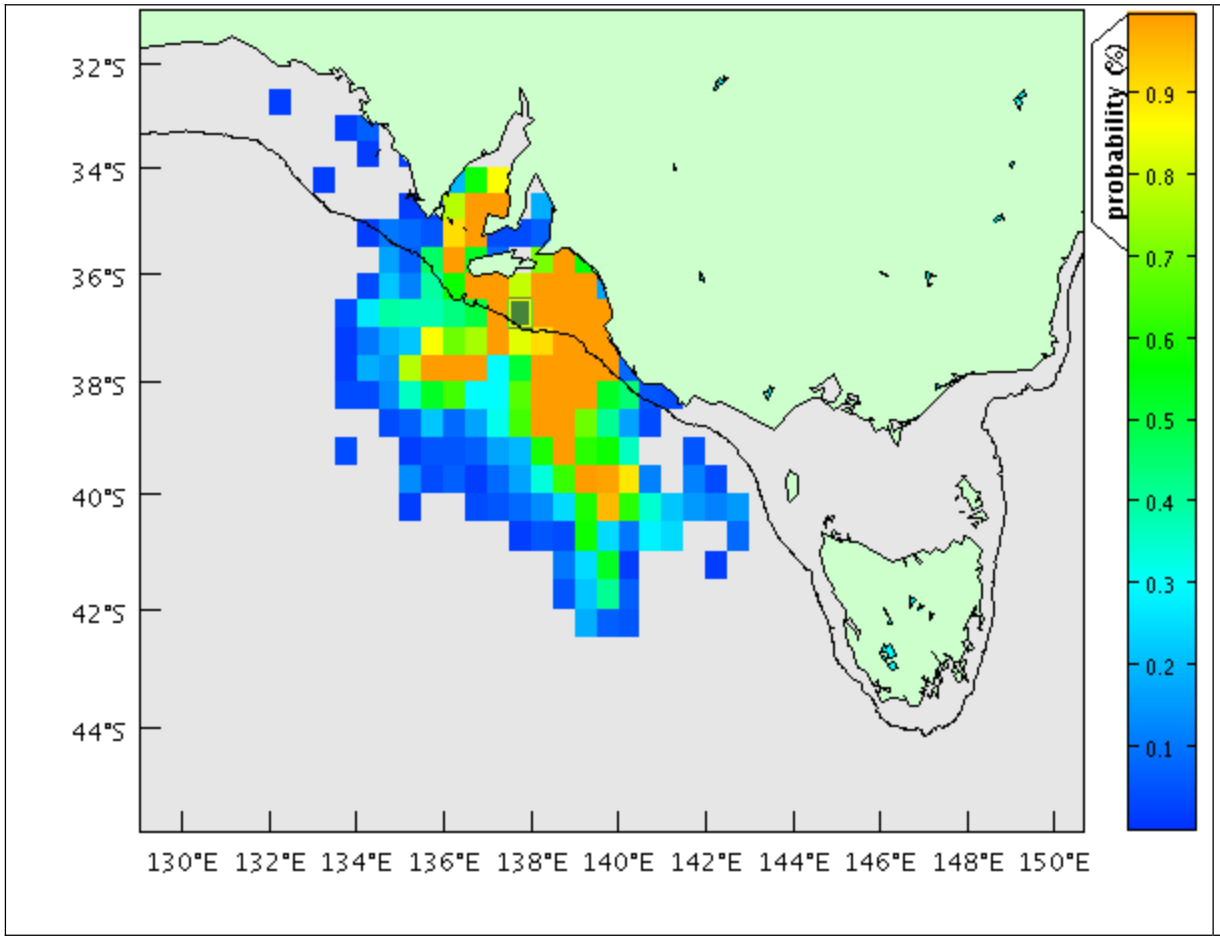
Produced by Scott Condie CSIRO Marine Research.




**MAP 30 Source Murray BAOI – 20 days**

Average distribution (%) of larvae 20 days after a July 1999 spawning within a 0.5-degree square in the Murray BAOI south of Kangaroo Island (highlighted cell).

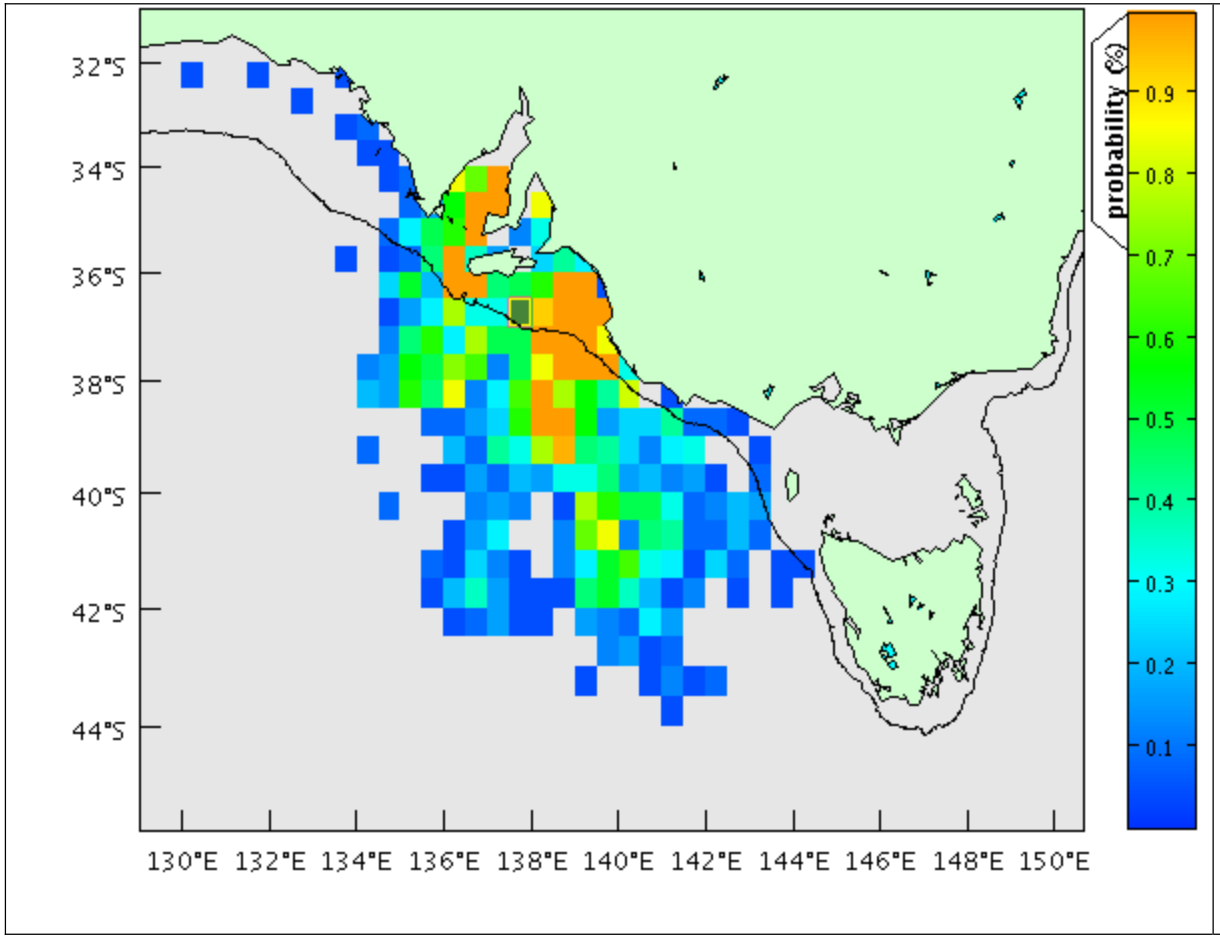
Produced by Scott Condie CSIRO Marine Research.




**MAP 31 Source Murray BAOI – 30 days**

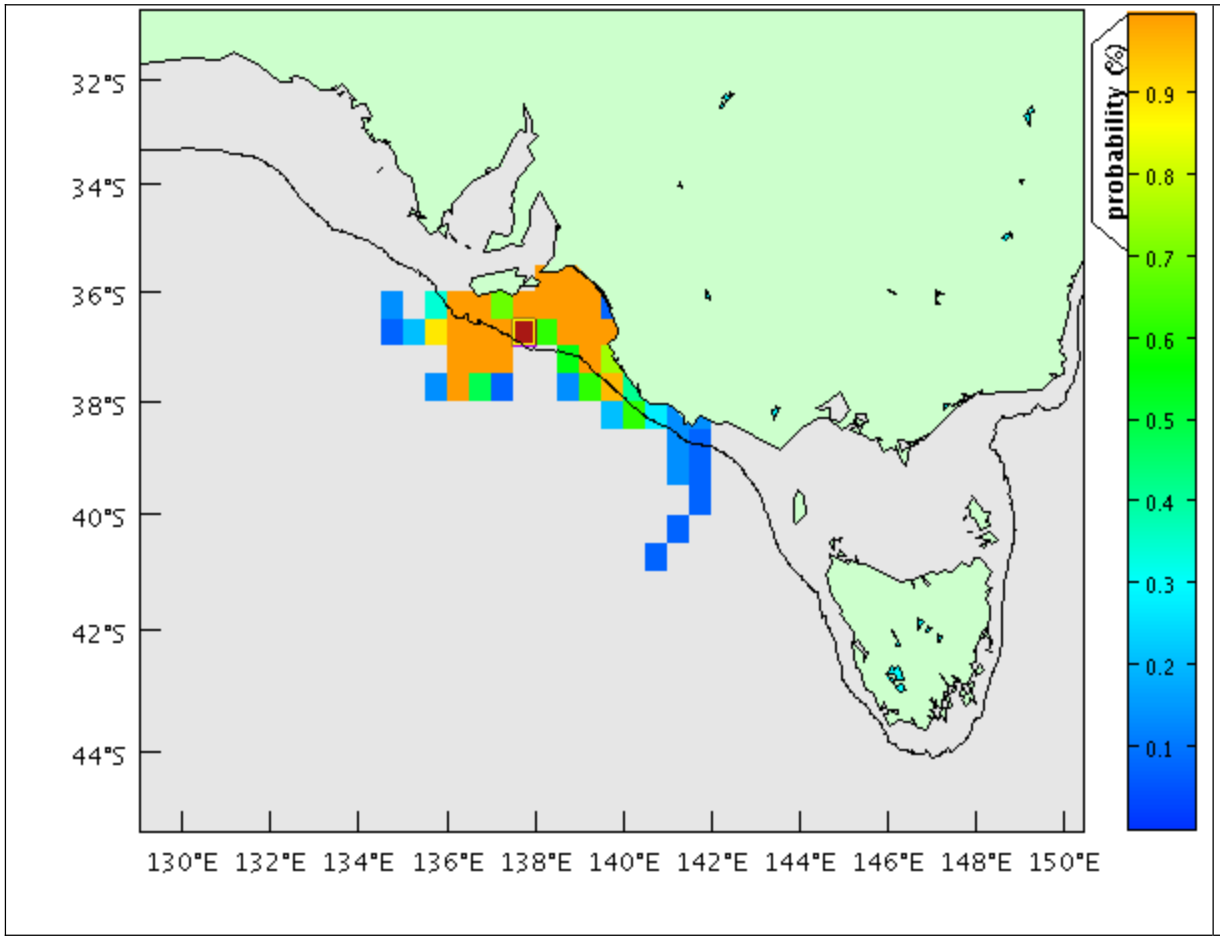
Average distribution (%) of larvae 30 days after a July 1999 spawning within a 0.5-degree square in the Murray BAOI south of Kangaroo Island (highlighted cell).

Produced by Scott Condie CSIRO Marine Research.




**MAP 32 Source Murray BAOI – 60 days**

Average distribution (%) of larvae 60 days after a July 1999 spawning within a 0.5-degree square in the Murray BAOI south of Kangaroo Island (highlighted cell).



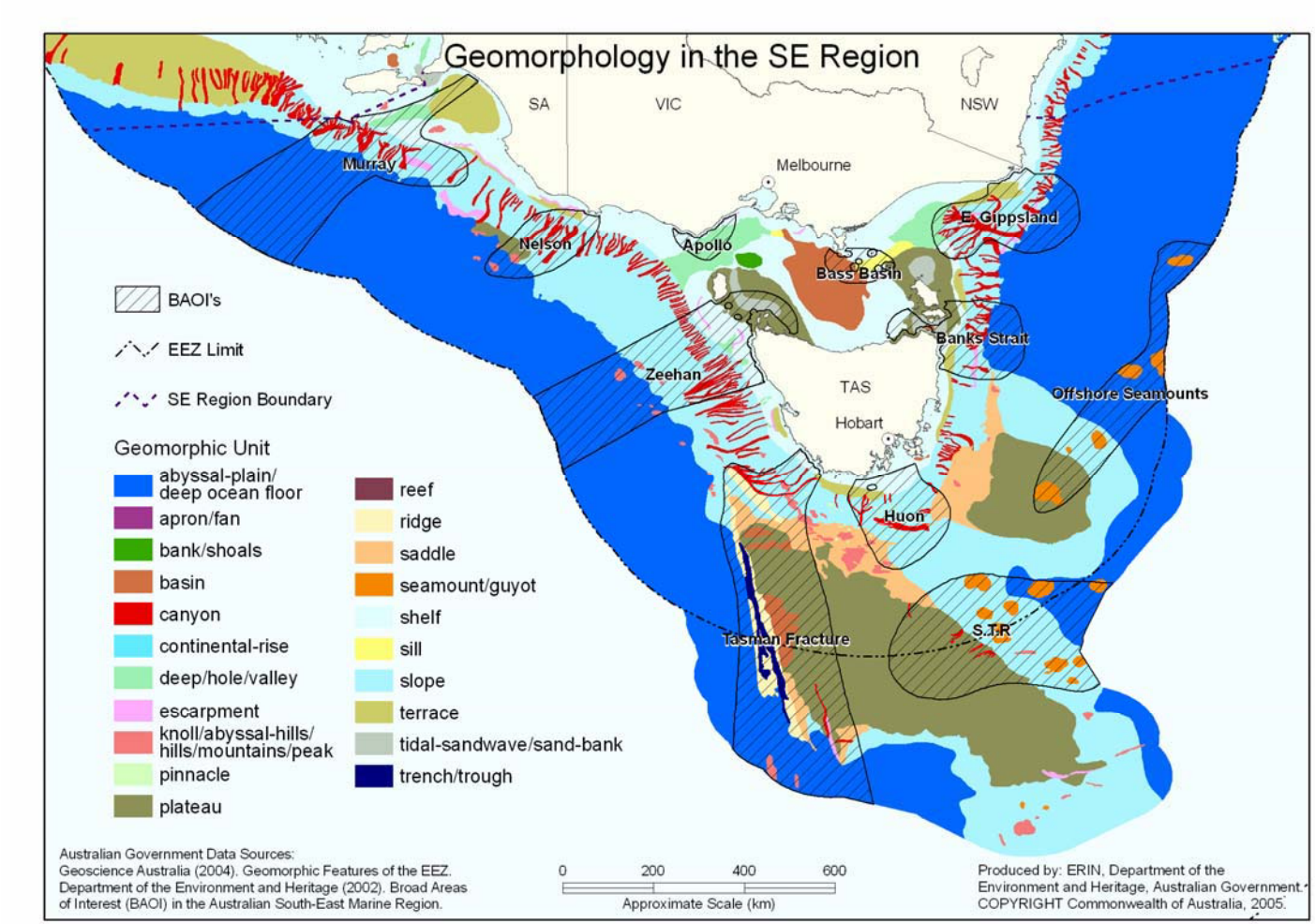

**MAP 33 Sink Murray BAOI – 10 days**

Average distribution (%) of water parcels 10 days before arriving at a 0.5-degree square in the Murray BAOI south of Kangaroo Island (highlighted region) in July 1999.

Produced by Scott Condie CSIRO Marine Research.

## 3.3 Geomorphic features

Map 34 shows additional information on the geomorphic features on the shelf (Harris et al. 2005) that was not available in the geomorphic map presented in the BAOI descriptions published in the User Guide in 2003. While this information does not directly pertain to any particular specification for MPA design it is likely to be particularly useful in informing sampling on the continental shelf.




**MAP 34 The BAOI and the level three geomorphic units on and off the shelf**

### 3.3.1 SEMR canyon classification
**(pers. comm. Peter Harris Geoscience Australia)**

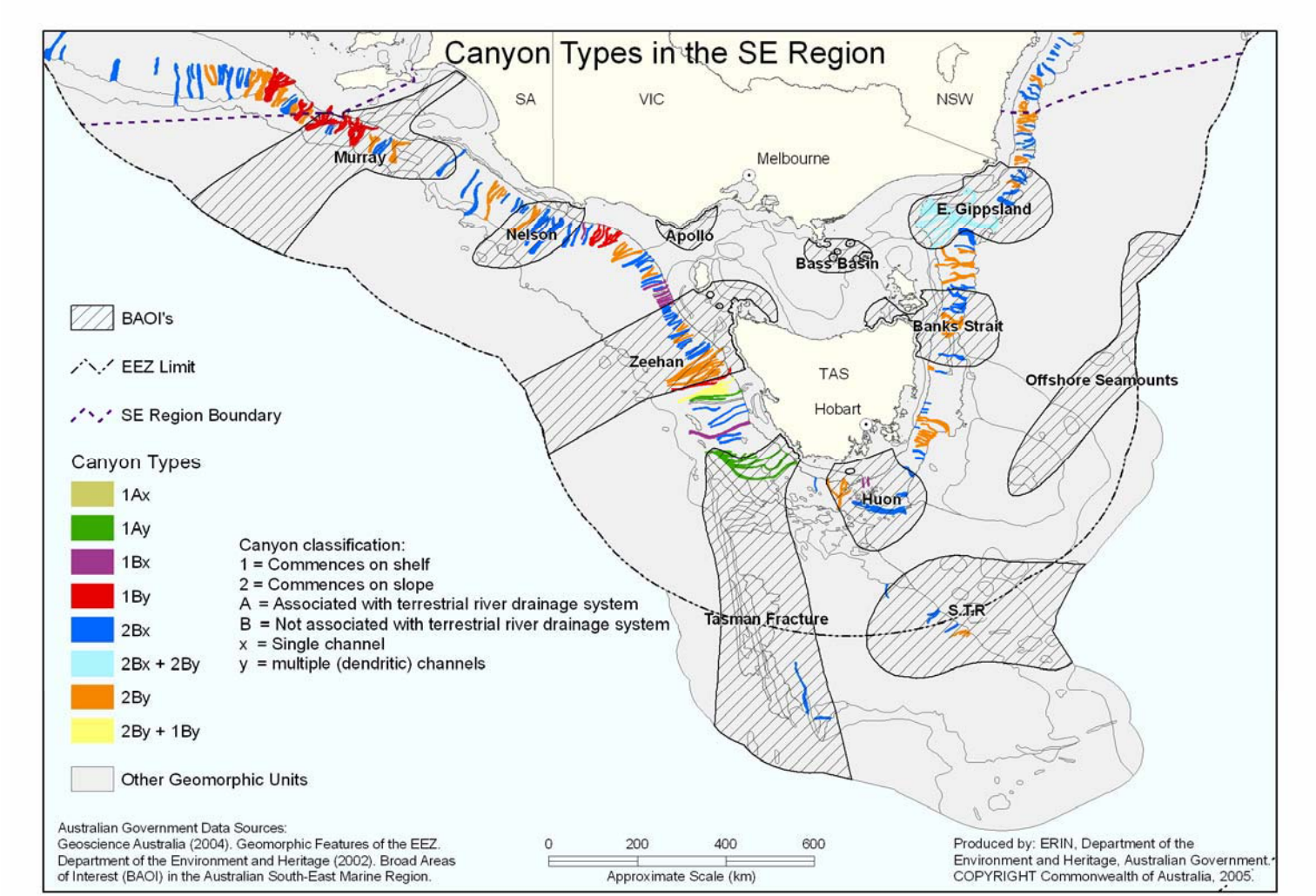
**Linage** This data was derived by Peter Harris (Geoscience Australia) and the database was attributed by CSIRO Marine Research.

**Canyon definition**
Definition: 1. a relatively narrow, deep depression with steep sides, the bottom of which generally has a continuous slope, developed characteristically on some continental slopes. (IHO-IOC Publication B-6, Standardization of Undersea Feature Names, 2nd Edition)

Submarine canyons serve as major conduits of terrigenous (land-derived) sediment from the continents to the deep ocean basins. Most large canyons commence on the continental shelf, commonly at the mouths of large rivers, and are incised into the continental slope. Canyons that originate on the shelf at the mouths of rivers usually contain terrigenous sediments, whereas those that originate on the slope and not in association with rivers contain mainly biogenic-hemipelagic sediments. Canyon lengths typically range from 50 to 300 km, sloping seawards at between 58 to 8 m/km. Canyon axes are generally aligned normal to the coastline, although they may be deflected along-slope by structural features. Canyons may occur as single channels or involve complex tributary systems. At their seaward terminations, submarine canyons commonly empty onto the abyssal plain where sediments accumulate to form large, wedge-shaped, submarine fan deposits.

Canyon classification:

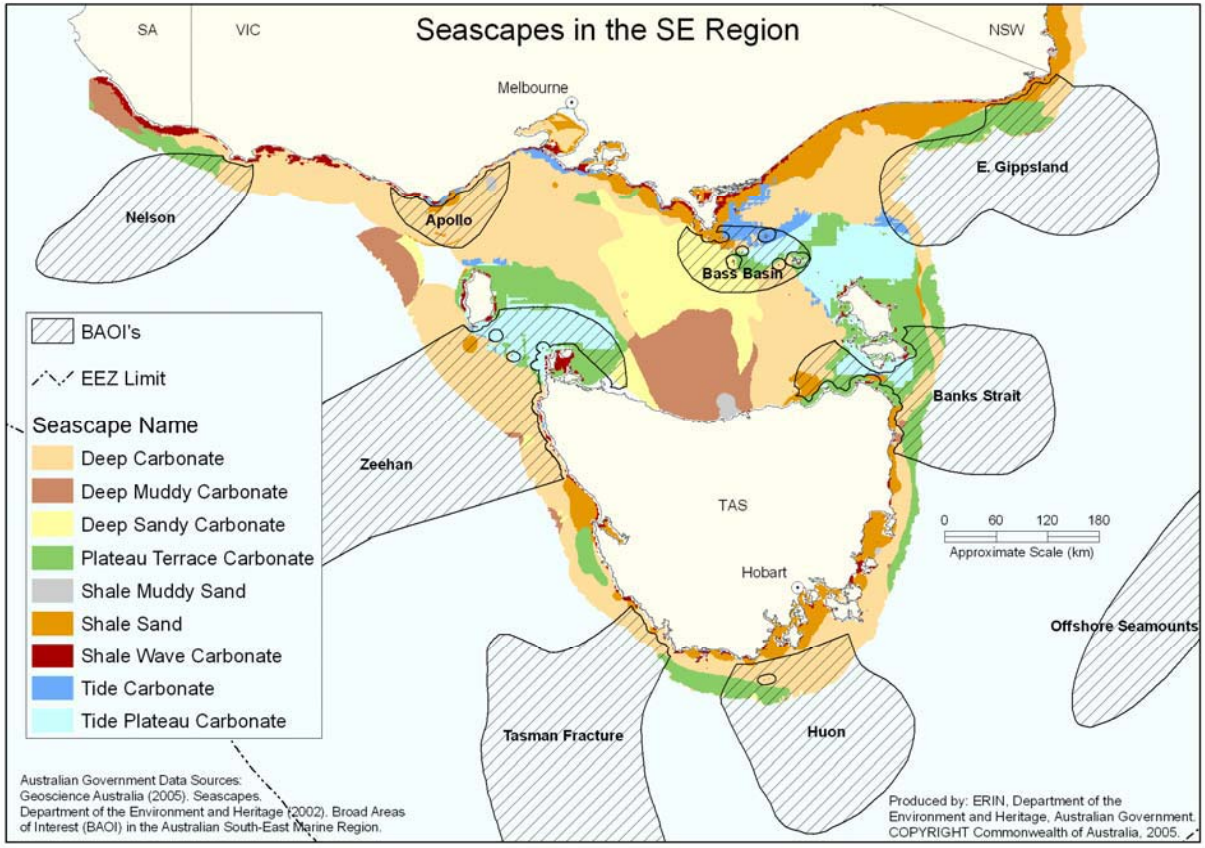
1 commences on shelf
1A associated with terrestrial river drainage system
1Ax single channel
1Ay multiple (dendritic) channels
1B Not associated with terrestrial river drainage system
1Bx single channel
1By multiple (dendritic) channels
2 commence on slope
2A associated with terrestrial river drainage system
2Ax single channel
2Ay multiple (dendritic) channels
2B Not associated with terrestrial river drainage system
2Bx single channel
2By multiple (dendritic) channel




**MAP 35 Canyon types**

### 3.3.2 Seascapes in the South-east Region

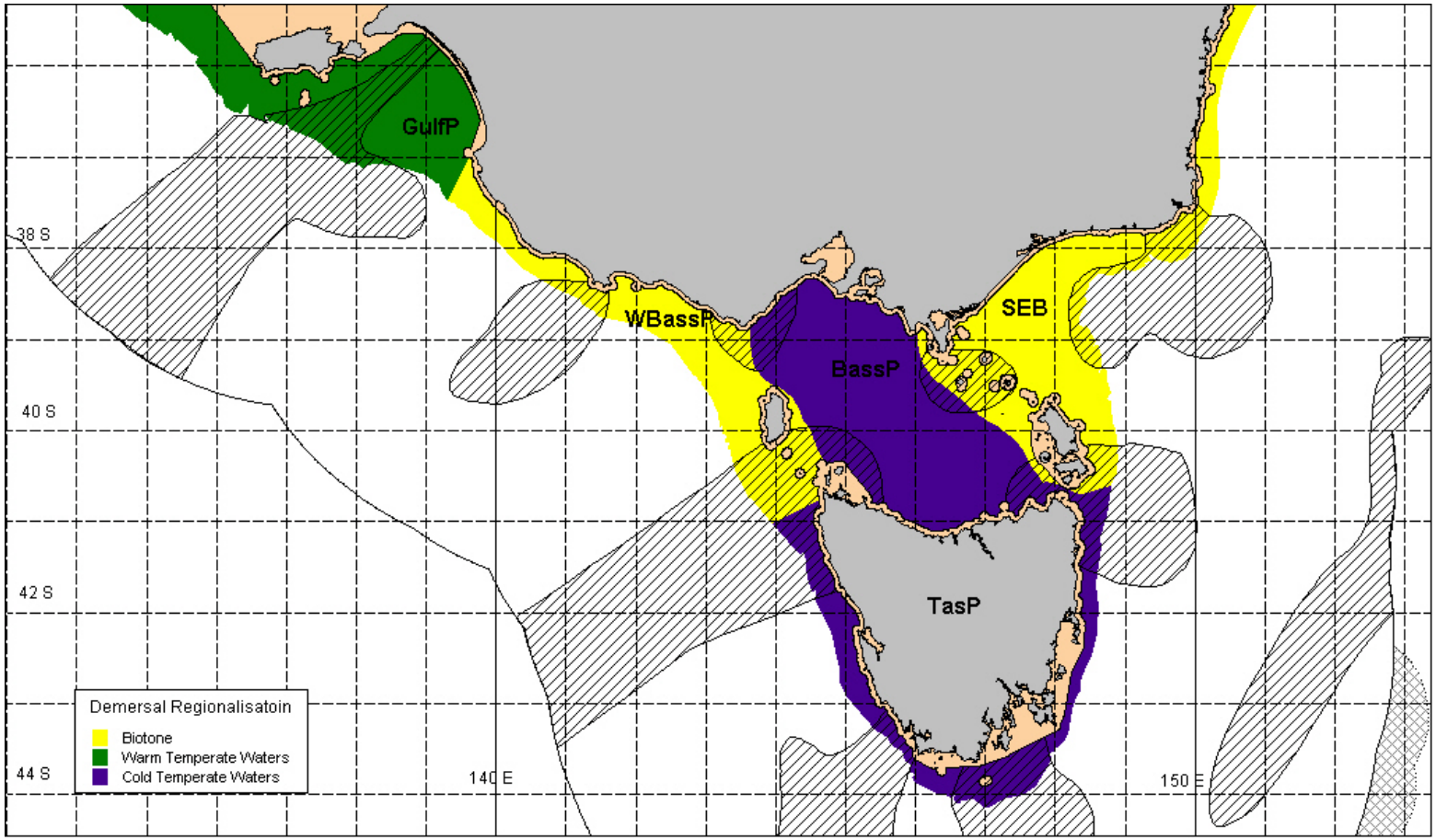
Map 36 shows "seascapes" on the shelf created by Geoscience Australia (Heap et al., 2005). The seascapes are an integration of geomorphic features, seabed sediment composition and oceanographic (waves and tides) information on the continental shelf.



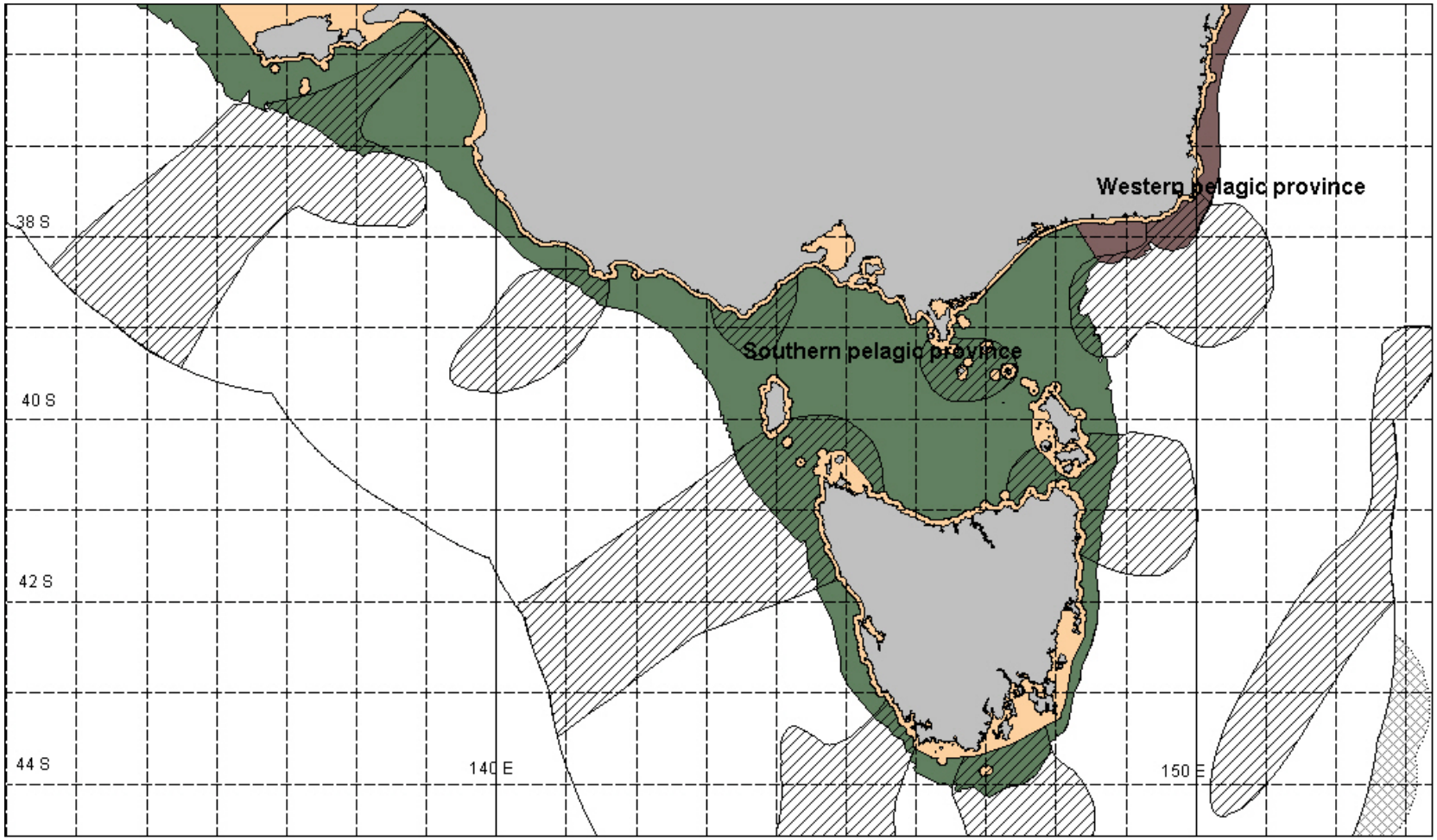

**MAP 36 The BAOI and seascapes on the shelf**

## 3.4 Higher level regionalisations on the shelf

In *Australia's SEMR: A users guide to identifying candidate areas for a regional representative system of marine protected areas'* (http://www.e.gov.au/coasts/mpa/ ) provided the lowest level, the meso-scale regionalisation, of the IMCRA bioregionalisation. Maps 37 and 38 show the two higher-level regionalisations – demersal and pelagic provinces and biotones (IMCRA Technical Group 1998). Please note that each meso-scale region is entirely contained within one of the demersal provinces/ biotones.



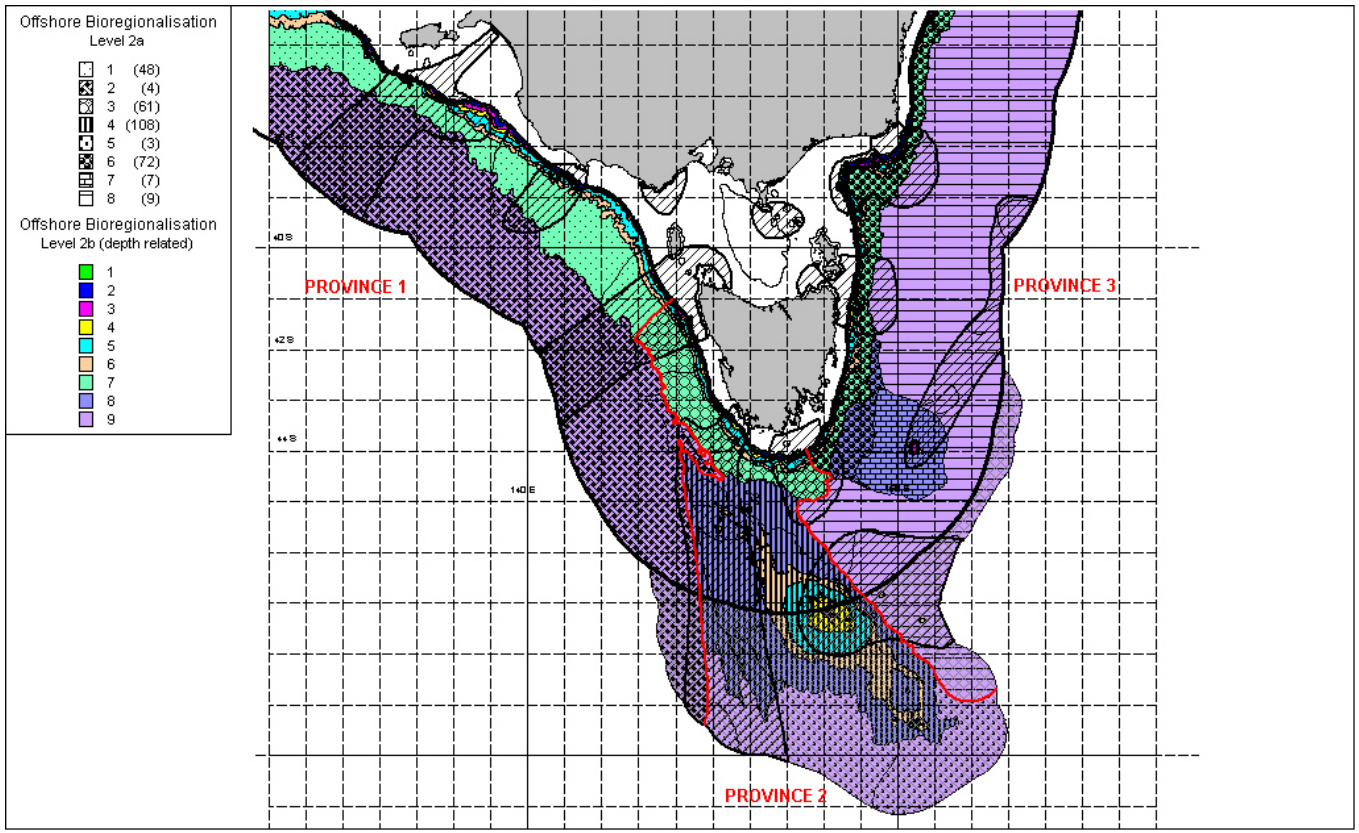

**MAP 37 IMCRA: The demersal provinces and biotones with the BAOI overlaid**




**MAP 38 IMCRA: The pelagic provinces and biotones with the BAOI overlaid.**

## 3.5 Higher level regionalisations off the shelf

In *Australia's SEMR: A users guide to identifying candidate areas for a regional representative system of marine protected areas'* (http://www.e.gov.au/coasts/mpa/ ) showed the Provinces and the Level 3 regionalisation, of the offshore bioregionalisation. Map 39 shows the two level 2 regionalisations – 2a and 2b. Level 2b defines sub-biomes within Level 2a based on depth bands (Butler et al.2001).




**Map 39 The Level 2a and 2b offshore bioregionalisation with the BAOI overlaid.**

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