Marine Ecology

14. MARINE ECOLOGY

14.1. Introduction

Spencer Gulf is well recognised as an important resource for the recreational and commercial fisheries it supports and its unique biological characteristics. This Chapter provides an overview of the ecological values of the marine environment of the Gulf, with a focus on the Upper Spencer Gulf and the Port Bonython region. It identifies the potential impacts the Project may have on the marine environment from an ecological perspective and provides appropriate measures to avoid or minimise these impacts. Monitoring requirements for both the construction and operational phases of the development are also outlined.

In summary, the impact assessment considers whether the Project will:

- Cause direct or indirect death of, or injury to, a fauna species
- Cause loss of an important habitat for a species or community
- Fragment habitat or create a barrier to movement
- Risk the introduction and distribution of a pest species or disease.

14.2. Methodology

The study approach has been to collate the considerable amount of available information available for the general study area, particularly from major investigations undertaken for other existing and proposed projects, government databases and management plans, as outlined in **Section 14.2.1** below.

The marine environment study area for the purposes of this Chapter is considered to be the marine aquatic environment extending out from the highest astronomical high tide mark (essentially the point the tide reaches on the largest high tide). The extent of the study area generally includes the whole of the Upper Spencer Gulf for context, however, more detail is provided on the local area between Black Point and Point Lowly where direct impacts may occur (**Figure 14.3e**).

A survey was specifically undertaken to provide additional information, as outlined in **Section 14.2.2**.

Legislation and policy relevant to the marine environment (refer to **Section 14.2.4**) was identified to ensure the environmental data collected for the study area was sufficient to comply with legislative requirements.

14.2.1. Sources of Information

For the marine biological environment, the major sources of information are indicated below. Any other sources used, for example, specific research papers, are referenced in the text and included in the references. The information sources include:

- An Environmental Impact Statement (EIS) and related reports for Port and Terminal Facilities at Stony Point, prepared for Santos in 1981
- An EIS and related reports for the Olympic Dam Expansion, prepared for BHP Billiton (BHPB) in 2009 – 2011
- An Oil Spill Contingency Plan prepared for Santos in 1998
- Marine ecological monitoring prepared on behalf of Santos in 1997
- Environmental reviews of the Santos Facility undertaken in 1982-1986
- The Eyre Peninsula Coastal Action Plan and Conservation Priority Study prepared for the Department of Environment and Heritage (DEH) in 2011.

A number of scientific papers were also reviewed, including:

- Assemblages of sessile marine invertebrates: still changing after all these years? (Butler & Connolly, 1999)
- An Inventory of Important Coastal Fisheries Habitats in South Australia, PIRSA Fish habitat program (Bryars, 2003).

Searches of threatened species databases were undertaken (searches were based on a 5km radius from the proposed jetty) to indicate the presence of species with a conservation status that may be affected by the Project. These databases included:

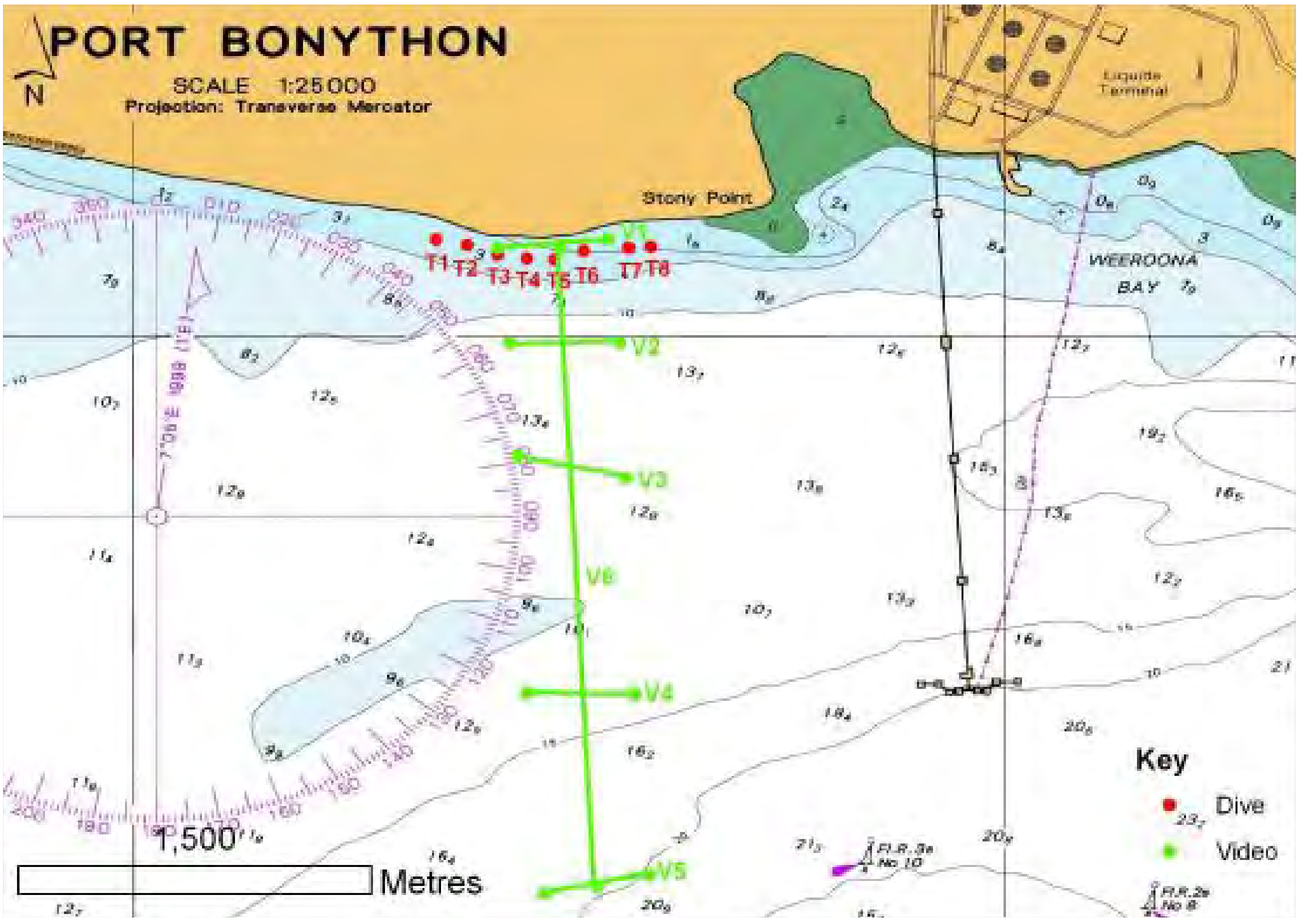
- Protected Matters Database (Commonwealth EPBC Act)
- Biological Database of South Australia/Nature Maps (South Australian NPW Act).

Additionally, searches of the Atlas of Living Australia were conducted over a broader area (Northern Spencer Gulf) to further determine the likelihood of presence of species identified in the threatened species databases above as potentially occurring.

14.2.2. Marine Surveys

To supplement the existing information sources outlined in **Section 14.2.1**, a survey to characterise habitat values was undertaken in 2009 by the South Australian Research and Development Institute (SARDI); the survey is included in **Appendix K.1**. Video surveys were undertaken along the length of the proposed jetty as well as over five 500m survey transects perpendicular to it. In addition, surveys of the subtidal reef to the north of the jetty were undertaken to record marine species and communities at eight sites, as illustrated in **Figure 14.2a**. These surveys followed the Reef Health Protocol, developed by Turner (1995) and were of sufficient detail that they may be used to provide a baseline for comparison for any future post-construction monitoring.

Figure: 14.2a: Survey locations for SARDI benthic survey (Theil & Tanner, 2009)



14.2.3. Impact Significance Criteria

For the purpose of assessing the environmental effects of the project on the marine biological environment, impact significance criteria are defined and are included in **Table 14.2a** below. The impact assessment approach has utilised aspects of both Federal and State legislation and guidelines (e.g. Matters of National Environmental Significance: significant Impact Guidelines 1.1 (Commonwealth of Australia, 2009)).

The environmental impacts are described for the construction period (refer to **Section 14.4**), which will last for approximately 18 months (for maritime infrastructure i.e. jetty and wharf), and the ongoing operational period. Also described are the mitigation measures that will be taken to minimise or prevent adverse impacts.

Based on the risk assessment methodology outlined in **Section 1.10** of **Chapter 1, Project Introduction**, the primary impacting processes during construction and operation are assessed, based on the potential impact, the likelihood that this impact will occur, and resultant level of risk. **Table 14.2a** below aligns with the general significance criteria but is specific to impacts on marine flora and fauna.

Table 14.2a: Impact significance categories for marine flora and fauna

Impact Significance	Description of Significance
Very high	Permanent (in excess of 50 years) decrease in an important population or subpopulation of a threatened species or community resulting in significant reduction in viability of the species or community. Adversely affects habitat critical to the survival of the threatened species by fragmenting, modifying, destroying, removing or isolating or decreasing the availability or quality of habitat to the extent that the species or community is likely to decline. Regional permanent (in excess of 50 years) decrease in numerous non-threatened or commercially important species resulting in severe change in regional community structure and reduction in biodiversity. Dominance of only a few species. Reduction in regional viability of numerous species.
High	Long-term (from five to 50 years) decrease in an important population or subpopulation of a threatened species or community resulting in a possible reduction in viability of the species or community. Adversely affects habitat critical to the survival of the threatened species by fragmenting, modifying, destroying, removing or isolating or decreasing the availability or quality of habitat to the extent that the species or community may possibly decline. Regional long-term (from five to 50 years) decrease in a number of non-threatened or commercially important species resulting in significant change in regional community structure and reduction in biodiversity. Reduction in regional viability of some species. Permanent (in excess of 50 years) decrease in an important population or subpopulation of an iconic species or its habitat resulting in significant reduction in viability of the species.
Moderate	Medium-term (one to five years) decrease in an important population or subpopulation of a threatened species or community, however, impact only expected to be temporary with no long term reduction in viability of the species or community. Moderate loss of suitable habitat for threatened species but not of the extent that it affects the viability of the species or community. Regional medium-term (one to five years) decrease in a number of non-threatened or commercially-important species resulting in change in regional community structure and reduction in biodiversity. Possible reduction in regional viability of some species. Long-term (from five to 50 years) decrease in an important population or subpopulation of an iconic species or its habitat resulting in a possible reduction in viability of the species. Long-term (from five to 50 years) decrease in an important population or subpopulation of an iconic species or its habitat resulting in a possible reduction in viability of the species.
Minor	Short-term (up to one year) decrease in a population or subpopulation of a threatened species or community with no effect on the viability of the species or community. Minor loss of suitable habitat for a threatened species. Local short-term (up to one year) decrease in some non-threatened or commercially-important species resulting in a change in local community structure and reduction in local biodiversity, however, impact only expected to be temporary with no long term reduction in viability of the species or community. Short-term (up to one year) decrease in a population or subpopulation of an iconic species or its habitat with no effect on the viability of the species.
Negligible	Minimal change to existing populations, possibly a temporary effect within the bounds of natural variability.
Beneficial	Positive change to existing populations or habitat.

14.2.4. Relevant Legislation and Policy

Legislation and policy relevant to the marine environment was identified in the early stages of the Project to help inform the scope of assessment and surveys required to comply with legislative requirements. Legislation that was identified as relevant to the marine environment is described below.

14.2.4.1. Environmental Protection and Biodiversity Conservation Act 1999

The **Environmental Protection and Biodiversity Conservation Act 1999** (EPBC Act) is the primary federal legislation protecting biodiversity in Australia. This legislation was used to:

Identify nationally threatened marine flora and fauna species and communities.

Determine the likelihood of protected species, habitats or places occurring in a defined area. A protected matters search has been conducted for an area including a 5km buffer zone around the proposed jetty to:

- Determine whether the Project was likely to have a significant impact on the threatened species/communities identified in the Protected Matter search using the EPBC significance criteria
- If there was an identified risk of a significant impact, determine the need for an environmental offset as required under the Act.

14.2.4.2. Quarantine Act 1908

The *Quarantine Act 1908* protects the borders of Australia from natural hazards. It is relevant to the Project in respect to international ship movements during operation, particularly regarding ballast water management.

14.2.4.3. National Parks and Wildlife Act 1972 (NPW Act)

In South Australia, the *National Parks and Wildlife Act 1972* protects biodiversity. It lists threatened species on a state level in Schedules; seven (endangered), eight (vulnerable) and nine (rare). Presence of protected species under the NPW Act in the area was searched via the Biological Database of South Australia as well as through checks against survey observations from the study area.

14.2.4.4. Fisheries Management Act 2007 (FM Act)

The *Fisheries Management Act 2007* provides for the conservation and management of the aquatic resources of the State including:

- The management of fisheries and aquatic reserves
- The regulation of fishing
- The protection of aquatic habitats, aquatic mammals and aquatic resources (provides protection for species and groups that are not necessarily listed as endangered, vulnerable or rare under the NPW Act)
- The control of exotic aquatic organisms and disease in aquatic resources.

14.2.4.5. Marine Parks Act 2007 (MP Act)

The *Marine Parks Act 2007* provides a framework for the dedication, zoning and management of the 19 marine parks in South Australia. Management plans developed under the Act determine the activities that may occur within zones of the marine park.

The Project is located within the Upper Spencer Gulf Marine Park, which is further described in **Section 14.3.1**.

14.2.4.6. Native Vegetation Act 1991 (NV Act)

Under the Native Vegetation Act 1991, any clearance of native vegetation (including marine aquatic vegetation), other than vegetation covered under exemptions, requires specific, written approval from the Native Vegetation Council (NVC).

The Act does not permit clearing of a "substantially intact stratum" of native vegetation, except under specific circumstances and where a Significant Environmental Benefit (SEB) is available and agreed. The Regulations to the Act detail the circumstances under which areas of marine vegetation may be cleared following approval by the NVC.

14.2.4.7. Natural Resource Management Act 2004 (NRM Act)

This Act promotes sustainable and integrated management of the State's natural resources and makes provision for their protection. It also deals with the establishment of NRM Boards for all NRM Regions of South Australia.

The Project is located within the Eyre Peninsula Natural Resource Management Region which is managed by the Eyre Peninsula Natural Resource Management Board (EPNRMB). The EPNRMB also takes an interest in the marine environment and funds the development of action plans and environmental studies.

14.2.4.8. Environment Protection Act 1993 (EP Act)

There are a number of policies and guidelines prepared under the Act that are relevant to the marine environment; including the *Environment Protection (Water Quality) Policy 2003* which provides water quality targets for a number of parameters to protect ecological values of the marine environment.

14.2.4.9. Coastal Protection Act 1972 (CP Act)

This Act deals with the protection of the coast in South Australia and the formation and roles of the Coastal Protection Boards. The CP Act divides South Australia into six Coast Protection Districts with the Project being located in the Eyre District. The functions of the CP Act include:

- Protecting the coast from erosion, damage, deterioration, pollution and misuse
- Developing any part of the coast aesthetically, or to improve it for those who use and enjoy it
- Carrying out, or being involved in, research into the protection, restoration or development of the coast.

14.3. Existing Environment

14.3.1. South Australian Marine Protected Areas

The South Australian Government has developed the South Australian Representative System of Marine Protected Areas as part of the National Representative System of Marine Protected Areas. This now involves 19 marine parks encompassing the major ecosystems and habitat types found within South Australian waters.

As a result of the Northern Spencer Gulf Bioregion containing habitats and species of conservation significance, it was incorporated into a Marine Park (refer to **Section 14.3.1**). The proposed Bulk Commodities Export Facility (BCEF or the Project) is located within the Upper Spencer Gulf Marine Park also known as Marine Park 10 (MP10). MP10 covers 1602km^2 and includes waters north of a line from the southern end of the Whyalla-Cowleds Landing Aquatic Reserve on the western side of Spencer Gulf to Jarrold Point on the eastern shore (DEWNR, 2012b). The Marine Park also includes the uppermost reaches of Spencer Gulf extending north of Port Augusta (**Figure 14.3a**). The landward boundary of the marine park extends at least to the median high water mark and in some instances incorporates coastal Crown Lands including beaches, sand dunes, estuaries and saltmarshes. The ports of Whyalla, Port Bonython (Santos Jetty) and Port Pirie are excluded from the Marine Park.

14.3.1.1. Values of the Marine Park

The environmental, economic and social values of MP10 can be summarised as follows (adapted from the Upper Spencer Gulf Marine Park Management Plan 2012) (DEWNR, 2012b):

Environmental

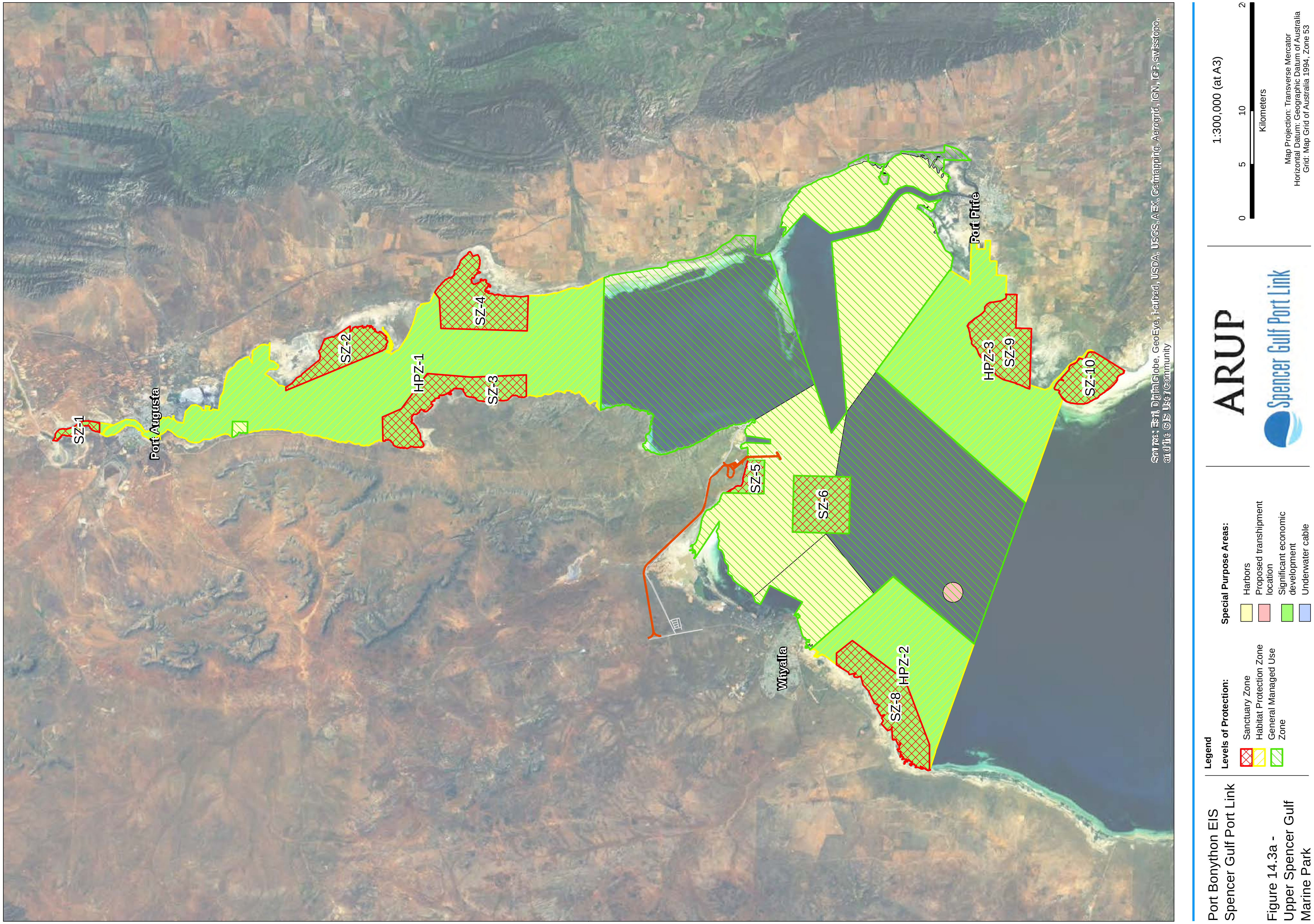
- Unique characteristic as an inverse estuary with higher salinity at the top of the Gulf. Influenced by high temperatures and large tidal ranges
- Recognised as a Wetland of National Importance containing a variety of coastal and marine habitats including saltmarsh, tidal flats and some of the largest stands of mangroves in South Australia (Baker, 2004)
- Important nesting and breeding site for local and migratory shorebirds
- The most extensive seagrass meadows in South Australia (Barker, 2004)
- aggregation of the Giant Australian Cuttlefish.

Economic

- Commercial fisheries including Spencer Gulf Prawn Fishery, the Blue Crab Fishery, the Charter Fishery and the Marine Scalefish Fishery
- Fitzgerald Bay aquaculture zone
- Tourism; including recreational and charter fishing, fishing competitions, sightseeing cruises and diving/snorkelling with Cuttlefish
- Commercial shipping from the ports of Whyalla, Port Bonython and Port Pirie supporting a range of industry sectors, including mining development
- Existing coastal infrastructure (e.g. power stations) and proposed infrastructure developments (e.g. desalination plants and port facilities) are of economic importance in the region
- Water and gas submarine cables traversing Spencer Gulf supply valuable essential services to the Eyre Peninsula community
- The region is part of a broad scale copper-gold geological province within the State and is of economic interest to the resource sector.

Figure 14.3a: Upper Spencer Gulf Marine Park

Figure 14.3a: Upper Spencer Gulf Marine Park



14.3.1.2. Zoning and Management of Marine Parks

The *Marine Parks Act 2007* provides the legislative basis for the Marine Parks while the Marine Park Management Plans provide the statutory basis for management of the Marine Parks. All management activities within the Marine Park must be consistent with, and seek to further the objects of, the *Marine Parks Act 2007*, which includes *'allowing ecologically sustainable development and use of the marine environment' (Marine Parks Act 2007).*

Ultimately, Marine Park management will seek to address the broader conservation challenge that is: to maintain natural systems, processes and the biodiversity that they support. Particular management challenges identified that are relevant to the BCEF include:

- Ensuring effective conservation of protected species and ecological communities
- Ensuring inflows from the land and the effects of development to meet increasing population needs do not have a detrimental effect on habitats and biodiversity
- Ensuring that marine pests are effectively managed
- Ensuring suitable access for shipping to enable the export development for the State.

The Marine Parks are based on multiple-use zoning, providing varying levels of protection for conservation, recreation and commercial use. Marine park zones are the principal tool under the *Marine Parks Act 2007* for managing both current and future activities that take place in marine parks.

14.3.1.3. Zoning and the BCEF

The zoning of MP10 that affects the proposed BCEF, as outlined in the Upper Spencer Gulf Marine Park Management Plan 2012 (DEWNR, 2012b) is shown in **Figure 14.3a**. The ship loading facility extends out into water that is zoned as a General Managed Use Zone (GMUZ-2). The GMUZ-2 zoning will be managed to provide protection for habitats and biodiversity within the Marine Park, while allowing ecologically sustainable development and use. Overlaying this zone in the area of the ship loading facility is a Special Purpose Area (harbour activities), SPA-3, explained in the Management Plan as:

Notwithstanding the zoning of the area, the following activities will be permitted in the special purpose areas (harbor activities) listed above:

> *a) Activities undertaken by or on behalf of the Minister responsible for the administration of the Harbors and Navigation Act 1993, or a port operator, for the purposes of maintaining or improving a harbor or port. (Harbor, port and port operator have the same meanings as in the Harbors and Navigation Act 1993.)*

To the west of the proposed ship loading facility is a Sanctuary Zone, SZ-5, protecting a known area of Giant Australian Cuttlefish breeding habitat. SZ-5 is also overlain with a special purpose area, SPA-5, identified for significant economic development. As stated in the draft management plan:

Notwithstanding the zoning of the area, the following activities will be permitted in the special purpose area (significant economic development) listed above:

> *a) Activities comprising a development or project, or that part of a development or project, within the ambit of a declaration under section 46 of the Development Act 1993; and*
>
> *b) Activities comprising development approved under section 49 (Crown development and public infrastructure) or section 49A (Electricity infrastructure development) of the Development Act 1993.*

With respect to marine ecological issues, management challenges relevant to the proposed development include:

- Ensuring effective protection of protected species
- Ensuring that marine pests are effectively managed.

These are addressed in **Section 14.4** and **14.5**, which examines the potential effects of the development and management measures required to prevent or minimise any adverse impacts.

14.3.1.4. Wetland of National Significance

The Upper Spencer Gulf, north of a line from Whyalla to Port Broughton, is listed in the Directory of Important Wetlands in Australia (Environment Australia 2001). The listing notes the significance the following features of the Upper Spencer Gulf:

- The mangrove forest at Chinaman Creek is considered to be the largest undisturbed stand of mangroves remaining in South Australia
- The Redcliff region is one of the finest examples of a sub-tropical marine and coastal ecosystem in the southern hemisphere, and contains the richest and most diverse coastal flora in South Australia.

Listing in the directory does not provide any form of protection in itself, but does inform planning for formal protection under the NPW Act and more recently under the MP Act.

14.3.2. Commonwealth Marine Protected Areas

14.3.2.1. Introduction

The south-west Marine Region is described in the Marine Bioregional Plan for the south-west Marine Region (SEWPaC, 2012b), prepared under the EPBC Act in order to improve the way the marine environment is managed in Commonwealth waters, particularly in relation to matters of national environmental significance. The south-west Commonwealth Marine Reserve Network is shown on **Figure 14.3b**.

Commonwealth Marine Reserves are declared in Commonwealth waters, generally offshore waters greater than two nautical miles from the coast and not inclusive of Spencer Gulf.

14.3.2.2. Relevance to BCEF

The Project will contribute to ship movements in the Commonwealth waters shipping lanes heading either east or west to Asian markets. Ships exiting the Gulf after loading join the existing shipping lane mostly in a westerly direction, although there may be small movement in an easterly direction.

The transiting of vessels is generally permitted through all zones of the south-west Marine Reserve Network, with the exception being during the seasonal closure of the Marine Mammal Protection Zone (located away from main shipping channels) (Director of National Parks, 2013).

14.3.3. Regional Overview

14.3.3.1. Major Habitats and Bio-geographical Regions of the Northern Spencer Gulf

Spencer Gulf encompasses two marine bio-geographical regions: Spencer Gulf and Northern Spencer Gulf (Thiel & Tanner 2009), as illustrated in **Figure 14.3d**. The BCEF jetty is located at Stony Point, which is approximately 294km from the entrance to the Gulf and 18km north east of Whyalla in the Northern Spencer Gulf bioregion.

This bioregion extends from Point Riley on Yorke Peninsula, to the head of the Gulf at Port Augusta and to Shoalwater Point on Eyre Peninsula, and covers an area of 4136km^2.

Key features of the bio region are described in BHPB (2009) as:

- A relatively sheltered eastern shore with beach ridges, wide inter-tidal flats, and tidal creeks that are frequently colonised by seagrass, mangrove and samphire communities, refer **Figure 14.3d**
- A shallow, subtidal zone, which is generally less than 10m in depth. This zone is colonised by extensive seagrass meadows, refer **Figure 14.3d**
- Narrow deep channels up to 30m of depth with fine silt, coarse sand and shell grit bottoms, dominated by benthic invertebrate communities

Rocky intertidal zone and shallow reef communities, which are up to 6m in depth along the west coast that fall away steeply into deep water.

The overlying water column was also identified as an important broad habitat by Social and Ecological Assessments (SEA, 1981).

The shallow seagrass and mangrove communities are generally regarded as the most critical areas of the Northern Spencer Gulf (Edyvane 1999a and b, cited in Thiel & Tanner, 2009). The clear, shallow, sheltered waters of this region have the most extensive seagrass meadows in the state, comprising 58.1 percent of the total Northern Spencer Gulf bioregion. This represents 75 percent and 43 percent of the total area of seagrass recorded in Spencer Gulf and South Australia, respectively (Edyvane 1999a and b, cited in Thiel & Tanner, 2009). As discussed in more detail in **Section 14.3.4** below, there are no seagrass meadows or mangroves at the jetty site. The nearest seagrass meadow is located approximately two kilometres away at Point Lowly (refer to **Figure 14.3e**). Seagrass meadows are located at Fairway Bank which is approximately one kilometre from the approach and departure channel for the BCEF. Seagrass meadows also occur in False Bay. A small patch of mangroves occurs in Weeroona Bay, but the nearest major mangroves occur on the eastern shores of the Gulf or south of Whyalla at Cowleds Landing (refer to **Figure 14.3d**).

The most dominant seagrass found in the Northern Spencer Gulf includes *Posidonia sinuosa, P. angustifolia, Amphibolis antarctica* and *Heterozostera nigricaulis* and *Halophila* sp. Mangrove forests in South Australia are composed solely of *Avicennia marina* var. *resinifera*. These occur along the sheltered intertidal margins of Northern Spencer Gulf. Mangrove thickets are well developed on the eastern shore but are less extensive on the western shore (Butler et al, 1977).

Figure 14.3b: The south-west Commonwealth Marine Reserve Network

Port Bonython EIS
Spencer Gulf Port Link

Figure 14.3b - South-west Commonwealth Marine Reserves Network

Zoning

- Marine National Park Zone (IUCN II)
- Habitat Protection Zone (IUCN IV)
- Special Purpose Zone (IUCN VI)
- Special Purpose Zone (Oil and Gas Exclusion) (IUCN VI)
- Multiple Use Zone (IUCN VI)

Maritime Boundary

- Limit of Australian exclusive economic zone

ARUP

Spencer Gulf Port Link

1:8,300,000 (at A3)

0 100 200 400
Kilometers

Map Projection: Geographic Lat / Long
Horizontal Datum: World Geodetic System 1984
Grid: Geographic Lat / Long

Figure 14.3b: The south-west Commonwealth Marine Reserve Network

Figure 14.3c: Map of South Australia showing the extent of South Australian Bioregions (DEWNR, 2012b)

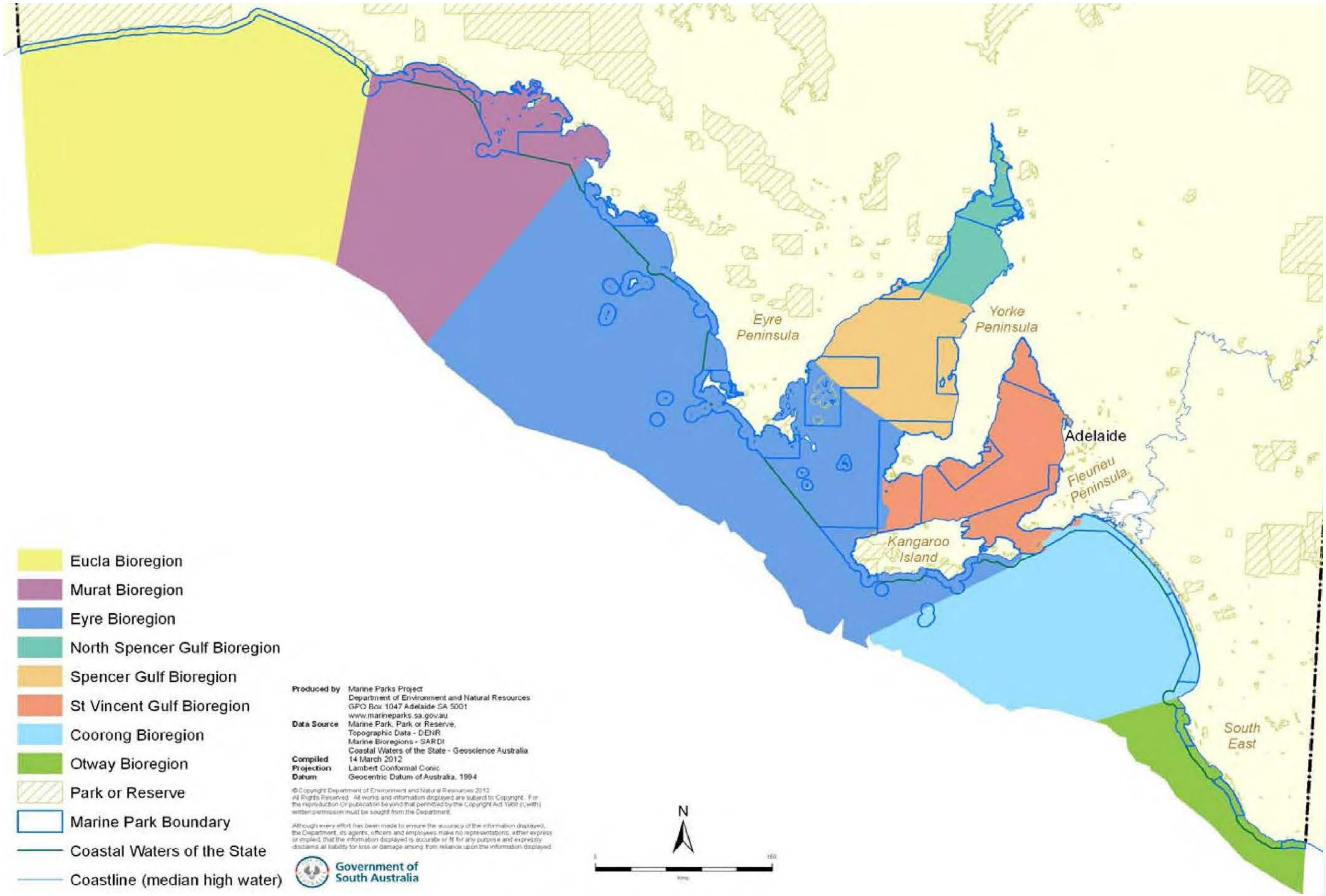


Figure 14.3c: Map of South Australia showing the extent of South Australian Bioregions (DEWNR, 2012b)

Figure 14.3d: Major habitats of the Upper Spencer Gulf (adapted from GIS layers provided by DEWNR, 2012b)

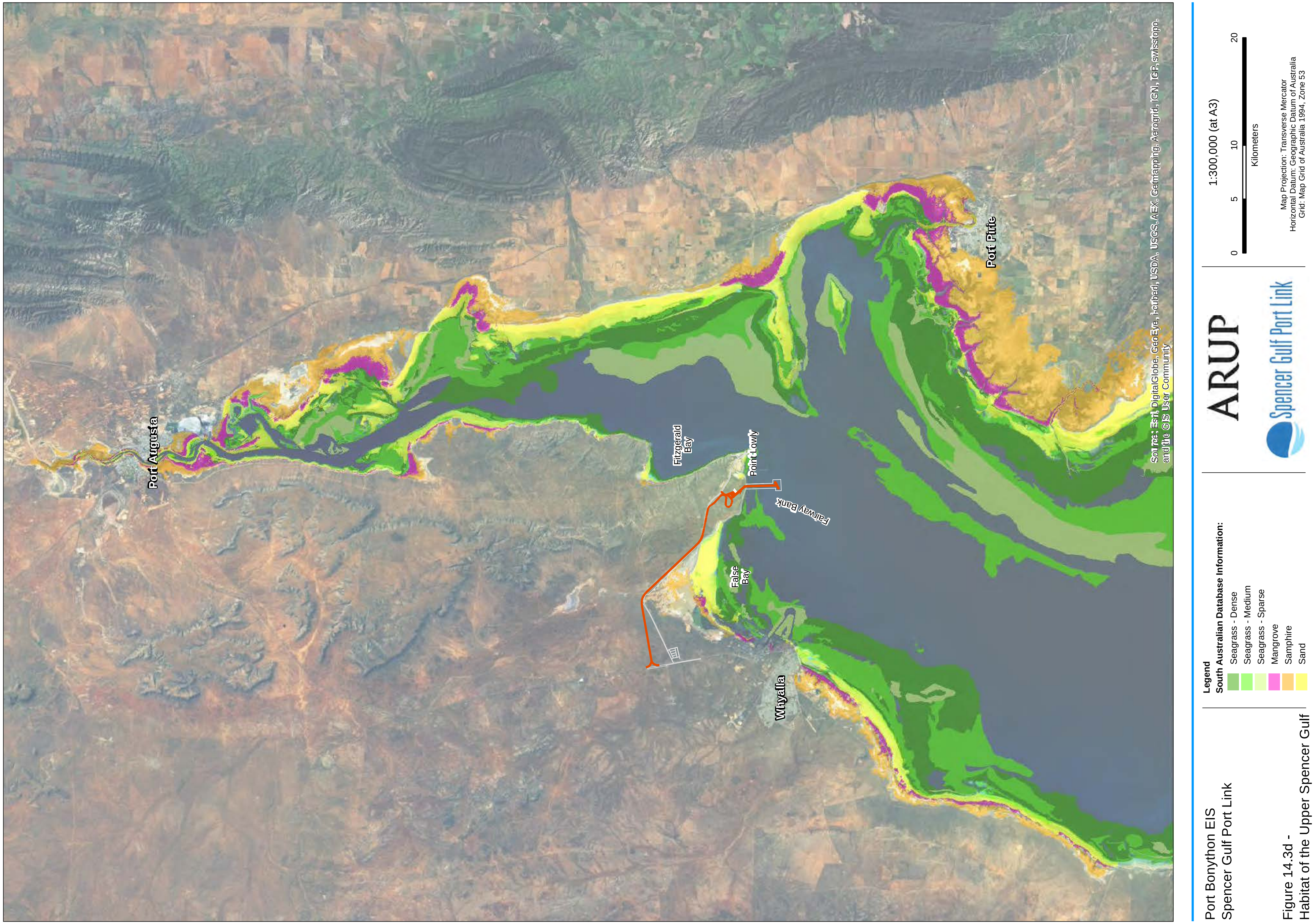


Figure 14.3d: Major habitats of the Upper Spencer Gulf (adapted from GIS layers provided by DEWNR, 2012b)

Yonga Biounit

Thiel and Tanner (2009) also describe the Northern Spencer Gulf Bioregion as consisting of two biounits: Yonga and Winninowie which are 423,557 and 55,267ha respectively. The BCEF is situated in the upper reaches of the Yonga biounit, which extends from Victoria Point, near the mouth of Franklin Harbour, to Point Lowly on the western side of Spencer Gulf. As stated in Edyvane (1999b), the biounit consists of:

- 248,596ha of sheltered Gulf waters, shoals and large areas of seagrass (59.1 percent)
- 161,715ha of sand (38.5 percent)
- 10,054ha of reef habitat (2.4 percent).

The mangrove habitats in this region and their associated mud flats and algal mats, coastal saltmarshes and seagrasses not only provide important habitat for fish and crustaceans but also birdlife (Edyvane 1999b). They support a diversity of fish, crustaceans, molluscs, pipefish and seahorses, some of which are of value to commercial and recreational anglers (Bryars, 2003). The Whyalla-Cowleds Landing Aquatic Reserve which is 3,239ha was established to protect these types of habitats in 1980 (Wood 2007). Edyvane (1999b) classified this aquatic reserve as well as Point Lowly as an area of high conservation value in the Yonga biounit.

In establishing an ecologically representative system of marine protected areas in South Australia, these habitats are recognised as important contributors to the biological productivity and ecological functioning of Spencer Gulf, particularly the northern part (Baker, 2004).

14.3.4. Black Point to Point Lowly Marine Environment

14.3.4.1. Habitats

At a local scale the area of interest is the intertidal and subtidal marine area between Black Point to Point Lowly, because of the location of the proposed BCEF and the construction and operation of the jetty. At this location the intertidal zone is relatively narrow and largely rocky, with deep water down to a depth of 20m around three kilometres, approximately. This contrasts with the majority of the Gulf where near-shore areas have extensive shallow seagrass and mangrove tidal flats, as shown on **Figure 14.3d.**

- As illustrated in **Figures 14.3e** and **14.3f** (BHPB, 2009) the marine habitats from Black Point to Point Lowly include:
- A rocky intertidal zone
- Rocky subtidal zone
- Sandy intertidal zones
- A seagrass bed
- A sponge community
- A deeper zone of silt/mud substratum
- A jetty pile community.

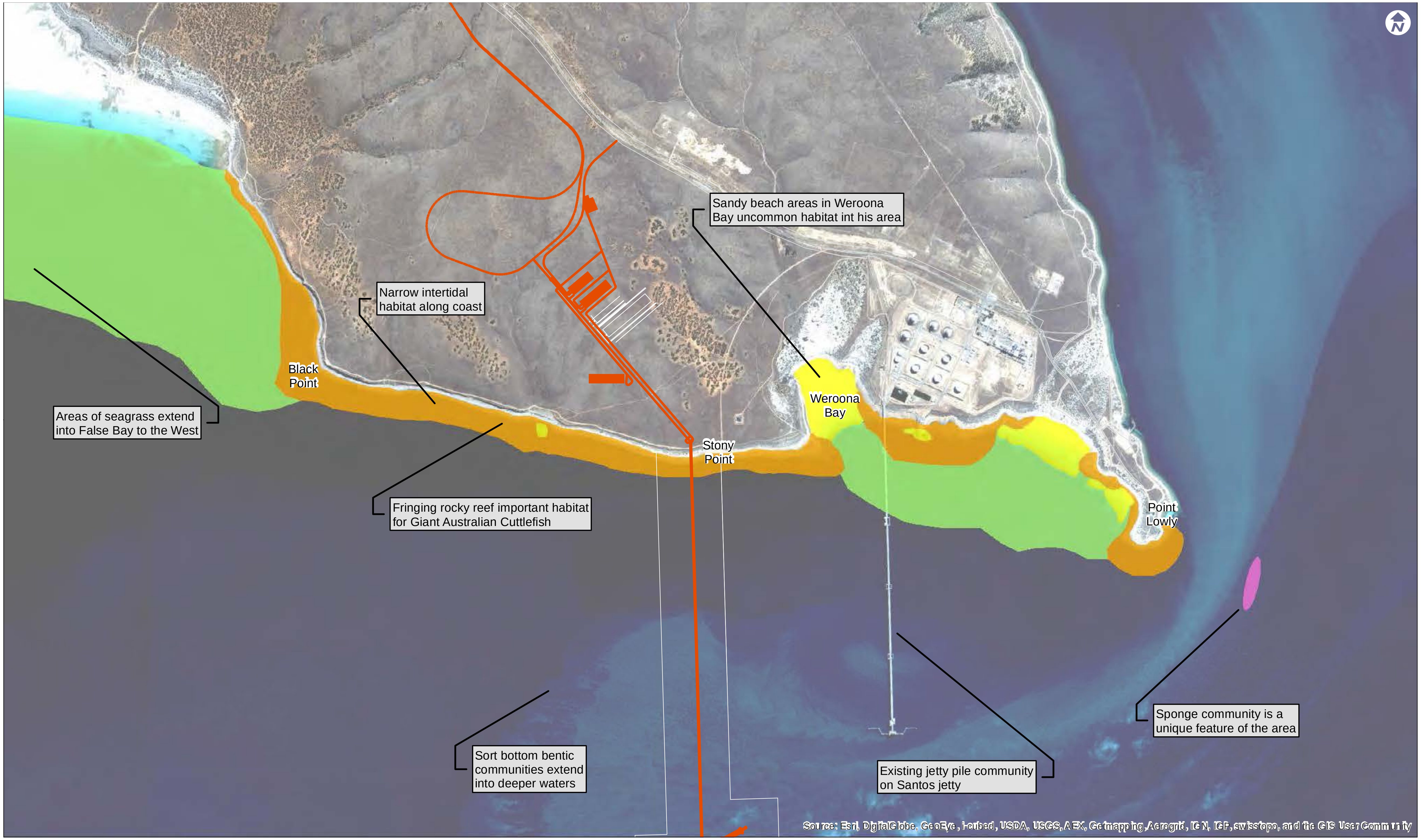
There is also a small stand of approximately 30 mangroves on the western shores of Weerona Bay.

These habitats are described below, with the descriptions of the Rocky Intertidal, Rocky Subtidal, Silt/Mud and Sandy zones being largely taken from the survey report for the Project, included as Appendix K.1 (Theil & Tanner 2009).

14.3.4.2. Rocky Intertidal Zone

Gastropods, Barnacles and Crustaceans mainly dominate the rocky intertidal zone. The Honeycomb Barnacle (*Chamaesipho columna*), has the largest distribution, inhabiting all levels on the intertidal platform as well as several crustaceans such as crabs and Isopods. The most common Gastropods in the upper levels of the intertidal zone are Sea Snails (*Austrocochlea* sp. and *Bembicium* sp.), whereas the Limpet (*Chiazacmea flammea*) and the Tube Worm (*Galeolaria caespitose*) dominate the mid to lower levels. The Gastropod *Lemintina siphon* extends its range from the lower levels of the intertidal to the subtidal zone (SEA, 1981). The Gastropod *Melanerita melanotragus* and Anemone *Actinia tenebrosa* were also identified during later surveys (Santos, 1986). The sandy intertidal zone (Weeroona Bay and Sandy/Lowly Bays) has a diverse infaunal community consisting of several species of Gastropods, Bivalves, Annelids and Crustaceans (SEA, 1981). The species recorded from this habitat are included in **Appendix K.2**.

Figure 14.3e: Marine Habitat; Black Point to Point Lowly



Port Bonython EIS
Spencer Gulf Port Link

Figure 14.3e -
Marine Habitat
(Black Point to Point Lowly)

Legend

Habitat Types:

- Rocky reef
- Sand
- Seagrass
- Sponge community

ARUP

Spencer Gulf Port Link

1:25,000 (at A3)

0 0.25 0.5 1

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: Geographic Datum of Australia
Grid: Map Grid of Australia 1994, Zone 53

Figure 14.3e: Marine Habitat; Black Point to Point Lowly

Figure 14.3f: Schematic transects of biota at Point Lowly (BHPB, 2009)

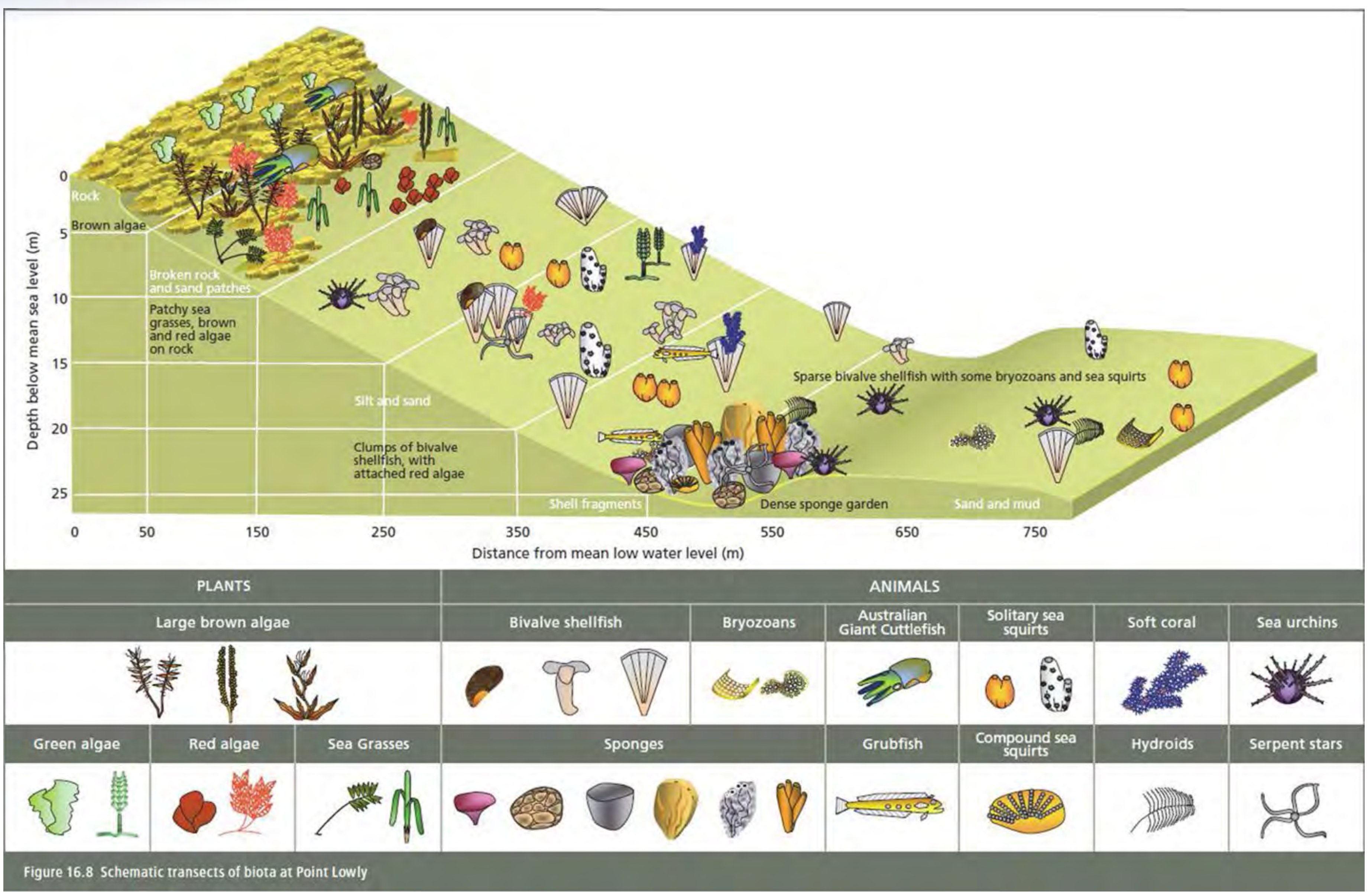


Figure 16.8 Schematic transects of biota at Point Lowly

14.3.4.3. Rocky Subtidal Reef

A recent benthic habitat map of the Port Bonython region shows that a majority of the coastline consists of cobble and medium profile reef (DEH, 2007a cited in Theil & Tanner, 2009). The rocky platform in the vicinity of Stony Point, a substrate of broken rocky platform which provides habitat for an abundant community of flora and fauna, continues offshore for about 150m to a depth of between six and seven metres. The species zonation was first described by SEA (1981), confirmed by later surveys, including Theil and Tanner (2009). The Red Algae (*Laurencia* sp.), dominates the shallows at a depth of between one and three metres with up to 70 percent cover in some places, but is gradually replaced as depth increases to between three and six metres, by a variety of Brown Algae (e.g. *Zonaria* sp., *Dictyopteris muelleri*) covering up to 50 percent of the rocky substratum (SEA, 1981). As the substrate changes from reef to sand at a depth of between five and six metres, a narrow and dense band of *Scaberia agardhii* is seen. Other algae in the vicinity of Stony Point include (SEA 1981, Manning 1984, cited in Theil & Tanner, 2009):

- The red Algae *Jania* sp
- *Laurencia majuscula* and *Champia affinis*
- The brown Algae *Caulocystis* sp
- *Sargassum* sp. and *Lobophora* variegate
- The green Algae Codium capitulatum.

Along the foreshore to the west of Stony Point (including the proposed site for the ship loading facility), the brown Algae *Sargassum* spp. and Turfing Brown Algae are seen on the rocky substrate (Collings et al., 2004). At Black Point (west of Stony Point), the habitat is dominated by the large brown Algae *Scaberia agardhii, Cystophora expansa* and *Caulocystis* sp. The understorey consists of *Gigartitina brachiata* mats and the red and brown Algae *Asparagopsis taxiformis* and *Lobophora variegata* (Hall and Hanlon, 2002). The rocky shores around Point Lowly are commonly dominated by subtidal communities such as brown *macroalgae Scaberia agardhii*, mixed *Cystophora* species (i.e. *C. botryoides, C. expansa, C. polycystidea*), *Lobophora, Caulocystis*, and *Sargassum linearifolium* (Edyvane 1999b).

Of note is the annual appearance of the filamentous brown Alga *Hincksia sordida*, which covers many of the large canopy-forming brown Algae. This may be due to increased nutrient availability and calm conditions, as discussed in **Chapter 13, Coastal Processes and Water Quality** but the bloom is reported to be dissipated by winter storms (BHPB, 2009).

A variety of invertebrates inhabit the rocky subtidal zone including Sponges, Cnidarians, Molluscs and Echinoderms (SEA, 1981). The Sessile Filter-Feeders (Sponges, Cnidarians and Bivalves) are the most dominant. The small Mussel *Mytilus* sp. covers up to 100 percent of the rock surface in the one to two metre depth range and the Hammer Oyster (*Malleus meridianus*) is abundant in the deeper section of the reef. A benthic survey conducted in 1995 also recorded dense Hammer Oyster cover on the substrate (forming up to 100 percent cover in some areas) in the four to five metre depth range at Point Lowly (Edyvane and Baker, 1996). Sponges and large specimens of the coral *Plesiastrea versipora* are distributed widely over the reef (SEA, 1981). The most common Sea Urchin, *Heliocidaris erythrogramma,* can reach high densities at five per square metres in areas of high Algal cover. Gastropods are also associated with the algae. Common reef fish such as the Banded Sweep (*Scorpis georgianus*), the Zebra Fish (*Girella zebra*) and the Dusky Morwong (*Psilocranium nigricans*) are seen in the reef zone (SEA, 1981).

The fauna at Black Point is similar to that at Port Bonython, with the Sea Urchin, *Heliocidaris erythrogramma*, Bivalves (Razor Fish, (*Pinna bicolor*), and Hammer Oysters, (*Malleus meridianus*)), and Sponges dominating the rocky reef (Hall & Hanlon, 2002). Marine ecological surveys undertaken at Port Bonython as part of an annual environmental monitoring program between 1982 and 1985 found a total of 178 species across all sites during the last survey (Santos, 1986). Molluscs accounted for 57 percent of the fauna, with the Bivalve *Brachidontes erosa* contributing the greatest at 44 percent. *Polychaetes* and Crustaceans comprised 21 percent and 16 percent of total abundance, respectively. Populations of the Sea Urchin *Heliocidaris erythrogramma*, representing the larger reef invertebrates, fluctuated considerably along the coast and between surveys. Several species of Turfing Algae and Sponges were also recorded. Algae biomass was greatest at Stony Point and lowest near Lowly Bay (Santos, 1986).

The Giant Australian Cuttlefish (*Sepia apama*), aggregates seasonally to breed on the reef using the crevices in which to lay eggs. This species is discussed in more detail in **Section 14.3.5**.

14.3.4.4. Sandy Subtidal Zone

The sandy subtidal zone is an extension of the two sandy intertidal zones, Weeroona Bay and Sandy/Lowly Bays. It extends about 300m offshore at a depth of six to seven metres, until it merges with the soft silty substrate typical of deeper waters. This habitat is dominated by patchy seagrass, mainly *Posidonia sinuosa* and *P. australis*, and some *Heterozostera nigricaulis* and *Halophila ovalis* in Sandy Bay, which reaches its greatest density at three metres and gradually becomes sparser with depth due to the silt-filled water column (SEA, 1981). A recent benthic habitat map of the Port Bonython region shows that continuous meadows of medium density seagrass are located in a narrow band of approximately 400m along the coastline of Port Bonython (DEH, 2007a). The band of seagrass then widens towards Point Lowly before extending offshore and becoming sparser with depth. In the vicinity of the proposed site for the ship loading facility at Stony Point, continuous but sparse seagrass extends 500m offshore (refer to **Figure 14.3e**). A continuous meadow of medium density seagrass is located further offshore as well as other sparse patches of seagrass. Razor Fish (*Pinna bicolor*) are associated with the seagrass and Razor Fish densities increase with depth. On the seaward edge of this sandy zone, sparse bands of initially *Scaberia agardhii* and subsequently the seagrass *Heterozostera nigricaulis* are found (SEA, 1981). *Asparagopsis armata* is also associated with the sandy subtidal zone (Manning, 1984).

14.3.4.5. Sandy/Silt Zones

The most extensive habitat in the vicinity of Stony Point consists of silt/mud substratum. SEA (1981) found this zone to start in depths of 6-10m and extend to the deeper waters at approximately 30m (BHPB, 2009). The substrate is reasonably uniform, with a mixture of silt and mud and occasionally small patches of coarse sand/shell grit. This soft bottom habitat has relatively stronger currents and turbid water. The most common fauna are the Yellow Ascidian (*Polycarpa viridis*), of which there are 8/m^2 and *Pinna bicolor*, of which there are 5/m^2. To a lesser extent common fauna includes the Scallop *Equichlamys bifrons*, the Spotted Ascidian (*Phalussia depressiuscula)* and the Stalked Bryozoan (*Lanceopora oblique*) (SEA, 1981). *P. bicolor* also supports a diversity of epifauna including the soft coral *Carijoa* sp., numerous sponges, the Hammer Oyster (*Malleus meridianus*), Barnacles and the Pencil Urchin (*Goniocidaris tubaria*). *P. bicolor*, as well as a uniform cover of Stalked Bryozoans, Orange Finger Sponges and Ascidians (epizoic on Pinna) were also recorded at a depth of 20m in the Point Lowly channel during surveys in 1995 (Edyvane & Baker 1996, cited in Theil & Tanner, 2009). As mentioned above, the deeper waters off Port Bonython support a mixture of sparse and medium-sparse seagrass (DEH, 2007a). McLaren and Wiltshire (1984, in Harris & O'Brien 1998) suggested that seagrass communities such as *P. sinuosa* and *Heterozostera* sp. might occur in lower current energy areas away from the main tidal channels, in depths up to 9m. The most common infauna includes an unidentified Burrowing Brittle Star and Tube-Dwelling Sandworm, but abundances are low. Several species of Filamentous Red Algae are the only macroalgae seen in this zone (SEA, 1981).

Further offshore the bathymetry of the seabed rises to an area known as Fairway Bank, which supports a large seagrass meadow (Baker, 2004). At Fairway Bank, patches of the green macroalga *Caulerpa cactoides* and sparse beds of *Posidonia angustifolia* were recorded at 10m depth (Edyvane & Baker, 1996 and SARDI S.A. Benthic Survey data, 1995, unpublished; cited in Baker, 2004).

14.3.4.6. Sponge Community

One deep water site at 28m depth, approximately 600m off Point Lowly was dominated by erect, spheroidal, encrusting, cupulate, tubular and fan-shaped Sponges. These collectively covered about 70 percent of the silt/sand. It was noted that the current regime was stronger at this location. Hammer oysters, bryozoans, brittle stars and hydroids were also present. Their abundance was higher relative to the silt/sand bottom community (BHPB, 2011a).

14.3.4.7. Sparse Seagrass Bed

As described in BHPB (2009), the seagrass bed is approximately 150m offshore (as illustrated in **Figure 14.3e**). It is a sparse seagrass community, largely consisting of *Posidonia sinuosa* and *P,australis,* with some Eelgrass (*Heterozostera nigricaulis*) occurring. Bands of the Corkweed (*Scaberia agardhii*) also occur. The density is greatest at about 3.5m, but declines with greater depth. It was noted that the currents were too strong and turbidity too high for dense seagrass to occur in the vicinity of Point Lowly.

The dominant fauna is the Razor Fish (*Pinna bicolor*), which provides a substrate for various epiphytic fauna and flora.

14.3.4.8. Jetty Pylon Community

As described in BHPB (2011a), the existing Port Bonython jetty pylons (Santos Facility), constructed in 1982, now provide a significant artificial reef, supporting a diverse fauna and flora. The characteristics of the community vary with depth similar to that of the sub-tidal rocky reef. Between 0-5m the biota is dominated by filamentous green Algae, the red Alga *Asparagopsis* sp. and Mussels. Between 5-10m there are Hammer Oysters (*Malleus meridianus*), Feathery Hydroids (*Halocordyle* sp.), encrusting Sponges, the Colonial Ascidian *(Clavelina* sp), and the soft Coral *Carijoa* sp. In greater than 10m depth the community consists of Amorphous Sponges, the Hammer Oyster and soft coral.

Fish species are also present. The field survey also found Sea Sweep (*Scorpis aequipinnis*) (most commonly observed), followed by Moonlighter (*Tilodon sexfasciatus*). Others included the Long-Snouted Boarfish (*Pentaceropsis recurvisostris*), Magpie Perch (*Cheilodactylus nigripes*), Western Talma *(Chelmonops curiosus*) and Globe Fish (*Diodon nicthemerus*).

In early 1982, when construction of the Santos Facility at Port Bonython began, a monitoring program was established to assess the environmental effects of the operation. This program also allowed researchers to observe the development and dynamics of the fouling assemblage on a newly created structure in an area of strong tidal currents, generally moderate wave exposure, and large seasonal fluctuations in temperature and salinity (Butler & Connolly, 1996). Early colonisation of the bare substrate of the jetty piles will give an indication of the species composition and density of Pelagic Larvae available in the Spencer Gulf. The results of this work provide some indication of the likely development of the fouling assemblage on the jetty piles of the current Project, noting that the development will not be directly comparable due to a number of changed environmental factors including the Santos jetty now providing a potential seed source of colonising organisms for the piles of the proposed BCEF.

The piles used for the Santos jetty were 1016mm diameter cylindrical steel piles with a coal tar epoxy coating. Observations of the colonisation of the piles began a very short time after the piles were installed and continued for a period of six and a half years (final observations in January 1989). The authors of the paper referred to here also undertook a follow-up study in December 1995, a further seven years after the previous observation, allowing an evaluation of a total of 13.5 years development of the assemblage (Butler & Connolly, 1999).

Butler and Connolly (1996) reported many Bivalves, especially *Electroma georgiana, Malleus meridianus, Ostrea angasi* and *Anomia trigonopsis*, were present early in the observation period, with much bare space. Hydroids were very abundant early with the percentage of cover increasing rapidly after four months, to be near 100 percent coverage after six months. Encrusting modular organisms occupied an estimated 30 percent of space after six months. After a little more than eight months, sheet, mound and tree form modular organisms, especially Sponges and *Carijoa* sp. were abundant along with unitary organisms, especially Bivalves and Ascidians.

There was little difference observed in the pattern of colonisation between bents (groups of piles at intervals along the jetty length), despite the different dates of their establishment. Exceptions were the dates of the initial arrival of *Carijoa* sp and *M. meridianus* which suggested a limited period of dispersive recruitment in late summer, and a bloom of unidentified pink and grey mound-forming sponges which were very abundant on the older piles at a time when piles at other observations sites were only two to four months old; these then died off from the older bents and never became established on the newer bents (Butler & Connolly, 1996).

It was noted that the Santos jetty at Port Bonython was colonised rapidly. Observation of some of the first piles installed showed 100 percent cover of three dimensional colonies, especially sponges, had developed in a little over 12 months; such assemblages take more than two years to develop in Gulf St Vincent (Butler & Connolly, 1996). The authors suggest that this may be due to high water movement and seasonally higher temperatures.

Unitary animals, especially *Malleus meridianus, Phallusia obesa* and *Polycarpa* spp., remained abundant after six to seven years although the solitary ascidians appeared to have declined; encrusting and mound-form modular cover was still only modest and spatially variable, the rest of the space being occupied by unitary and arborescent forms (Butler & Connolly, 1996).

When the site was revisited seven years after the initial study ceased, no new species were recorded colonising the piles, indicating some stability in the species composition at least had been reached. There were, however, shifts in the relative abundance of those species present. Butler and Connolly (1999) were unable to conclude, based on insufficient number of samples through time, whether the assemblage on the piles at the Santos jetty had reached a state of stability or whether there is ongoing changing dynamics.

These studies indicate that there is likely to be rapid colonisation of the proposed jetty as part of the BCEF, resulting in a local increase in biodiversity.

14.3.4.9. Tropical Affinities

As summarised in AGC (1989), two characteristics of the Gulf which have regional biological interest are the presence of relic tropical algal species and the presence of certain coelenterates.

Two species, *Asparagopsis taxiformis* and *Platysiphonia mutabilis*, occur only westward of the South Australian Gulfs and appear to have warm temperate affinities. Two other species (*Sargassum decurrens* and *Hormophysa triquetra*) are tropical and subtropical in their distribution. Thus there is a small but distinct tropical and possibly relic element in the algal flora. However it is also suggested that they could be immigrants, perhaps via the Leeuwin Current which originates in the Western Australian tropics (Ridgeay & Condie 2004, in BHPB 2011a). Generally, the number of algal species for Upper Spencer Gulf is much less than that recorded for rocky bottom on oceanic coasts (Shepherd & Womersley, 1970, 1971, 1976, 1981 and Shepherd, 1983, cited in AGC 1989) and reflects the environmental extremes and habitat diversity in the upper Gulf. Many of the algal species found are widely distributed throughout the southern Australian (Flindersian) region and are therefore considered as having intermediate warm-cool temperate, biogeographic affinities (Womersley, 1959, 1981 a,b).

The presence of certain *Coelenterates* has special interest. *Echinogorpia sp.* and *Scytalium sp.* appear to be endemic in Upper Spencer Gulf (Grashoff, 1982). *Virgularia mirabilis*, a cosmopolitan species, is known in South Australia only from this region (Utinomi and Shepherd, 1982) and *Carijoa* sp., a tropical species, is recorded in South Australia only in mid and Upper Spencer Gulf (Versevldt 1982). In addition, the *Ascidian Sycozoa pedunculata* is known in southern Australia only from Upper Spencer Gulf and Investigator Strait (Kott 1972 a,b, 1975). The last four species, except *V. mirabilis,* appear to have tropical affinities, suggesting that isolated populations are confined to Gulf waters. Nowhere in Upper Spencer Gulf does *Pinna bicolor* support the rich epizoic fauna described for Upper Gulf St. Vincent.

14.3.4.10. Proposed Jetty Alignment Transect

The report by Theil and Tanner (2009) included transect surveys along the alignment of the proposed jetty for the BCEF. These surveys, comprising of both diver and video observations, identified four main habitat groups using cluster analysis of percent cover data:

- Rocky reef – canopy Algae and red understorey Algae
- 80 percent sand, 20 percent seagrass/animal
- 50 percent sand, 50 percent animal
- 70 percent shellgrit/sand, 30 percent animal/Algae.

The extent of these four habitat groups along the alignment is shown in **Figure 14.3g**, with the composition of these groups displayed in **Figure 14.3h**.

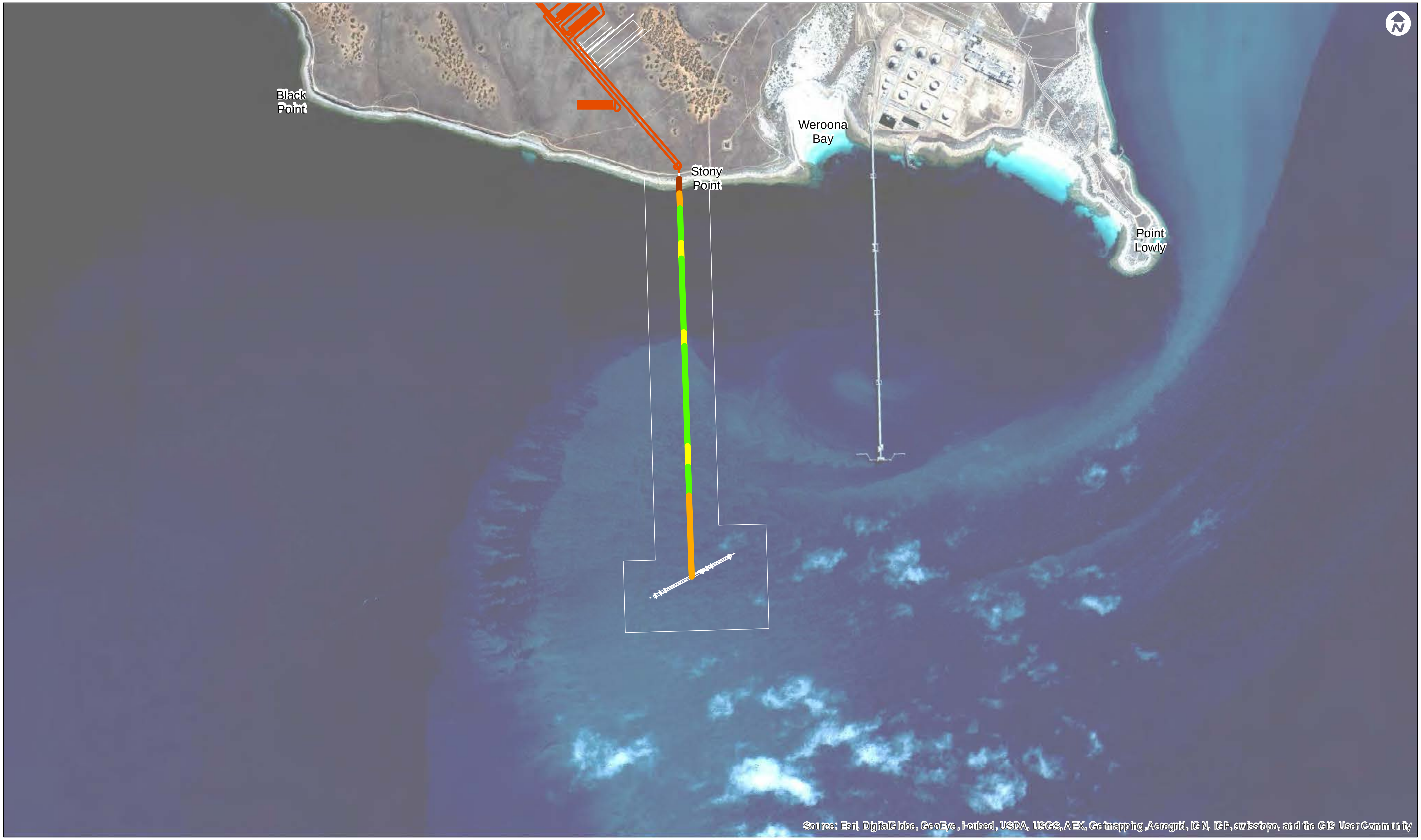
Group One consists entirely of rocky reef habitat, with a majority of the taxa consisting of the red understorey Algae *Asparagopsis taxiformis* (65 percent), unidentified brown understorey Algae (40 percent) and brown canopy Algae (7 percent, probably *Cystophora* spp. or *Caulocystis* spp.). The rocky reef habitat is located in the first 100-200m of the video transect (**Figure 14.3g**).

Group Two largely consists of sand/mud habitat (81 percent) with some animals (13 percent, mostly the Razor Fish *Pinna bicolor*), and covers a majority of the transect along the proposed jetty (**Figure 14.3.g**). This habitat also has a small amount of the seagrass *Heterozostera* sp. (5 percent), which is mostly located 200-300m offshore from the rocky reef. A small amount of the seagrass *Amphibolis* sp. may occur approximately 800m offshore but it is uncertain whether the seagrass was attached due to poor visibility.

Group Three has roughly equal proportions of sand/mud (52 percent) and animals (48 percent). This habitat has the overall greatest proportion of animals, which are mostly *Pinna bicolor.*

Group Four consists mostly of shell grit/sand habitat (69 percent), with the remaining consisting of similar proportions of Algae (unidentified red and brown understorey algae) and animals (e.g. the ascidian *Polycarpa* sp., Razor Fish *P. bicolor*, Soft Coral *Carijoa* sp.) (**Figure 14.3h**). A majority of this habitat is located at the end of the proposed jetty (~21m) and continues inshore for approximately 800m. (**Figure 14.3g**). A small proportion of this habitat is also found in the rocky reef zone as well as the canopy Algae *Scabaria agardhii* (**Figure 14.3g**).

Figure 14.3g: Benthic map showing the locations of the four different habitat groups found along the length of the proposed jetty (Theil and Tanner, 2009)



Port Bonython EIS
Spencer Gulf Port Link

Figure 14.3g -
Benthic Habitats of the
Proposed Jetty

Legend

Benthic habitats:

- Rocky reef - Canopy algae and red understorey algae (Group 1)
- 80% sand, 20% seagrass/animal (Group 2)
- 50% sand, 50% animal (Group 3)
- 70% shellgrit/sand, 30% animal/algae (Group 4)

ARUP

Spencer Gulf Port Link

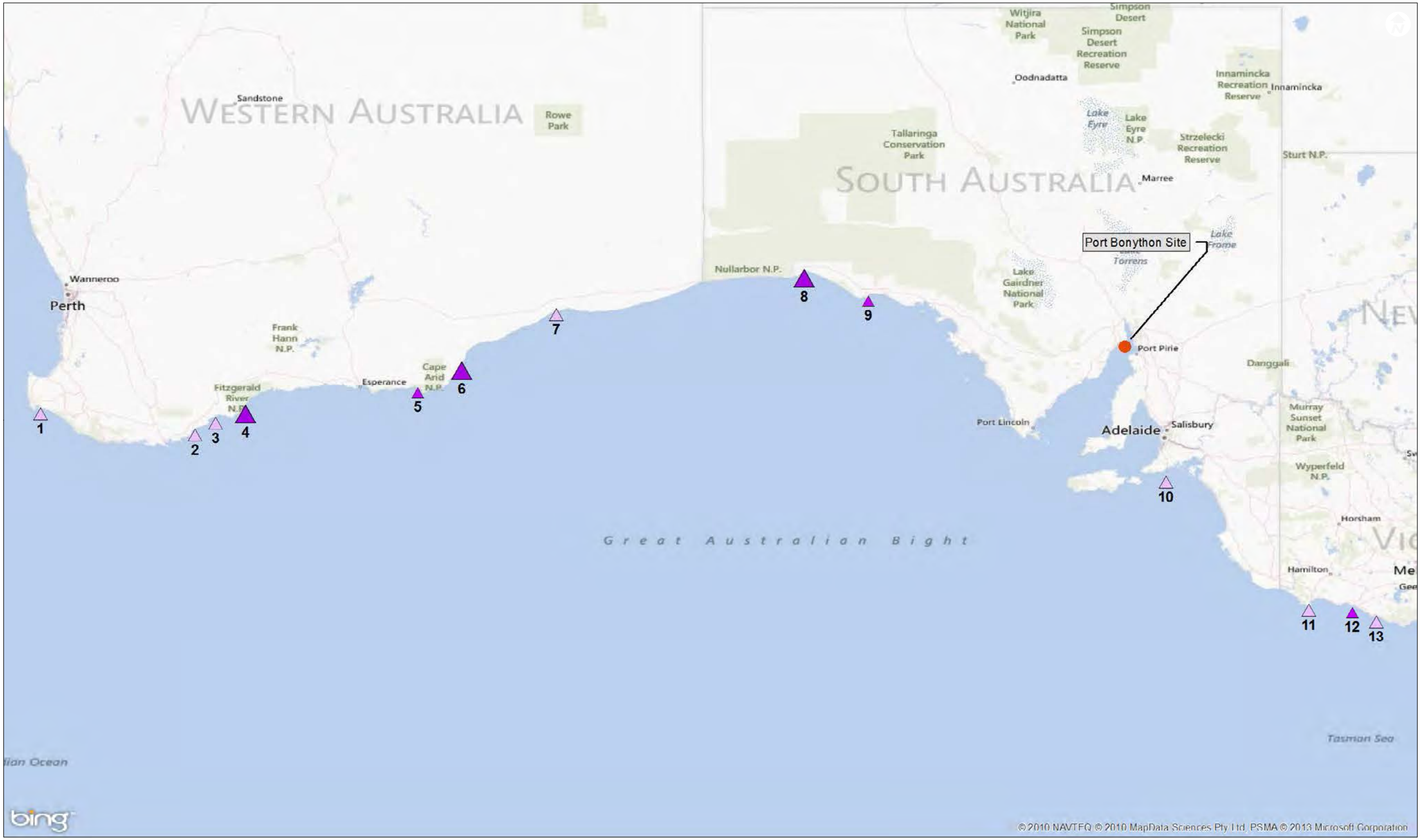
1:25,000 (at A3)

0 0.25 0.5 1
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: Geographic Datum of Australia
Grid: Map Grid of Australia 1994, Zone 53

Figure 14.3g: Benthic map showing the locations of the four different habitat groups found along the length of the proposed jetty (Theil and Tanner, 2009)

Figure 14.3h: Map of species range, core coastal range and coastal aggregation areas of Southern Right Whales (SEWPaC, 2012a)



Port Bonython EIS
Spencer Gulf Port Link

Figure 14.3h -
Coastal Aggregation Areas

Legend

Coastal aggregation areas:

- Established - large
- Established - small
- Emerging

1. Flinders Bay
2. Hassell Beach
3. Cheyne, Wray, Dillon & Bremer Bays
4. Doubtful Island Bay
5. Yokinup Bay area
6. Israelite Bay area
7. Twilight Cove
8. Head of Bight
9. Fowlers Bay
10. Encounter Bay
11. Portland
12. Port Fairy 7 Warnambool
13. Port Campbell & Peterborough

ARUP

Spencer Gulf Port Link

1:8,000,000 (at A3)

0 100 200 400

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: Geographic Datum of Australia
Grid: Map Grid of Australia 1994, Zone 53

Figure 14.3h: Map of species range, core coastal range and coastal aggregation areas of Southern Right Whales (SEWPaC, 2012a)

14.3.5. Listed Species

14.3.5.1. Presence of Listed Species in the Upper Spencer Gulf

The Northern Spencer Gulf supports numerous marine species of conservation value. Some of these species are protected by legislation under the EPBC Act, NPW Act or the Fisheries Act as outlined in **Table 14.3b**.

A database search of marine fauna species listed for protection under Federal and State legislation identified 40 species of conservation significance that could potentially occur in the Upper Spencer Gulf within two kilometres of the Project. This included eight threatened species and 32 non-threatened species. The eight threatened species are the Southern Right Whale (*Eubaleana australis*), Humpback Whale (*Megaptera novaeangliae*), Australian Sea-lion (*Neophoca cinera*), Australian Fur-seal (*Artocephalus pusillus*), Loggerhead Turtle (*Caretta caretta*), Green Turtle (*Chelonia mydas*), Leatherback Turtle (*Dermochelys coriacea*) and the Great White Shark (*Carcharodon carcharias*).

These 40 species identified as potentially occurring in the area were assessed with regards to:

- Occurrence of the species in the study area and Upper Spencer Gulf (i.e. recent records and presence of habitat)
- Mobility of species (i.e. is the species a resident of the area or seasonal visitor)
- The importance of affected habitat for that species.

Using an assessment based on the following criteria, species identified as being exposed to a credible risk from the Project were assessed in more detail.

Mobility

1. Highly mobile species with other suitable habitat away from the impact area
2. Sedentary or species with reduced mobility
3. Species with critical habitat in the area.

Distribution

a. Never recorded in the Upper Spencer Gulf or rare historical record

b. Occasionally recorded in the Upper Spencer Gulf

c. Regularly recorded in the Upper Spencer Gulf.

Credible Risk to Species

Based on mobility and distribution, a matrix can be created to determine the credible risk to listed species, shown in **Table 14.3a**.

Table 14.3a: Credible risk to listed species

	Distribution		
Mobility	**a**	**b**	**c**
1	No	No	Yes
2	No	Yes	Yes
3	No	Yes	Yes

Table 14.3b: Listed, Threatened, Endangered and Protected Species

Species	Status*		Comments	Mobility	Occurrence	Credible Risk
	EPBC Act	SANPW Act Fisheries Act				
Mammals						
New Zealand Fur-seal (*Arctocephalus forsteri*)	Ma	P	South Australian Museum has records of a juvenile found at the Whyalla jetty in 1993 along with a second individual found further north near Douglas Point in 1999. Records also exist from around the Port Augusta area. Anecdotal evidence (DEWNR, 2013) suggests sightings are becoming more regular in the Whyalla region.	1	c	Yes
Australian Fur-seal (*Arctocephalus pusillus*)	Ma	R, P	Prefers cooler waters and not generally associated with the Gulfs in South Australia. No records held by the South Australian Museum for Upper Spencer Gulf. Species more prevalent to the east of Kangaroo Island.	1	a	No
Bryde's whale (*Balaenoptera edeni*)	Ce, Mi	P	A rare visitor to the Spencer Gulf and South Australia in general. Single deceased specimens were identified by the South Australian Museum near Port Augusta in 1986 and 1989 (Atlas of Living Australia, viewed online 21.1.2013)	1	a	No
Pygmy Right Whale (*Caperea marginata*)	Ce, Mi	P	No records were discovered for the Upper Spencer Gulf; however, sightings have been recorded in the southern area of the Gulf near Port Lincoln. It is possible that they are a rare visitor to the waters around Port Bonython.	1	a	No
Short-beaked Common Dolphin (*Delphinus delphinus*)		P	Common throughout South Australian waters, including Upper Spencer Gulf. South Australian Museum holds records for around Point Lowly and Whyalla areas. Species likely to be present at times in the study area feeding on small fish and cephalopods.	1	c	Yes
Southern Right Whale (*Eubalaena australis*)	En, Mi	Vu, P	Winter visitor to South Australian waters where it aggregates to breed and calve. No aggregation areas in the Upper Spencer Gulf, however, records of the species moving through the area are held by the South Australian Museum, including the waters around False Bay.	1	b	Yes**
Dusky Dolphin (*Lagenorhynchus obscurus*)	Ce,Mi	P	Unlikely to occur in Upper Spencer Gulf since generally favours cooler waters (<18°C). Nearest observation near Kangaroo Island.	1	a	No
Humpback Whale (*Megaptera novaengliae*)	Vu, Mi	Vu, P	Species predominantly moves up the east and west coasts of Australia on migration pathways from summer feeding grounds to northern breeding grounds. Australian population recovering at near maximum biological rate following historical whaling (SEWPaC 2013b). Sightings appear to be increasing in South Australian waters, including Upper Spencer Gulf	1	b	Yes**

Species	Status* EPBC Act	Status* SANPW Act Fisheries Act	Comments	Mobility	Occurrence	Credible Risk
Mammals						
Australian Sea-lion (*Neophoca cinera*)	Mi	R	The largest breeding colonies of the Australian Sea-lion occur to the east of Port Lincoln (SEWPaC, 2013f). Members of these colonies may seasonally visit the Upper Spencer Gulf to take advantage of foraging opportunities such as the Cuttlefish aggregation. Confirmed sighting of male in poor condition hauled out in Fitzgerald Bay (Atlas of Living Australia, viewed on 21.5.2013)	1	b	No
Indian Ocean Bottlenose Dolphin (*Tursiops aduncus*)	Ce	P	Species widespread in South Australian waters, including the Upper Spencer Gulf. A pod of this dolphin species has taken up residence around the Whyalla boat ramp and regularly interacts with vessels transiting this area. Observations of this species have occurred within the study area of an individual feeding on Giant Australian Cuttlefish (Finn et al, 2009)	1	c	Yes
Common Bottlenose Dolphin (*Turiops truncatus s. str.*)	Ce	P	Widely distributed in South Australian waters, more frequently observed in open ocean (rather than in Gulfs). South Australian Museum holds record of observations in False Bay and Port Pirie. Likely an occasional visitor to the area.	1	b	No
Sharks and Rays						
Great White Shark (*Carcharodon carcharias*)	Vu, Mi	P	Recorded in the area around Whyalla and Point Lowly, likely attracted to the area following aggregations of prey such as Snapper and Kingfish. Also known to be attracted by aquaculture activities. Species is poorly studied, however, study area not recognised as important habitat or breeding area.	1	b	No
Porbeagle (*Lamna nasus*)	Mi		Unlikely to occur in Upper Spencer Gulf since generally favours cooler waters (<18°C). Occurs in both northern and southern hemispheres.	1	a	No
Reptiles						
Loggerhead Turtle (*Caretta caretta*)	En, Ma, Mi	-	A deceased specimen was identified by the South Australian Museum that washed up on the shore in Weeroona Bay, adjacent to the Santos Facility at Port Bonython, in 2000. Previously, in 1992, a deceased specimen was identified washed up near the power station at Port Augusta, indicating that the species occurs occasionally in the Upper Spencer Gulf (Atlas of Living Australia, viewed online 21.1.2013).	1	b	No
Green Turtle (*Chelonia mydas*)	Vu Mi	-	A record is held by the South Australian Museum for sightings of an individual swimming in the Port Pirie area on the eastern shores of the Upper Spencer Gulf before becoming beached and dying in 1987 (Atlas of Living Australia, viewed online 21.1.2013).	1	b	No
Leatherback Turtle (*Dermochelys coriacea*)	En, MaMi	Vu	The Leatherback Turtle's ability to regulate blood flow allows it to utilise cold water foraging habitats unlike other turtle species. A pelagic species associated more with open waters and unlikely to occur in the Upper Spencer Gulf.	1	a	No

Species	Status*		Comments	Mobility	Occurrence	Credible Risk
	EPBC Act	SANPW Act Fisheries Act				
Fish						
Southern Pigmy Pipehorse (*Acentronura austral*)	Ma	P	Rarely recorded, but known records suggest its habitat is among macroalgae and seagrass to around 20m depth (Browne et al 2008). No records for Upper Spencer Gulf.	2	a	No
Tiger Pipefish (*Filicampus tigris*)	Ma	P	Nineteen specimens have been collected during Snapper trawls across Upper Spencer Gulf in the last few years (SARDI unpublished data 2007; cited in BHPB, 2009). Several reported by documentary filmmaker on sandy bottom in False Bay (Cuttlefishcountry.com/category/news/, viewed on 15/3/2013)	2	b	Yes
Upside-down Pipefish (*Heraldia nocturna*)	Ma	P	Prefers reef habitats, down to approximately 30m in low energy bays with little sediment (Browne et al 2008). Often associates with *Maroubra perserrata*. South Australian Museum records only exist in the Southern Spencer Gulf, no records from Upper Spencer Gulf.	2	a	No
Short-snouted Seahorse (Hippocampus breviceps)	Ma	P	The shorthead seahorse populates moderate- to low-energy inshore habitats, often in *Ecklonia* kelp or *Sargassum*, or mixed patches of macroalgae and seagrass, to about 15 m (Browne *et al*, 2008). The shorthead seahorse is also found on sponge reef in deeper water, amongst floating macroalgae or around jetties (Kuiter 2003; cited in Browne, 2008)). South Australian Museum holds records and specimens of this species collected from the Port Pirie area. Presence of species also reported at False Bay and Cowleds Landing (B.McDonald, pers. comm.; cited in BHPB, 2009)	2	b	Yes
Rhino Pipefish (*Histiogamphelus cristatus*)	Ma	P	Often found in shallow estuarine seagrass beds, in patchy *Posidonia* seagrass and rubble substrates, as well as sandy areas around worm casts (Browne et al 2008). The South Australian Museum holds records around the Franklin Harbour area in mid Spencer Gulf. Also a few records from False Bay (B.McDonald pers. comm. 2007; cited in BHPB, 2009)	2	b	Yes
Knife-snouted Pipefish (Hypselognathus rostratus)	Ma	P	In the Spencer Gulf it is common in deeper water trawls (P.Jennings, pers.comm.; cited in Browne 2008). One record from False Bay (B.McDonald, pers. comm.; cited in BHPB, 2009)	2	b	Yes
Deep-bodied Pipefish (*Kaupus costatus*)	Ma	P	A relatively common species that prefers shallow, low energy *Zostera* seagrass flats on silty substrates and can tolerate suspended sediment during storms as well as temperatures >30°C (Browne et al, 2008). The South Australian Museum holds records taken from the Port Pirie area.	2	b	Yes
Brushtail Pipefish (*Leptoichthys fistularius*)	Ma	P	Is the longest pipefish known and is found in the seaward aspect of estuaries and bays with extensive seagrass meadows, generally 2-20m deep (Dawson 1985; cited in Browne 2008). In the Spencer Gulf, it is common in beam trawl samples in Posidonia seagrass (P.Jennings pers.comm.; cited in Browne 2008). Several hundred were recorded in False Bay and Cowleds Landing (McDonald, 2008; cited in Browne, 2008)	2	b	Yes

Species	Status*		Comments	Mobility	Occurrence	Credible Risk
	EPBC Act	SANPW Act Fisheries Act				
Fish						
Australian Smooth Pipefish (*Lissocampus caudalis*)	Ma	P	Associated with 'broken bottom', shallow water habitats often 3-4m deep where it mimics the exposed roots of *Amphibolis* and *Zostera* (Dawson 1985; cited in Browne et al 2008). A few records exist from False Bay and Cowleds Landing (McDonald 2008; cited in BHPB, 2009)	2	b	Yes
Javelin Pipefish (*Lissocampus runa*)	Ma	P	Associated with rubble habitats and intertidal rock pools (Browne et al 2008). A record from the Australian Museum from Point Riley near Wallaroo suggests there is a possibility the species occurs in the Upper Spencer Gulf.	2	a	No
Sawtooth Pipefish (*Maroubra perserrata*)	Ma	P	Prefers reef substrates, presence often associated with *Heraldia nocturna*. Records held by South Australian Museum only for Southern Spencer Gulf. Likely that reef around Port Bonython unsuitable.	2	a	No
Red Pipefish (*Notiocampus ruber*)	Ma	P	A small, rarely seen species, occurring to a depth of around 20m among red macroalgae on reef substrate (Browne et al 2008). No records from the Upper Spencer Gulf.	2	a	No
Leafy Seadragon (*Phycodurus eques*)	Ma	P	Occurs in inshore habitat including seagrass meadows, macroalgal-dominated reefs and mixed algal and seagrass areas, but not open areas of mud or sand (Connolly et al, 2002; cited in Browne et al 2008)	2		
Weedy Seadragon (*Phyllopteryx taeniolatus*)	Ma	P	Observations from Gulf St Vincent suggests preferred habitat at between 5m and 15m depths in *Posidonia* and *Amphibolis* seagrass (S.Shepard, pers.comm.; cited in Browne et al 2008). A record of the species from Douglas Banks in the Upper Spencer Gulf was viewed on the Atlas of Living Australia (http://www.ala.org.au/).	2	b	Yes
Pug-nosed Pipefish (*Pugnaso curtirostris*)	Ma	P	Widespread in Gulf St Vincent, from low tide level to approximately 11m depth in numerous habitat types such as mangrove lined tidal creeks, seagrasses, broken bottom and rubble (Browne 2008). Several dozen recorded in False Bay and Cowleds Landing (B.McDonald pers. comm. 2007; cited in BHPB, 2009)	2	b	Yes
Robust Pipehorse (*Solegnathus robustus*)	Ma	P	Known mainly from 26 trawled specimens from eastern Great Australian Bight waters at depths between approximately 30m and 70m. Species has also been recorded from Corny Point, at the bottom of Spencer Gulf (Baker, 2008)	2	a	No
Spotted Pipefish (*Stigmatopora argus*)	Ma	P	The most widely distributed and abundant pipefish in the shallower *Posidonia* seagrass meadows of Gulf St Vincent (Browne 2008). This is likely also the case in Spencer Gulf with more than 800 recorded in False Bay and Cowleds Landing (McDonald 2008; cited in BHPB, 2009)	2	b	Yes
Widebody Pipefish (*Stigmatopora nigra*)	Ma	P	In Gulf St Vincent, the Widebody Pipefish is abundant in *Zostera* seagrass and often occurs in dense *Posidonia* seagrass (Browne et al 2008). Records exist from Cowleds Landing, to the south of Whyalla (McDonald 2008; cited in BHPB, 2009)	2	b	Yes

	Status*					
Species	EPBC Act	SANPW Act Fisheries Act	Comments	Mobility	Occurrence	Credible Risk
Fish						
Ring-backed Pipefish (*Stipecampus cristatus*)	Ma	P	Has been recorded from clean sandy bottom with sparse seagrass, and near tidal channels in large estuaries at depths of 3-15m (Kuiter 2003; cited in Browne et al 2008). The South Australian Museum holds records of the species in the southern Spencer Gulf, range possibly extends into the Upper Spencer Gulf.	2	a	No
Hairy Pipefish (*Urocampus carinirostris*)	Ma	P	A small and inconspicuous species, possibly more prevalent than records suggest. Only records from South Australia from eastern Great Australian Bight.	2	a	No
Mother-of-pearl Pipefish (*Vanacampus margaritifer*)	Ma	P	Found mostly among vegetation over sand and rubble, to a depth of approximately 10m (Dawson 1985; cited in Browne et al 2008). Few records exist in South Australia, The Museum of Victoria holds a specimen collected from the Port Lincoln area.	2	a	No
Port Phillip Pipefish (*Vanacampus phillipi*)	Ma	P	Prefers deeper seagrass beds. Records exist from False Bay and Cowleds Landing (McDonald 2008; cited in BHPB, 2009) and the Port Pirie and Port Davis area (South Australian and Australian Museums)	2	b	Yes
Long-snouted Pipefish (*Vanacampus poecilolaemus*)	Ma	P	Inhabits seagrass beds in low energy habitats in clear water, from 1-10m depth, and occasionally deeper (Browne 2008). More than 100 were recorded from False Bay and Cowleds Landing (McDonald 2008; cited in BHPB, 2009)	2	b	Yes
Verco's Pipefish (*Vanacampus vercoi*)	Ma	P	An endemic species known from more than ten sites in South Australian Gulfs with a likely preferred habitat of shell and rubble seagrass beds, on low to moderate energy coastlines (Browne et al 2008). A few records occurred from Cowleds Landing (B.McDonald pers. comm. 2007; cited in BHPB, 2009)	2	b	Yes
Flora						
Garweed (*Zosta muelleri subspecies mucronata*)		R	Garweed is found at depths of less than 10m and is considered dense on eastern Spencer Gulf whilst relatively sparse on western Spencer Gulf (BHPB, 2009). Recorded from Whyalla and Port Pirie, along with other locations in the Upper Spencer Gulf (Atlas of Living Australia, viewed 5/8/2013)	N/A	N/A	N/A

En=Endangered

Vu=Vulnerable

R= rare

Ma=Listed marine species (EPBC Act) – Note that marine species, whilst protected under the Act, are not threatened species.

Mi=Listed migratory species (EPBC Act)

Ce=Listed as cetacean (EPBC Act) – Note that Cetacean species, whilst protected under the Act, are not threatened species.

P=Protected under the Fisheries Management Act 2007

** Southern Right Whale and Humpback Whale classed as credible risk due to risk and susceptibility to ship strike

* Status under Australian (AUST) legislation (Environment Protection and Biodiversity Conservation Act 1999) and South Australian (SA) legislation (South Australian National Parks and Wildlife Act 1972 or Fisheries Management Act 2007)

Some species are visitors to the region. The Australian Sea Lion may occasionally visit the Northern Spencer Gulf seasonally in winter and spring to feed on Cephalopods and fish as there are no safe haul-out or breeding sites in the area. There are regular seasonal sightings in winter of the Southern Right Whale, sighted both as individuals and in small groups in Northern Spencer Gulf. Other species of whale such as the Bryde's Whale and Pygmy Sperm Whale have been irregularly sighted in Northern Spencer Gulf and are presumably stray individuals as these species are rarely observed in South Australian waters. There have also been seasonal reports of migratory turtles such as the Hawksbill Turtle, Green Turtle and Loggerhead Turtle that are visiting Northern Spencer Gulf from the northern parts of Australia. Several pipefish species including the Tiger, Deep-bodied, Gales, and Spotted, are known to occur in Northern Spencer Gulf seagrass beds.

Syngnathids such as Pipefish, Seahorses and Seadragons are known to occur in the Upper Spencer Gulf and include two species of Seahorses, *Hippocampus bleekeri* and *H. abdominalis*. The Leafy and Weedy Seadragon (*Phyllopteryx taeniolatus* and *Phycodurus eques*), are known to occur in Spencer Gulf and are likely to occur in the upper regions of the Gulf.

Additional information is provided below on the Southern Right Whale (*Eubaleana australis*), Humpback Whale (*Megaptera novaeangliae*), New Zealand Fur-seal (*Arctocephalus forsteri*), Indian Ocean Bottlenose Dolphin (*Tursiops aduncus*) and Short-beaked Common Dolphin (*Delphinus delphinus*) and Syngnathids as these are the threatened species that are most likely to occur in the Upper Spencer Gulf.

14.3.5.2. Profile of Conservation Species Likely to Occur in the Upper Spencer Gulf

Southern Right Whale (*Eubaleana australis)*

Following the cessation of whaling activities, the Australian population of the Southern Right Whale is increasing at near the maximum biological rate. Despite this recovery, the total population is still estimated to be only at around 10 percent of the population that existed prior to whaling (IWC, 2001; cited in SEWPaC, 2012a). Southern Right Whales are migratory, moving from their summer feeding grounds in the Southern Ocean to warmer Australian coastal waters over the winter months to calve and breed. Southern Right Whales are seasonally present in South Australian coastal waters generally between the months of May and November. The Spencer Gulf does not contain any recognised aggregation areas (**Figure 14.3h**); the closest location where regular sightings occur is in Sleaford Bay near Port Lincoln. The *Marine bioregional plan for the South-west Marine Region* recognises that all of the South Australian coastline should be considered as potential habitat for the Southern Right Whale (SEWPaC, 2012b).

Observations suggest that Southern Right Whales are occasional visitors to the Upper Spencer Gulf, particularly when compared to the frequency of sightings around known congregation areas such as Victor Harbor and Fowlers Bay. There is no obvious reason for their presence in the Gulf, since it is not recognised as a breeding, calving, or feeding area. There is a possibility that the semi-protected waters of the Gulf could provide some use as a resting area. **Table 14.3c** displays data of sightings of Southern Right Whales in the Upper Spencer Gulf held by the South Australian Whale Centre. **Table 14.3c** does indicate that, although uncommon, Southern Right Whales have been known to travel up Spencer Gulf, as far as Port Augusta. Sightings of whales in the Spencer Gulf may be under-reported due to the sparse population along the coastline and lack of formal survey data.

Migration speeds of Southern Right Whales are unknown but medium range coastal movements indicate sustained travel at 1.1—3.7km/hr (Burnell 2001) and female-calf pairs leaving the Head of Bight calving ground maintained speeds of 2.7—4.2km/hr over 24 hours (Burnell, unpublished data; cited in SEWPaC, 2012b). Swimming speed near shore is generally slow, but they are capable of speeds of over 15km/hr over short distances (Bannister et al. 1996). These bursts of speed may be used to avoid potential threats, such as ship strike. Right Whales produce social sounds ranging in frequency from 50 to 600Hz, studies of Right Whales in the northern hemisphere suggests that they can hear frequencies in the range of 10Hz to 22kHz (Parks et al, 2001).

Known threats affecting Southern Right Whales in Australian waters are identified in the Conservation Management Plan for Southern Right Whale (SEWPaC 2012a) as entanglement and vessel disturbance. Potential threats include whaling, climate change/variability, noise interference, habitat modification and overharvesting of prey.

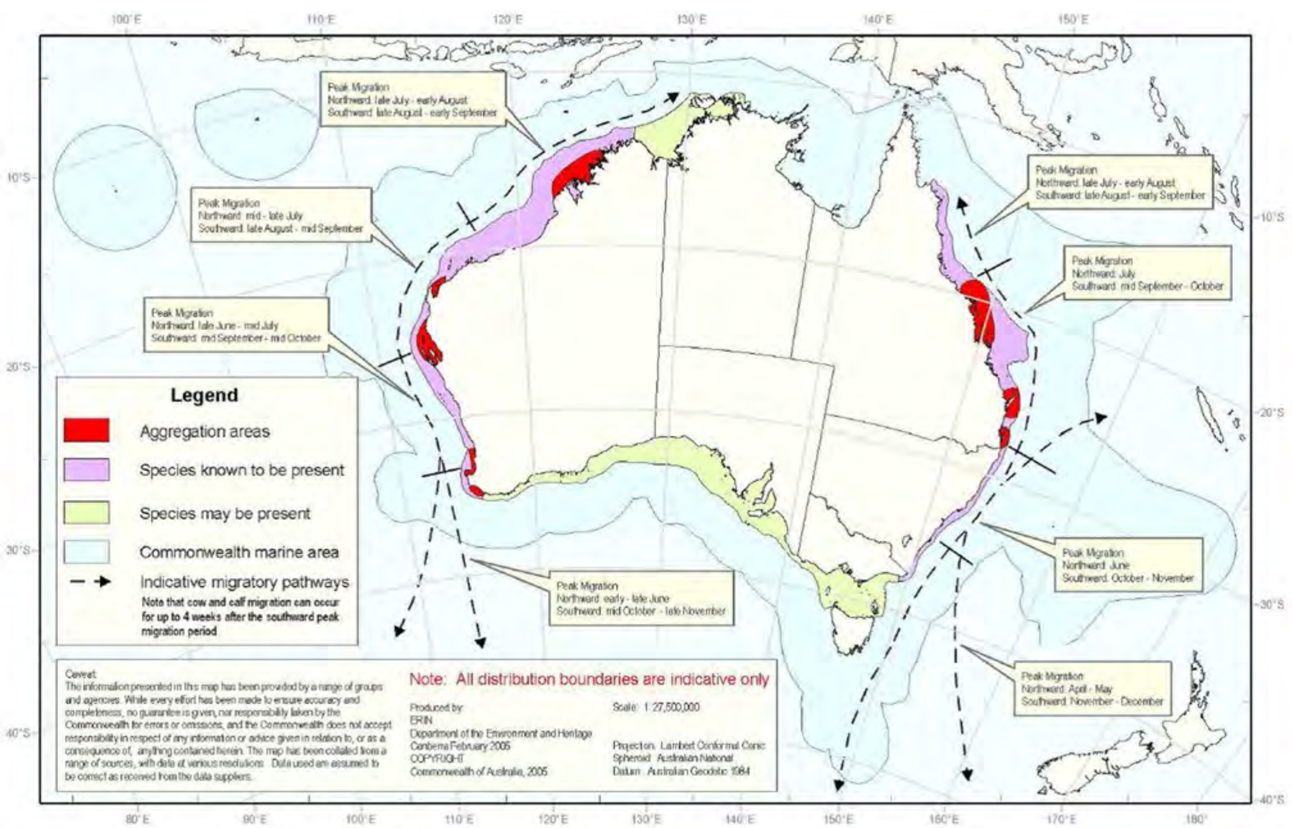
Humpback Whale (*Megaptera novaeangliae*)

Humpback Whales have a large distribution, occurring in both the northern and southern hemispheres. Migration of Humpback Whales through Australian waters generally occurs through autumn as whales move up through the Southern Ocean then up the east and west coasts of Australian to aggregation areas on the northern coast where breeding and calving occurs through winter and spring before returning to southern waters for the summer period (**Figure 14.3i**). Despite these general migration patterns, Humpback Whales don't tend to be as predictable as Southern Right Whales with numerous 'out of season' sightings reported. In South Australia, there have been sightings from every month, with the possibility that these are Whales from both the east and west coast populations (C.Kemper, 2006; cited in SEWPaC, 2013b). In the Upper Spencer Gulf, Humpback Whales are an occasional visitor (**Table 14.3c**).

Table 14.3c: Whale sightings recorded in the Upper Spencer Gulf (SA Whale Centre cetacean sighting log up to the end of 2012)

Date	Species	Town	Number	Behaviour
19.09.2012	Humpback Whale	Point Lowly	2	Diving, tail lifting, head lifts, travelling, blowing
11.08.2012	Unidentified	Point Lowly	1	Travelling
03.07.2012	Southern Right Whale	Point Lowly	2	Breaching, tail lifting, tail slapping, flipper slapping, head lifts, circling, blowing
20.07.2011	Southern Right Whale	Black Point	2 adults	Breaching, diving, tall lifting, tail slapping, flipper slapping, head lifts, body rolling, circling, playing, travelling, feeding
20.07.2011	Southern Right Whale	Point Lowly	2 adults	Tail slapping
11.09.2010	Southern Right Whale	Point Lowly	2 adults	Travelling
21.07.2010	Southern Right Whale	Whyalla	2 adults	Breaching
03.07.2006	Humpback	Port Augusta	3	Breaching
30.05.2006	Humpback	Port Augusta	2	Swimming in area for about 1 hour before moving south
20.08.2002	Southern Right Whale	Whyalla	1 adult	Tangled in fishing net
26.08.1999	Southern Right Whale	Port Augusta	1 adult	None recorded
04.06.1998	Southern Right Whale	Port Augusta	2 adult	None recorded
02.06.1998	Unidentified	Port Bonython	2 adult	None recorded
09.08.1997	Southern Right Whale	Whyalla	2	None recorded
13.07.1997	Humpback	Whyalla	1	None recorded

Figure 14.3i: Distribution, migration, and recognised aggregation areas of the Humpback Whale (SEWPaC, 2013b)



Population estimates of the east and west coast Australian populations vary, but it is generally accepted that both populations are growing by around 10 percent per annum (SEWPaC, 2013b). Despite this, the west coast population is still at around 60 percent and the east coast population 40 percent of original population estimates prior to whaling (SEWPaC, 2013b).

Identified potential threats to Humpback Whales include whaling and habitat degradation as a result of (SEWPaC, 2013b):

- Acoustic pollution
- Entanglement
- Physical injury and death from ship strike
- Built structures that impact on habitat availability
- Changing water quality and pollution.

Syngnathids (Pipefish, Seadragons)

Syngnathids are a family of fishes that include Seadragons, Seahorses and Pipefish and are known from a variety of habitats in South Australia, but are particularly well known as inhabitants of shallow inshore waters, including seagrass areas. All Syngnathids gained protection under the *EPBC Act 2000*, giving the family of fish protection in all Australian waters. The family was also given protection in South Australian waters under the FM Act in 2006.

The rigid body conformation and small fins of Syngnathids are not well adapted for rapid swimming, and thus escape from predators through flight is rare (Brown et al 2008). Instead, Syngnathids rely more on camouflage – mimicking seagrass or macroalgae, sheltering in caves or crevices, and the hard bony rings of their body to avoid predation.

In marine food webs Syngnathids are primary, and perhaps significant, predators on zooplankton and nekton, however, their importance as a food to secondary predators has been considered minor (Brown et al 2008). Syngnathids are often abundant, and can often be the most numerous fish, particularly in inshore seagrass beds (Brown et al 2008).

Syngnathids are generally considered to have strong habitat association and are commonly found in near-shore habitats, which increases their vulnerability to population decline from site-specific threats such as coastal development, trawling and dredging.

Several pipefish species are known from the Upper Gulf Spencer, predominantly associated with seagrass beds. High numbers of some species have been reported from these habitats in False Bay (refer to **Table 14.3.b**).

14.3.5.3. Non-threatened Species of Local Interest

New Zealand Fur Seal (*Arctocephalus forsteri*)

The New Zealand Fur Seal occurs around the southern Australian coastline and New Zealand and populations are still recovering following historical seal hunting. Known Australian breeding colonies occur on islands off South Australia and Western Australia and to a lesser extent off Victoria and Tasmania (Menkhorst & Knight, 2011). New Zealand Fur Seals feed mainly at night on Cephalopods and Pelagic fish, also on seabirds, such as Little Penguins, and Crustaceans (e.g. Western Rock Lobster). Goldsworthy and Page (2009) mapped the 'at-sea' distribution of juvenile and adult male and female New Zealand Fur Seals in South Australia based on a collation of existing data (**Figure 14.3j**). This outlines the main foraging areas that are known to have a high level of use. It can be seen that juvenile New Zealand Fur Seals include Upper Spencer Gulf in their foraging range; this is confirmed by records held by the South Australian Museum (refer to **Table 14.3b**).

The nearest breeding colonies to the study area are located on islands at the southern extreme of the Spencer Gulf (i.e. Neptune Islands offshore from Port Lincoln). Although Upper Spencer Gulf is not within the historic main foraging range of adult New Zealand Fur Seals, individuals, most likely adult males, may enter Upper Spencer Gulf foraging for prey items that are seasonally available (such as Cuttlefish). The current population recovery is likely to cause greater numbers of New Zealand Fur Seals to explore foraging opportunities in the Upper Spencer Gulf.

Vulnerabilities and pressures to New Zealand Fur Seals are described in the *Species group report card-pinnipeds* prepared under the EPBC Act to support the marine bioregional plan for the South-west Marine Region (refer **Section 14.3.2**). In this document, pressures potentially relating to the proposed development, such as noise and collision with vessels, were related as "of less or no concern" (SEWPaC, 2012c).

Figure 14.3j: Estimated at-sea distribution of juvenile (top), adult male (bottom left) and adult female (bottom right) New Zealand Fur Seals in South Australia (Goldsworthy & Page, 2009)

Indian Ocean Bottlenose Dolphin (*Tursiops aduncus*)

Indian Ocean Bottlenose Dolphins have a global distribution and are found Australia-wide but are more commonly associated with tropical and sub-tropical waters. Whilst not a threatened species, they are commonly found in the study area.

Figure 14.3k: Inquisitive Indian Ocean Bottlenose Dolphin approaches boat near the Whyalla boat harbour

These Dolphins can show an affinity for human interaction and are the species kept at aquariums such as Sea World, Qld and Pet Porpoise Pool, NSW. A pod of this species has taken up residence around the Whyalla boat harbour and often approaches boats returning from fishing excursions (refer to **Figure 14.3k**).

In south-eastern Australia, inshore Indian Ocean Bottlenose Dolphins show a high degree of site fidelity to some local areas and appear to belong to relatively small communities or populations (Möller & Beheregaray 2001; Möller et al. 2002; cited in SEWPaC, 2013c). They feed on fish and Cephalopods, with the latter likely to be a primary food source during periods of Cuttlefish aggregation around Point Lowly. Observations of an individual Indian Ocean Bottlenose Dolphin feeding on Giant Australian Cuttlefish near the study area have been reported (Finn et al, 2009). In these observations the dolphin showed specialised behaviour in the treatment of the Cuttlefish in order to remove the buoyant calcareous cuttlebone before consumption.

The preliminary findings of a dolphin survey commissioned by BHP Billiton at Point Lowly in January and May 2010 (Gibbs 2010), suggest that Point Lowly is a relatively high use area for Bottlenose Dolphins with all life stages sighted (i.e. adult, juveniles and calves) and a variety of behaviours observed including resting, feeding, socialising and transit (Gibbs 2010).

The presence of cow and calves pairs in the sheltered waters of the bay adjacent, and to the west of the lighthouse point, suggests that this may be a nursery area.

Short-Beaked Common Dolphin (*Delphinus delphinus*)

Common Dolphins are generally found in both shallow and deep offshore waters in tropical, sub-tropical and temperate climates. They have been recorded in all Australian States and Territories but are regarded as uncommon in northern Australian waters (SEWPaC, 2013d). Common Dolphins are found in medium sized groups to extremely large schools, ranging in size from about 20-30 to hundreds and thousands of individuals (Evans 1994; cited in SEWPaC 2013d). There are no estimates of Australian population size or trends (SEWPaC, 2013d).

Short-Beaked Common Dolphins generally inhabit offshore areas where epipelagic schooling and mesopelagic fishes and squids occur, forming the main component of their diet. In South Australia, the diet of Common Dolphins has been reported to consist of fish and cephalopods, including fishes of the families Clupeidae and Carangidae, Southern Calamari, Arrow Squid and Octopus (Kemper & Gibbs 2001; cited in SEWPaC, 2013d). More prevalent in the southern Spencer Gulf, Short-beaked Common Dolphins are not a common occurrence in Upper Spencer Gulf, however, may move up the Gulf following seasonal abundances of prey items.

The main threats that are likely to affect Short-beaked Common Dolphins in Australia have been identified as indirect catches in commercial fishing, entanglement in debris, intentional killing and pollution (SEWPaC, 2013d).

Giant Australian Cuttlefish (*Sepia apama)*

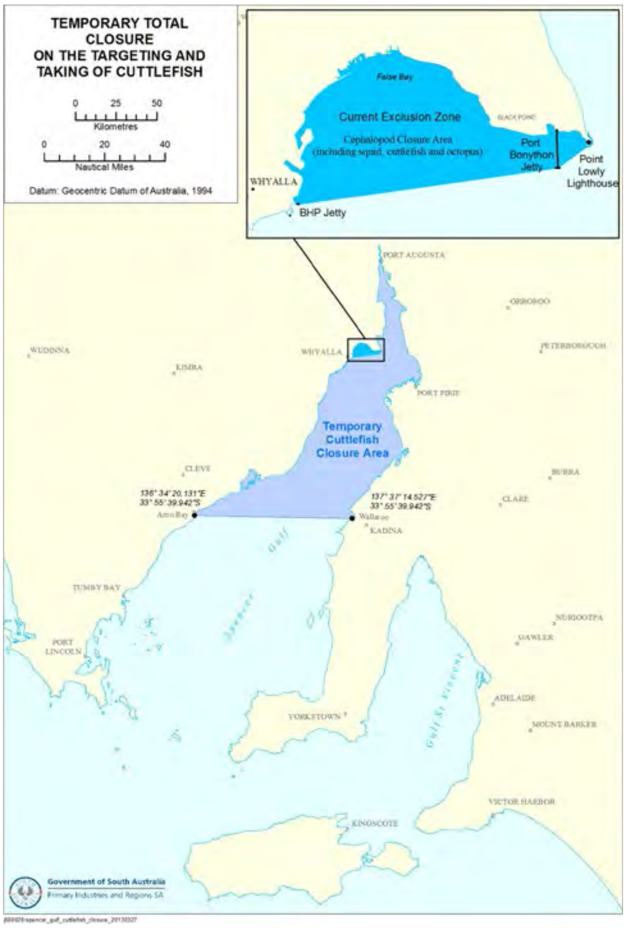
Cuttlefish Protection

Although not listed as a threatened species under Federal or State legislation, the Giant Australian Cuttlefish (*Sepia apama*) is considered by many to be an iconic species in the region, particularly with regards to the aggregation phenomenon witnessed at Point Lowly. As such it is provided a level of protection under the *Fisheries Management Act 2007* with a permanent Cephalopod closure area in False Bay extending from a line from Point Lowly lighthouse, south-west to the end of the Port Bonython jetty, then west to the Arrium Jetty in Whyalla (**Figure 14.3l**). This is a year round closure that prohibits the taking, and use of fishing tackle that targets all cephalopods including Cuttlefish, squid and octopus. In March 2013, the State Government announced a temporary closure to Cuttlefish fishing in the northern Spencer Gulf, north of a line from Wallaroo to Arno Bay. This closure applies only to the taking of Cuttlefish, so if taken inadvertently by persons targeting other Cephalopod species (i.e. Squid), they must be immediately and carefully returned to the water. This temporary closure applies until 27th March 2014 when it will be reviewed. There is also a declared sanctuary zone within the Upper Spencer Gulf Marine Park (refer **Section 14.3.1**) encompassing the area around Black Point. Although this sanctuary represents a 'no take' zone, the zone is situated in an area that is already part of the cephalopod closure area. However, the sanctuary zone does afford additional protection for Cuttlefish habitat and other species within the sanctuary.

Distribution

The Giant Australian Cuttlefish is widely distributed across temperate southern Australia from Morton Bay in southern Queensland to Point Cloates in Western Australia, and northern Tasmania (Lu, 1998; cited in Hall & Fowler, 2003). Populations from WA, SA/Victoria and NSW show significant genetic difference and it has been suggested that they be managed as evolutionary significant units to preserve the genetic diversity found among them (Hall and Fowler, 2003). Furthermore, it is suggested that there are at least three distinct populations or stocks within South Australia: Streaky Bay, Spencer Gulf and Gulf St Vincent (Kassahn & Donnellan YEAR cited in Hall & Fowler 2003). Recent research has also suggested there are divisions within the Spencer Gulf population, with the population of the Northern Spencer Gulf having limited interaction with Cuttlefish south of Wallaroo (Gillanders et al, unpublished data; cited in Steer et al 2013).

Figure 14.3l: Cuttlefish closure areas (Government of South Australia, DATE)



Lifecycle

The Giant Australian Cuttlefish is the largest species of Cuttlefish known. Like most other cephalopods, it is expected to be short-lived and semelparous, spawning only once at the end of their lifecycle.

Sepia apama differs from many other species of Cuttlefish by spawning in winter as opposed to summer; likely due to local environmental conditions and food availability for juvenile stages (Hall & Fowler 2003). The aggregation of *Sepia apama* on the fringing subtidal reef around Point Lowly generally begins in May and is over by August with a peak in abundance around early June although the timing of peaks can vary between years (Hall and Fowler, 2003). Mating behaviour is reliant on vision, as males use elaborate colour displays to court females (Steer et al. 2013),which is of interest because of the potential effects of turbidity. Studies of the South African Chokka Squid (*Loligo reynauldii*), Roberts (1998, cited in Steer et al.2013), indicated that wave height, turbidity and sea temperature were the key parameters in spawning success. Periods of high turbidity arising from onshore winds and coastal swell were found to disperse spawning aggregations, presumably because of poor visibility (Augustyn et al. 1994, Roberts & Sauer 1994, cited in Steer et al. 2013).

The distinct peaks in abundance during the aggregation period suggest that the majority of individuals aggregating in the area do not persist for long. Tagging studies using acoustic telemetry reported a combined sex residence time mean of 19 days (Payne, 2010). Hall and Fowler (2003) conducted experiments where Cuttlefish were tagged at the Arrium Wall and re-sightings recorded to determine trends in movement. Although only small numbers of re-sightings were recorded, results did suggest that some individuals remained in the same area as they were tagged for up to six weeks after initial capture. A small number were also resighted in the main aggregation area (Black Point to Stony Point), some 15-18km from the point of capture.

The area around Black Point and Stony Point have consistently recorded the highest counts of *Sepia apama* during the aggregation period in surveys conducted between 1998 and 2010. These two locations, and the area between them, is generally considered the focus of the breeding aggregation, with other sites such as Fitzgerald Bay and Backy Point recording lower aggregation numbers (Hall, 2010). The sex ratio of the aggregation has been estimated at around four to one in favour of males, likely due to the shorter residence times of females in the aggregation area (Payne, 2010). Mature adults aggregate in the subtidal reef zone characterised by broken bedrock which forms important structure for attachment of eggs.

The eggs of *Sepia apama* are the largest known decapod mollusc eggs, and they undergo a long period of development (Cronin 2000; cited in Hall & Fowler 2003). Collection of eggs for past research has noted eggs first observed in small numbers in late May, after which numbers increased rapidly, such that by mid-June approximately half the rocks in the survey plots (10x10m) supported over 100 eggs each (Hall & Fowler 2003). Further deposition occurred through July on most rocks and to a lesser extent in August. Eggs were found in cryptic locations, attached to the underside of rocks and within crevices of the broken bedrock reef between three and five metres deep. Very few eggs were found attached to exposed rock surfaces (Hall & Fowler, 2003). Eggs are individually attached to the underside of crevices, rocks and overhangs in the subtidal reef area by the female. The eggs are laid in early winter then left unattended during the three to five month developmental period. Hatching generally occurred from September through to November, with water temperature having the greatest effect on egg development time (Hall & Fowler 2003) (**Figure 14.3m**).

Figure 14.3m: In situ water temperature profile at Black Point from 15th May 1999 to 6th November 2000 compared to timing of egg development and hatching from eggs laid in different months during the breeding season (Hall & Fowler, 2003)

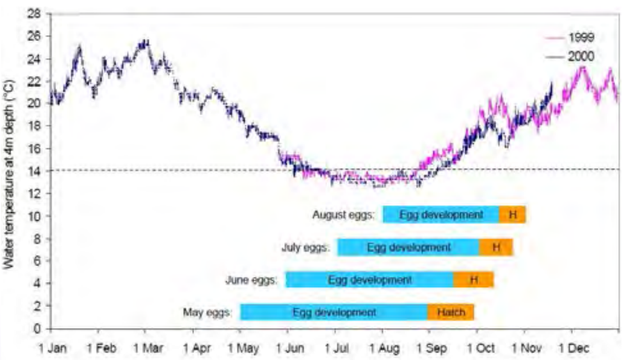


Figure 14.3m illustrates importance of temperature, such that even with eggs laid early in the season, hatching still occurs during a relatively narrow period due to later eggs developing quicker in warmer temperatures.

Hall and Fowler (2000) found that larger and older females deposited larger eggs, which produced larger hatchlings. Larger hatchlings also resulted from development at higher temperatures, refuting some previous findings. The relatively long period of egg development allows advanced development of hatchlings, such that they emerge as juveniles that closely resemble miniature adults (Boletzky 1974; cited in Hall & Fowler 2003).

Juvenile cephalopod growth rates are often exponential due to their short lifecycles with juvenile growth rates of *Sepia apama* in captivity varying with water temperature and food availability (Hall &Fowler 2003).

The movement and behaviour of juveniles after hatching in the aggregation area is not well understood. It has been reported that juvenile *Sepia apama* have poor sustained swimming capacity (Payne et al 2013) such that dispersion of juveniles may relate closely to water movement. Oceanographic modelling suggests 70–80 percent of Cuttlefish hatched at Point Lowly in October (the peak timing of Cuttlefish hatching) are likely to become confined to the western side of Spencer Gulf by February, some 40–50km from the aggregation site (Kaempf et al, 2010; cited in Payne et al, 2013). Importantly, northern Spencer Gulf experiences a slight clockwise circulation of water masses during summer (Kaempf et al, 2010; cited in Payne et al, 2013), which will make it more energetically expensive for these Cuttlefish to travel south (towards southern Spencer Gulf) than to travel north (towards Point Lowly) in the months leading up to the spawning period. This movement pattern is collaborated somewhat by a commercial crab fisherman fishing the area around Cowleds Landing, approximately 20km south of Whyalla, who reported increased Cuttlefish as by-catch during the period around April and May, coinciding with when the Cuttlefish migrate to the aggregation area around Point Lowly for spawning (Hall &Fowler, 2003). Tagging of Cuttlefish caught in research trawls through the northern Spencer Gulf resulted in a small male being recaptured in the aggregation area, some three and a half months and 65km north of where it was originally captured, fitting with a northern migration pattern. Trawl surveys also identified higher densities in the channels of the Gulf (more in April compared to February) suggesting these may be potentially used as movement corridors (Hall &Fowler, 2003). Very few Cuttlefish were present in the aggregation area from September to March, i.e. outside the spawning period (Hall &Fowler, 2003).

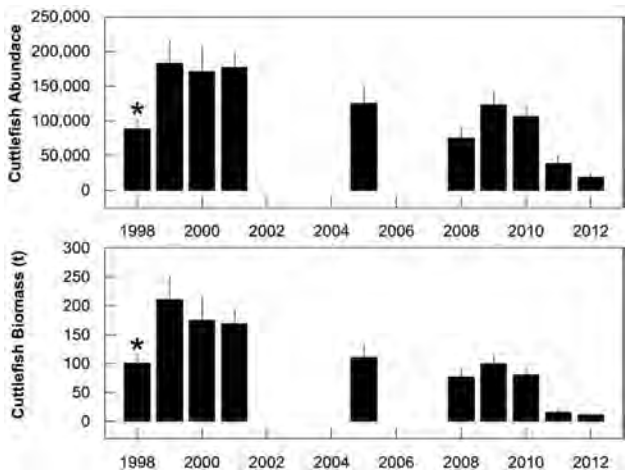
With the poor sustained swimming capacity seen for *Sepia apama* hatchlings (Payne et al, 2013), such circulation patterns in Spencer Gulf may have important implications for the appearance of Cuttlefish in the aggregation area around Point Lowly on a seasonal basis.

It has been proposed that there are two year classes in the northern Spencer Gulf *Sepia apama* population at any point in time; one class where the juveniles grow rapidly, such that they reach maturity by the first winter and can attempt to breed followed by death. The second class are slower to develop and continue feeding through the first winter before reaching maturity in the second winter when they can attempt to breed before dying (Hall & Fowler 2003). This model assumes that only individuals that are mature are present in the aggregation area and individuals have a maximum lifespan of around two years.

Population Status

The population of *Sepia apama* aggregating in the Point Lowly area was first studied in response to the rapid development of a commercial fishery for the species between 1994 and 1997 when the annual catch increased by over 700 percent to a peak of 262 tonnes in 1997 (Hall & Fowler 2003). Seasonal closures of the main spawning area around Black Point began midway through the 1998 season with the taking of Cuttlefish now prohibited in all waters of the northern Spencer Gulf. Although not a complete data set, the surveys that have been conducted over the period from 1998 to 2013 show a consistent decline in seasonal aggregations of *Sepia apama* (**Figure 14.3n**).

Figure 14.3n: Annual estimates of total biomass and abundance (± se) of the Giant Australian Cuttlefish aggregation around Point Lowly during peak spawning from 1998 to 2012 (Steer et al, 2013).



*The fishing closure commenced halfway through the 1998 season therefore 1998 estimates were reflective of a population exposed to heavy fishing pressure.

The decline of the population prompted a recent study into the possible cause of the decline (Steer et al 2013). The results of this report were inconclusive, with the only correlation found being a negative correlation with rainfall (i.e. years of low rainfall had high Cuttlefish abundance; high rainfall years had low abundance). The report also suggested that there was not sufficient data to rule out that the high numbers present around the late 1990's and early 2000's was an unusual natural phenomenon, and that the population was now returning to a more 'normal' level. There is also the possibility that the population has become more dispersed, using other, smaller habitat areas for spawning in the Upper Spencer Gulf (Steer et al, 2013).

14.3.6. Introduced Marine Species in Upper Spencer Gulf

SARDI has recently published a report that reviews records and distribution mapping of introduced marine species in South Australia (Wiltshire et al, 2010). These species are summarised in **Table 14.3d**.

The report notes that not all introduced species should be considered pests; since some have not displayed invasive characteristics or become established in SA waters. Additionally, it reports some "pest" species are cryptogenic, i.e. it is uncertain whether they were introduced or if Australia is part of their native range. For this reason, each species in the report has been given a status of either:

- **Trigger list species (introduced)**: as listed in the Australian Marine Pest Monitoring Manual (National System for the Prevention and Management of Marine Pest Incursions 2010a)
- **Introduced**: non-native, probably spread by human activity
- **Cryptogenic**: uncertain origin
- **Native**: previously reported as introduced.

Other species which have been recorded in surveys of the Point Lowly area include (D.Wiltshire, pers comm.):

- Hydroides longispinosus (polychaete)
- Aglaophenia postdenta (hydroid).

Table 14.3d: Introduced Marine Species in the Upper Spencer Gulf (Wiltshire et al, 2010)

Name	Class	Status	Comments	Occurrence in Upper Spencer Gulf
European Fan Worm *(Sabella spallanzanii)*	Polychaeta	Trigger list species (introduced)	First recorded in SA in 1986, a Mediterranean species possibly introduced from WA, where it may have occurred as early as 1965.	Unconfirmed reports from Whyalla marina. Was not recorded during surveys at Port Bonython in 1995-96 (Bulter &Connolly, 1999)
Alexandrium minutum	Dinophycae	Trigger list species (introduced)	Known from Europe, Egypt and New Zealand and first recorded in Australia in WA in 1982	Widespread in SA with regular detections in shellfish growing areas through the SA Shellfish Quality Assurance Program. No records for USG but recorded further south towards Port Broughton.
Plumularia setacea	Hydrozoa	Cryptogenic	Occurs in temperate to sub-tropical regions	Recorded from Redcliff point, approx.22.5km SSE of Port Augusta
Myxicola infundibulum	Polychaeta (worm)	Cryptogenic	Native to the Mediterranean, its introduction to Australia is unclear as it is possible not all worms ascribed to M.infundibulum are this species	The species has been reported to occur at Port Bonython based on unpublished BHPB data. It is possible that the species is found throughout SA
Tanais dulongii	Malacostraca	Introduced	Reported from a single personal observation in 1991 from Port Pirie. No specimens exist	Uncertain
Parasesarma erythodactyla	Malacostraca (crab)	Cryptogenic	Native to the east coast of Australia, recently recorded in South Australia in mangroves at Port Augusta in 2008 and at Point Lowly in 2009	Established in USG and may be extending its range southwards on Eyre Peninsula
Megabalanus tintinnabulum	Maxillopoda (Barnacle)	Cryptogenic	Regarded as cosmopolitan and likely to have been spread by biofouling of ship hulls. First recorded in WA in 1949	Classed as established in SA with records (unconfirmed) from Whyalla
Blue Mussel (*Mytilus galloprovinciallis*)	Bivalvia (Mussel)	Cryptogenic	Mussels of the genus *Mytilus* are found throughout global temperate seas and have sometimes been considered a single cosmopolitan species: *M.edulis,* although other species have been described such as *M.galloprovinciallis* from the Mediterranean	The identity of Australian *Mytilus spp.* Is currently in question and as such can not be reliably established at present. Blue Mussels that may be *Mytilus galloprovinciallis* are widespread including records from Port Bonython
Pearl Oyster *(Pinctada albina sugillata)*	Bivalvia (Oyster)	Cryptogenic	Native to the Torres Strait and east coast of Australia. Anecdotally been reported in the USG since the 1980's.	Confirmed records from Port Bonython and Fitzgerald Bay. Established in USG.
Bulgula neritina	Gymnolaemata	Cryptogenic	Cosmopolitan species, probable spread by shipping. First recorded in Victoria in the 1880's	Confirmed record from Stony Point. Established and widespread in SA
Botrylloides leachi	Ascidiacea	Cryptogenic	Known from the Mediterranean, Red Sea, north-east Atlantic and around Australia except the northern coast. A seasonal species that is becoming a dominant species in winter	Confirmed record from Whyalla and Port Bonython. Widespread in SA
Half-bridled Goby *(Arenigobius frenatus)*	Actinopterygii	Cryptogenic	Known from the east coast of Australia. Recently identified at Port Augusta	Confirmed in Port Augusta. No other records for the state.
Bryopsis plumose	Bryopsidophyceae	Cryptogenic	A widespread and morphologically variable species	Established and widespread over SA including records from Port Augusta

Name	Class	Status	Comments	Occurrence in Upper Spencer Gulf
Ulva lactuca	Ulvophyceae	Cryptogenic	A cosmopolitan species, with all *Ulva* in southern Australia originally thought to be this species. Now recognised as six separate species with *U.lactuca* regarded as relatively uncommon	Despite not being as common as other *Ulva sp., U.lactuca* is still regarded as established and widespread in SA with a confirmed record from Whyalla
Antithamnion cruciatum	Florideophyceae (Red Algae)	Introduced	Found in the temperate Atlantic and Mediterranean. Only recorded occurrence in southern Australia is at Whyalla, suggesting a possible introduction	Confirmed at Whyalla – only record in state
Schottera nicaeensis	Florideophyceae (Red algae)	Introduced	Probably native to Europe and introduced to South Africa and Australia	Confirmed at Stony Point and Glenelg – only records in state

14.3.7. Commercial and Recreational Fisheries

The northern Spencer Gulf supports a rich scale fish and invertebrate species fishery, including the Western King Prawn (*Melicertus latisulcatus*)which has significant commercial value. Of particular importance is the Spencer Gulf Prawn Fishery (SGPF), which is the largest of the three commercial prawn fisheries in South Australia, which includes the Gulf St. Vincent and the Western Coast Prawn fisheries (SARDI, 2005). The SGPF is a single species fishery, based on the Western King Prawn. The SGPF is managed by the Department of Primary Industries and Resources of South Australia (PIRSA) under an existing plan. The plan includes monitoring of the marine environment and strongly promotes conservation of seagrass meadows and juvenile prawn habitats.

Northern Spencer Gulf is also an important fishing area in South Australia in terms of commercial yield per annum for a number of fish species, including;

- Garfish (Hyporhamphus melanochir)
- King George Whiting (Silliaginodes punctatus)
- Snapper (Chrysophrys auratus)
- Western sand Whiting (*Sillago schomburgkii*)
- Tommy Ruff (Arripis georgianus)
- Snook (Sphryraena Australuzza novaehollandiae)
- Yellow-fin Whiting (*Sillago schomburgkii*)
- Calamary (Sepioteuthis australis).

Other scale fish, invertebrates and elasmobranches caught in the area include:

- Blue Swimmer Crab (*Portunus pelagicus*)
- Australian Salmon (Arripis trutta esper)
- Yellow-eye Mullet (*Aldrichetta forsteri*)
- Leatherjacket species
- Eagle Ray,Fiddler Ray and other ray species
- Bronze Whaler Shark and other shark species.
- Giant Australian Cuttlefish (*Sepia apama*).

Prior to the Cuttlefish spawning area closure which commenced in 1999, northern Spencer Gulf was also the major region in the State for commercial fishing of Giant Australian Cuttlefish, particularly during the mid to late 1990s. With the exception of minor increases in 1999/2000, 2006/07 and 2009/10, catch rates of Cuttlefish from the commercial sector have trended downwards over the last 14 years, declining from a peak of 253kg.boat day^{-} in 1997/98 to 77kg.boat day in 2010/11 (Steer et al, 2013). Giant Australian Cuttlefish are addressed in detail in **Section 14.3.5.3**.

14.4. Potential Impacts to the Marine Environment

14.4.1. Marine Environmental Values

The assessment of environmental impacts is provided in the following Sections, with regards to the construction phase and the longer term operational phase for the Project.

The habitats, flora, fauna and general biodiversity of the marine environment have been described in **Section 14.3**. From this review of the existing environment, the main environmental values are summarised as:

- Habitat for breeding aggregations of the Giant Australian Cuttlefish
- The presence of listed fauna, including:
  - Cetaceans (Southern Right Whale, Humpback Whale, Indian Ocean Bottle-nosed Dolphin)
  - Sygnathids (numerous pipefish occur or potentially occur)
- The presence of commercially and recreationally important fisheries
- An aquaculture zone in Fitzgerald Bay.

More broadly the environmental values of Upper Spencer Gulf also include:

- Extensive seagrass meadows and mangroves

- Nursery habitat for commercially and recreationally important species
- Unique biodiversity such as presence of species with tropical affinities.

14.4.2. Construction Impact Assessment

14.4.2.1. Habitat Loss

Appendix E.1 shows the 300m exclusion zone that will be enforced during construction for safety reasons, and a 200m work zone along the length of the jetty.

The marine habitats directly affected during construction include:

- A small area, approximately 80 m^2, of the intertidal zone as a result of constructing the cantilever abutment
- A small area, between 50-100m^2 of subtidal reef due to pile construction
- A small area, less than one percent of the 59ha work zone, of the soft bottom community which will be affected by the jetty construction and changed light conditions.

A post-construction survey will be undertaken to accurately define the impacted areas, which is discussed further in **Section 14.5.3** on monitoring.

The habitat disturbances are put into context when considered from a regional perspective (**Figure 14.3d**). Similar habitats exist elsewhere in the Gulf including adjacent area to the west of the proposed ship loading structure which was recently declared a sanctuary zone under the *Marine Parks Act 2007.* This affords the area one of the highest levels of protection under the Upper Spencer Gulf Marine Park zoning (refer to **Section 14.3.1**).

The construction of the ship loading jetty and wharves is not expected to create barriers to the movement of any marine species. Piles will be spaced at approximately 30m intervals for the length of the trestle, so connectivity with coastal and offshore habitats to the east and west of the trestle is maintained. Additionally, the proposed development is not expected to alter current velocities, increase erosion, or create any other adverse conditions that may restrict movement of marine organisms (Refer to **Chapter 13, Coastal Processes and Water Quality**). Overall, with regard to the Impact Significance Criteria, the impact of the small areas of habitat loss is minor and the risk rating low.

14.4.2.2. Habitat Gain

Additional habitat will be created by the installation of piles. As documented in **Section 14.3.4.8**, the piles on the adjacent Santos jetty were colonised quickly following installation. A similar regime of colonisation is expected to occur following the installation of the piles for the current Project. The jetty effectively becomes an artificial reef and is seen as beneficial. However, it may influence predator/prey interactions in the area. This could have both positive (i.e. more small fish species sheltering in the structure as prey) or negative (attracts larger predators such as snapper) impacts on the Giant Australian Cuttlefish.

Neither of these impacts is able to be quantified with any certainty. However, the recent report by Steer et al (2013), that examined possible causes for the decline in Cuttlefish numbers, did not mention the existing Santos jetty as an issue in attracting sufficient numbers of predators to affect the population. Additionally there was no correlation between the population of Snapper in the Upper Spencer Gulf (extrapolated from fisheries data) and the decline in Cuttlefish numbers.

14.4.2.3. Marine Water Quality

During construction, the main potential impacts include:

- Potential increases in turbidity and suspended solids/ sedimentation, which is considered to be the main issue, as a result of:
  - Piling activities
  - Propeller wash from construction vessels
  - Silt loads in stormwater run-off from land based construction activities
- Potential contamination from wastewater (nutrients and pathogens) as a result of inadequate waste disposal or spills
- Potential oils spills from fuelling of construction vessels and leakages from equipment used.

Potential impacts on marine water quality are discussed in detail **in Chapter 13, Water Quality and Coastal Processes.** The impact of deterioration in water quality on the marine environment is discussed below.

Turbidity and Suspended Solids

Construction activities can impact on adjacent marine communities as a result of sediment disturbance, which when excessive, can result in adverse impacts, including:

- Increased turbidity in the water column affecting visibility for fauna and reducing light availability for flora
- Increased suspended solids in the water column, which may be abrasive and cause clogging e.g. of gills
- Sedimentation through silt deposition smothering fauna and flora.

As indicated above, piling and propeller wash from construction vessels are the main marine activities which could have impacts. The potential effects with regard to the inshore reef and offshore benthic communities are examined below.

Effects of Pile Construction

(i) ***Reef Community***

Pile construction will occur in the subtidal reef, extending for approximately 200m offshore outside of the aggregation season. For the first 1km piles will have 5m centres laterally and 32m centres longitudinally. Piling will have an impact on turbidity and sedimentation, but it is expected that the effects will be localised and transitory. It is difficult to quantify the effects, but in this case, it is considered that the effects on reef biota will be minor as a result of:

- The use of hollow piles, which because of the smaller penetration area compared to a solid pile, causes fewer disturbances
- The short duration of piling each day, approximately 30 minutes per pile, with four piles per day likely to be constructed (with the remainder of time applied to establishing the piling rig in readiness to hammer the piles). This and with the effects of long-shore water movement, tides and wave action will ensure that biota in close proximity to work areas will only be exposed to any increased turbidity for short periods and not be subjected to prolonged periods of elevated turbidity
- Mobile fauna, including Sygnathids and other fish species will be temporally displaced, moving from the area of disturbance. It is more likely that noise will have a greater effect causing displacement, as discussed in **Section 14.4.2.4** below
- Sedimentation to the extent of having any permanent adverse impact on sessile filter feeding organisms, such as Mussels, Hammer Oyster, organisms which are susceptible to the smothering effects of sedimentation, is unlikely. In the event of a short-term increase of suspended solids, which could clog breathing and which may also be abrasive, they will close as they will in the presence of any irritant
- Sedimentation does impact on reef macroalgae, but the subtidal reef will not be impacted by such a transient effect. Where a decline in reef communities has been observed, such as on some of the reefs along the Adelaide Metropolitan Coast, they have been affected by terrigenous (rivers, stormwater) sources and dredging, with much larger amounts of sediment over a long period (Cheshire &Turner 2000, cited in Cheshire et al, 2002)
- There will be no increase in turbidity during the breeding season and hence no effect on visual breeding cues (Steer et al, 2013)
- As construction moves offshore, any risk to the inshore reef decreases, particularly as the circulation pattern, discussed in **Chapter 13, Coastal Processes and Water Quality** will result in dispersion away from the coast.

The above comments on piling also have to be seen in the context of the occasional high turbidity/suspended solids that are likely to occur frequently in the shallow area inshore waters as discussed in **Chapter 13, Coastal Processes and Water Quality**. In the nearshore waters, turbidity is regularly high, with a range of 0-26 NTU. It is also important to note that this will be along the whole length of the reef.

Installation of steel piles could have an impact on turbidity, but it is expected that the effects will be localised and transitory. It is difficult to quantify the effects without physical measurement of the sediment release from pile driving as there are very limited data. Compared to dredging, it is an activity that has little effect. A monitoring study was undertaken for the Columbia River bridge Project to examine effects of piles installation, with both hammer and vibrational piling. The monitoring found that at 10m and 200m from the piles turbidity increases were low, between 2-3 NTU, which was less than the natural variation for the monitoring period (Evans & Associates, 2011). Even though it was in more estuarine conditions, it nevertheless illustrates the fact that there was only a small transient effect.

The current proposal indicates that open ended (hollow) piles of 1-2m diameter (pending detailed design) will be driven into the seabed. It has considerably less disturbance to sediment compared to solid piles. Considering the use of hollow piles and outcome of the Columbia River monitoring study, impacts of the piles installation are considered negligible.

The installed steel piles there will have negligible impact on hydrodynamic regime and hence will not be expected to increase the amount of suspended sediment in the water column.

(ii) **Soft Bottom Benthic and Pelagic Communities**

As summarised by Thiel and Tanner (2009), the three soft bottom habitats found along the jetty alignment (refer **Section 14.3.4**) include:

- A sand mud zone, where the Corkweed (*Scaberia aghardii*) is the dominant canopy algae and the Razor Fish (*Pinna bicolor*) with sparse patches of the seagrass (*Heterozostera* sp.)
- A zone of shellgrit/sand with dense aggregations of Razor Fish, which provide a substrate for a variety of fauna and flora, including red foliaceous Algae, soft Corals, Sponges and Ascidians
- A shellgrit/sand zone towards the end of the jetty where species richness declines. The red foliaceous Algae disappear and Razor Fish and ascidians are the dominant taxa.

With regard to the biota of these habitats, it is also anticipated that the effects of pile installation on turbidity and suspended solids in the water column and sedimentation on adjacent areas will also be localised and transitory, considering the following:

- With the progressive construction of the 3km jetty, only small areas of the benthic community will be affected at any one time. As piles are constructed any adjacent areas affected by sedimentation will rapidly recover, as indicated above in the previous Section
- As a result of the use of hollow piles, and physical hammer time being 30 minutes for each pile (approximately 4 piles per day will be constructed) and with the proposed method of construction, sediment re-suspension increasing turbidity/suspended solids and sedimentation in adjacent areas will be minimal. The effect will be of short duration with turbidity and suspended solids increases occurring as pulses
- Similar to the mobile fauna of the reef community, avoidance behaviour will protect pelagic species from the effects of elevated turbidity/suspended solids in the water column. It is likely that many of these fauna will avoid the area because of noise affects, as discussed below in **Section 14.4.2.3**
- The soft bottom benthic and pelagic communities frequently experience sediment re-suspension from spring tides, currents and from wave induced turbulence in inshore waters during storm events, as evidenced by the frequently occurring high turbidity levels (refer to **Chapter 13, Coastal Processes and Water Quality**). In comparison, the effects of piling are likely to be relatively minor
- The effects of any turbidity increase on light availability for phytoplankton and bottom flora are also likely to be localised and transitory.

(iii) ***Seagrass Communities***

There is some scattered *Heterozostera nigricaulis* and near Point Lowly there is a *Posidonia sinuosa* and *P. australis* seagrass bed between one to three kilometres from the proposed jetty, refer **Figure 14.3e**. The effects of piling are very unlikely to adversely affect the vegetation, as seagrasses have tolerances well beyond any potential effect of construction, as summarised in **Table 14.4a** below. Any effects on turbidity may only be minor and lasting hours, whereas the seagrass can survive months in light intensities below their minimum requirements.

Table 14.4a: Duration of time species of seagrass can survive in light intensities below their minimum requirements (from Longstaff et al, 1999, cited in Cheshire et al, 2002)

Species	Light availability	Period survived (months)	Measurement used
Heterozostera tasmanica	2% of surface irradiance	2-4	Leaf clusters
Posidonia sinuosa	12% of ambient	24	Shoot density

Overall, with regard to the Significance Criteria, the effects of piling on water quality are expected to be minor and the risk rating low.

Propeller Wash from Construction Vessels

The effects of work boats on sediment re-suspension are examined in detail in **Chapter 13, Coastal Processes and Water Quality**. It is expected that they will have a minimal contribution to re-suspension of material through propeller wash due to the shallow draught of these vessels.

It is likely that any increase in turbidity caused by construction vessel movements will be minor and within natural background variation in an area characterised by periodically high turbidity levels. Also the general circulation pattern described will ensure adequate dispersion away from the inshore reef.

Oil Spills and Waste Management

Oil Spills from Re-fuelling

Fuelling of some of the construction vessels may occur at the tug wharf. This will be by road tanker and will involve diesel fuel oil. There will be no storage of fuel for vessels on the construction site. This avoids the need for storage tanks and fuel pipelines with the associated risks of breakages or leaks.

The potential spill material is diesel fuel oil, a distillate, which will float and have a very high evaporation rate (approximately 98 percent within 75 minutes (AGC1988b)). Should a leak or spill occur, the volumes will be restricted to the size of the tanker, and will evaporate rapidly. Any residual oils that do come ashore will be in the intertidal zone, where it is unlikely to impact on the subtidal reef, seagrass or foliaceous red Algae/ Pinna soft bottom benthic communities.

This assumes that no spill management procedures are in place, which will not be the case. These measures are discussed further in **Chapter 13, Water Quality and Coastal Processes**.

Overall, with regard to the Significance Criteria, the effects of oil spill from re-fuelling on the marine environment are expected to be minor and the risk rating low.

Oil Leakages from construction equipment

Potential environmental impacts from construction equipment oil leaks are likely to be very localised, minor in effect and the risk rating low. Nevertheless, these should be prevented and measures to achieve this are discussed in **Chapter 19, Environmental Management Plan.**

Waste Management

There will be a temporary, portable toilet located on the jetty for use during construction activities. This will be a typical self-contained unit with no discharges to the marine environment.

Construction of the Project may increase the potential for hard waste to be introduced to the marine environment. This includes such items as binding material (e.g. rope) and packaging (e.g. plastics) creating a risk to marine organisms of entanglement, smothering, choking and asphyxiation. All waste material produced during marine construction activities will be transported back to shore and disposed of or recycled as appropriate offsite.

14.4.2.4. Effects of Construction Noise

A detailed investigation has been undertaken of the effects of construction on underwater noise, which is included in **Chapter 15, Underwater Noise**. In summary, the primary sources of noise as a result of construction activities are likely to be:

- Engine noise from boat and barge movements
- Piling noise.

A 'zone of effect' has been determined around construction noise sources comparing propagated noise levels to animal sensitivities, summarised as follows:

Marine Mammals

With no mitigation measures, the most conservative zones of impact are reported for marine mammals:

- Whale temporary hearing damage may occur within approximately 10m of the piling rig
- Pinniped temporary hearing damage may occur within approximately 50m of the piling rig
- Avoidance behaviour is expected for marine mammals within 5000m of the piling source.

Impacts are assumed here to be approximately the same in any direction, although noise levels are predicted to reduce in very shallow water (i.e. one to two metres in depth) towards the shore. Given the low numbers of Whales that frequent the area, it is expected that any potential impacts can be readily managed through construction management practices, as outlined in **Section 14.5**, noting that the Project area does not constitute core habitat for whales, with the absence of aggregation areas in the Spencer Gulf.

Similarly, with Pinnipeds being occasional visitors to the area with no breeding or haul-out sites recorded in the area, the risk is expected to be low.

The risk to Dolphins has been carefully considered, particularly with a possible nursery area being present around Point Lowly (BHPB, 2011a). Piling activities may invoke a behavioural response in Dolphins in this area. However, it is important to consider that piling activities will only be conducted for a short period each day (each pile having approximately a 30 minute hammer time, with an average of four piles a day installed), with considerable time needed to move the piling rig between each pile location. It is also noted that the Indian Ocean Bottlenose Dolphins in this area live in a high noise environment with substantial boat traffic and regularly move around Whyalla harbour so may have some tolerance to marine noise. Nevertheless, Dolphins will likely be disturbed, but the impact will be short term and minor.

Fish

Using the results from both piling sources with no mitigation measures, the most conservative zones of impact are reported for fish:

- Fish mortality will likely occur within one to two metres of the piling rig
- Avoidance behaviour is expected for fish within 5000m of the piling source.

The group of fish most at risk are considered to be the Syngnathids due to their generally low mobility and strong habitat association. Fortunately the habitat most associated with this species, seagrass, is not present in significant quantities in the direct impact area of the Project, although within the zone of potential avoidance behaviour. As such, it will be expected that very few mortalities will result from piling activities. A behaviour response may occur for individuals residing in close proximity to the piling activity (i.e. the seagrass communities of Weeroona Bay) which could temporarily reduce the suitability of habitat in this area.

Cephalopods

The most conservative zones of impact (without mitigation measures in place) are reported for cephalopods:

- Auditory damage to cephalopods will occur within 50m of the source location
- Avoidance behaviour is expected to occur within approximately 300m of the noise source.

When considering cephalopods the main focus has been on the aggregation of the Giant Australian Cuttlefish along the reef area from Black Point to Point Lowly (May-September). During the Project planning phase, it was decided that inshore construction activities at or in close proximity to the reef will not occur during the Giant Australian Cuttlefish breeding season, in order to minimise the risk to the breeding population. Monitoring will be undertaken at the beginning of the aggregation season. Should the presence of Cuttlefish not be detected, piling activities will continue within this zone. As indicated in **Section 14.3.5.3**, the Cuttlefish are short lived and only breed once. The impact to Cephalopods from construction noise is low.

14.4.2.5. Effects of Light Spill

Marine flora and fauna are influenced by light in a number of ways, with the response to light dependent on the species and lifestage. Effects on marine ecosystems have also been observed; many aquatic invertebrates, such as Zooplankton, move up and down in the water column in what is known as "diel vertical migration" (Longcore and Rich, 2004). This may be a response to avoiding predation during lighted periods, and results in many zooplankton foraging near the surface during dark conditions. Artificial lighting may disrupt this diel vertical migration which can, in turn, affect populations of algae that the zooplankton feed on (Moore et al 2000; cited in Longcore & Rich 2004).

The effects of artificial light from the current Project need to be considered in the context of the adjacent Santos Facility which is a significant source of artificial light. It is likely that local fauna, particularly larger and mobile fauna, are already accustomed to artificial light in the area.

Artificial light can affect behaviour of native fauna including foraging strategies and predator/prey interactions.

Most of the construction activities will occur during the day, limiting the need for artificial lighting in the marine environment, apart from that required for safe navigational and security purposes. This will minimise the effects on nocturnal species. However, there may be occasions when construction activities are required at night. It is also to be noted that the construction area is several kilometres from False Bay and the potential for disturbance of migratory birds using the bay will be minimal

14.4.2.6. Marine Pest Introduction

Although often considered more of an issue for international vessel movements, the transfer of pests between ports and regions within Australia is also an issue. Australian ports and construction vessels therefore could be a source of marine pests not currently found within the study area.

Marine pests are not only an issue for the local marine environment; they can also have financial implications for the operation of the port. If a marine pest becomes established at a port then there may be restrictions or additional mitigation requirements placed on ships that dock at the affected port when transiting to other non-affected ports.

It is important to prevent the establishment of marine pests in the Upper Spencer Gulf as they can have a variety of impacts including:

- Threatening and displacing native marine life
- Damaging the attractiveness and value of coastal areas
- Threaten the local economy through impacts to:
  - Fisheries
  - Aquaculture
  - Recreational activities (e.g. diving, snorkelling, fishing, etc.)
  - Amenity value
- Cause human illness.

Marine pests can be introduced to the Project area through marine pests that have accumulated on vessel hulls and internal structures, through deliberate or accidental introduction by ship personnel, via vessel stowaways or ballast water discharge. All vessels involved with the construction of the Project (e.g. staff and material transport barges, tugs) need to be considered in the context of marine pest introduction risk.

Because of the potential impacts and in the absence of compulsory guidelines or other safeguards, the introduction and spread of pest species could be very serious. Consequently, with regard to the Significance Criteria, the potential effects are considered to be moderate and the risk rating medium.

14.4.2.7. Potential Effects on Aquaculture and Commercial and Recreational Fisheries

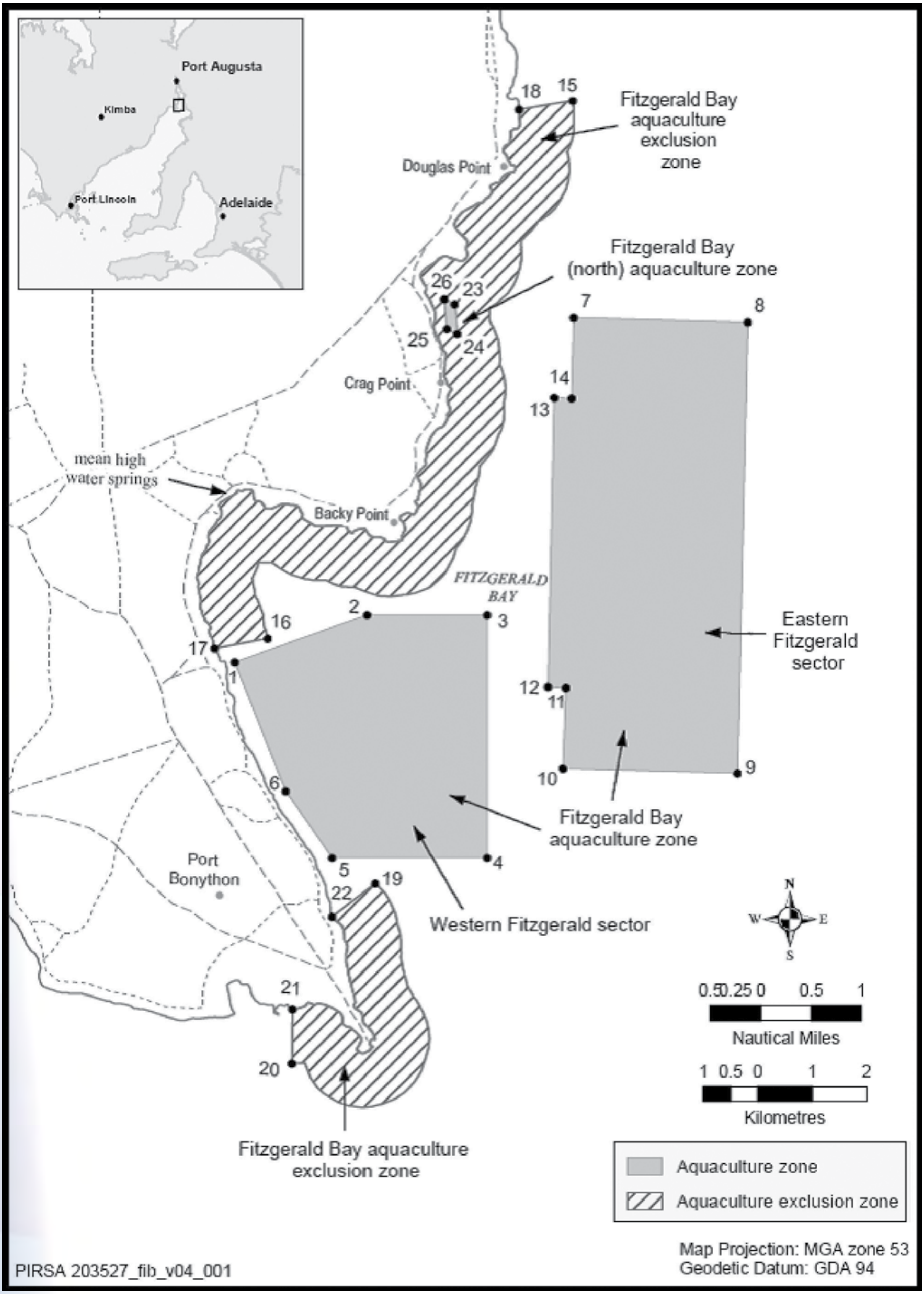
Aquaculture

The nearest aquaculture leases are in Fitzgerald Bay as shown on **Figure 14.4a** and have previously been used for Kingfish aquaculture; it is understood that there are no operations at this location currently. During construction there is not expected to be any impacts to these leases as there will be no impairment of water quality (Refer to **Chapter 13, Coastal Processes and Water Quality**). There is some risk, albeit unlikely, that marine pests introduced during construction could impact on the leases.

Commercial and Recreational Fisheries

Construction effects should have negligible impacts on fisheries species in view of the minimal impact on water quality expected as a result of construction. Piling activities may result in some behavioural avoidance response in the vicinity of the jetty; however these will be localised and transitory. No fish nursery areas will be lost as there will be no removal of mangrove or seagrass habitats which are important in the lifecycle of many fisheries species. In addition, there is a low risk of marine pest introduction during the construction process.

Figure 14.4a: Map of Fitzgerald Bay aquaculture zones and exclusion zone areas (PIRSA 2008)



14.4.2.8. Boat Strike

There will significant boat activity during the construction of marine infrastructure with transport of material and personnel (refer **Chapter 2, Project Description**). This will create the potential for impacts on marine fauna via boat strike with the marine mammals being the most vulnerable group due to their need to surface to breathe. Marine Turtles are also at risk but due to their unlikely presence in the Spencer Gulf the risk is low.

Without any mitigation measures the highest risk level is associated with boat strike is that of small, fast moving boats coming into contact with dolphins, given their regular sightings around the Point Lowly area. The presence of juveniles may also make an impact more likely as they may not yet have realised the risks associated with an approaching vessel. Boat strike could cause death or serious injury to a Dolphin. Despite heavy use of the area by high speed fishing vessels, there have been no reports of strikes; as such the risk considered moderate.

14.4.3. Operation Impact Assessment and Management

14.4.3.1. Ship Strike

Spencer Gulf Waters

Dolphins are highly mobile, agile animals and their regular presence near the busy Whyalla boat harbour and Santos ship loading facility suggests that they can avoid ship strike, particularly the large, slow moving tugs and bulk carriers associated with operation of the BCEF.

Whales are highly mobile, migratory species that are uncommon in the Upper Spencer Gulf. The two species identified as having a credible risk, the Humpback Whale and the Southern Right Whale, are occasional visitors, with the habitat in the study area not being important for breeding or aggregation areas (refer **Section 14.3.5**). The low numbers of Whales observed in Spencer Gulf, along with the relatively low instance of reported ship strike, suggests that the risk to whales as a result of ship strike is low, even in the context of increasing ship movements.

The predominant threat of vessel strike during the operation of the Project will be from the movement of bulk carriers (estimated at around 277 per year). These large, relatively slow moving ships are not generally considered a threat to smaller, highly mobile marine mammals such as Dolphins and Seals, but can be a threat to Whales.

The operation of the BCEF will increase the number of large vessel movements into the Spencer Gulf. Cape-size vessels (with a capacity of 180,000 t) will contribute the majority of ship movements.

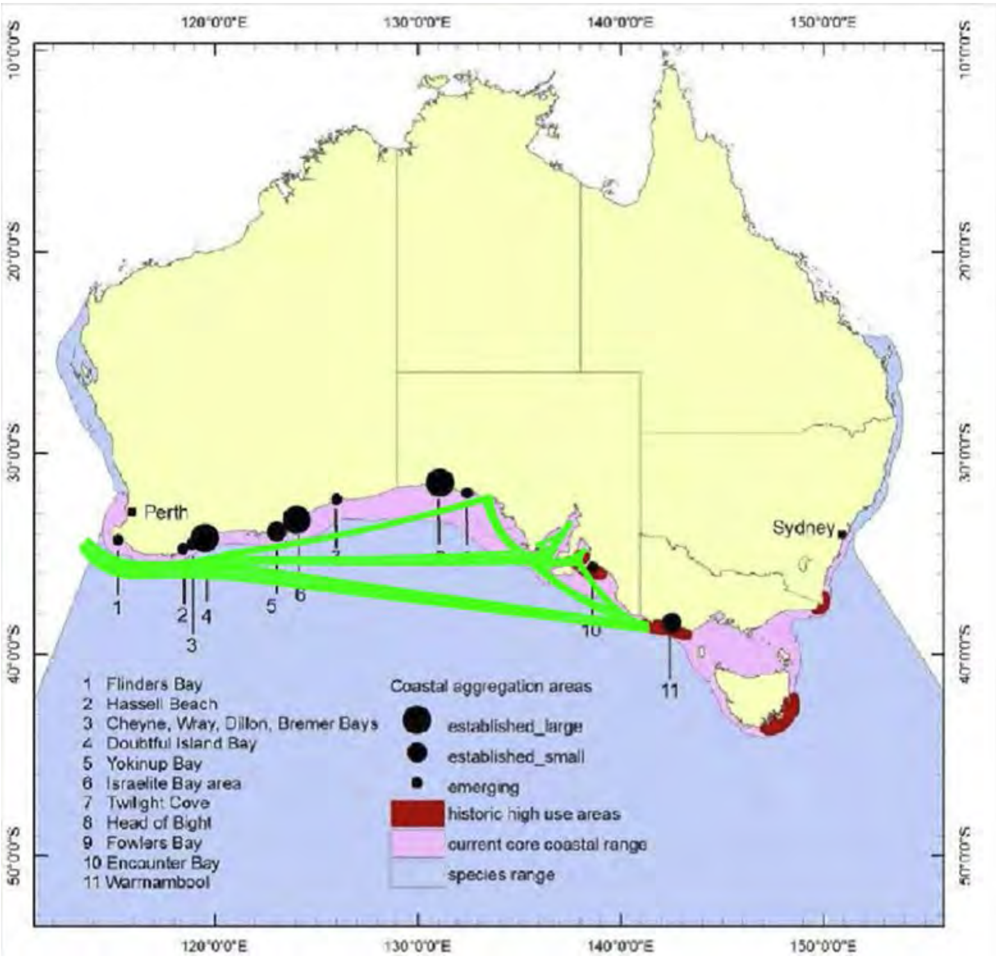
The risk to whales from ship strike is considered low, based on the following:

- There are no known Whale aggregation areas in the Spencer Gulf and only low numbers are expected to travel up the Gulf as far as Port Bonython (refer to **Section 14.3.5**). While it is likely some individuals may enter the Gulf as part of their movement along the southern coastline of Australia there are no recognised movement patterns of the whales through the Gulf
- There is an existing deep water facility at Port Bonython (Santos refinery) which has been operational for the last 30 years; there have been no recorded incidents of Whale strike as a result of this Project
- Although Southern Right Whales appear to be the primary species involved in vessel collisions in the southern hemisphere, there are low numbers of recorded strikes in Australasian waters (Van Waerebeek et al, cited in SEWPaC, 2012a). This observation is supported by the low number of strikes on Southern Right Whales recorded by the IWC in Australian waters as summarised in **Table 14.4b**. Two fatal vessel collisions and three non-fatal collisions were recorded in Australian waters in the period 1950-2006 (Kemper et al, 2008). From 2007 to 2011, an additional three ship strikes on Southern Right Whales, including two deaths, have been reported to the IWC (IWC, 2011). The data set from 1950-2006 shows instances of entanglement (often from fishing, aquaculture and related industries) are nearly three times more common than boat strikes (five vessel collisions, 13 entanglements) (Kemper et al, 2008)
- It should be noted that most of recorded incidents are thought to relate to smaller vessels. There are no formal requirements for larger commercial vessels to report whale strikes, so records may not be complete. Larger vessels travelling at maximum speed may also be unaware of an incident occurring. It is reasonable to assume however that the incidence is low, or there will be higher numbers of dead or injured whales reported along the South Australian coastline
- The existing shipping channels into Spencer Gulf are aligned towards the centre of the Gulf in deeper water, meaning that if the Whales move in the shallow inshore waters that they tend to prefer whilst in Australian waters (SEWPaC, 2012a), they may avoid ship lanes and reduce risk of ship strike. These existing shipping channels will be utilised by vessels travelling to and from Port Bonython.

Table 14.4b: Summary of boat strikes on southern right whales in Australian waters (International Whaling Commission website, DATE, Kemper et al, 2008)

Date	Location	Fate Of Animal	Comments
2011	10km ESE Border Village, SA	Fatally wounded	Female whale struck by unknown vessel
September 2009	Ulludulla, NSW	Fatally wounded	Ship strike on calf reported then later washed up on beach with severely impacted upper jaw and cranium
August 2008	South west coast, WA	Injury healed	Female showing healed ship strike scar. No residual effects noticed
November 2002	Waterfall Bay, Tas	Severe external injury	A whale, believed to be a mother protecting a calf, rose under a boat and lifted it more than 1m out of the water before turning it 180 degrees and tossing it
August 2002	Prosser Bay, Tas	Minor external injury	Two whales disturbed by starting up outboard motor
July 2001	Cape Jervis, SA	Fatally wounded	Hit by ferry
October 1984	South Arm, Tas	Severe external injury	Accidently hit by fishing boat
February 1981	Orwell Rocks, SA	Death	Washed up dead on beach after floating at sea. Observers noted that incident may have been a vessel strike but no details to substantiate this.

Figure 14.4b: Shipping routes in relation to recognised Southern Right Whale aggregation areas (Australian Maritime Safety Authority, Flinders Ports and SEWPaC)



Commonwealth Waters

In the recent *Conservation Management Plan for the Southern Right Whale* (SEWPaC, 2012a), the risk to the south-east population from vessel collision is rated as high, primarily due to the large population centres within the south-east population area (e.g. Adelaide, Melbourne, Sydney) and high shipping traffic associated with these major centres.

The Project will contribute to ship movements in the Commonwealth waters ship lanes heading either east or west to Asian markets. Ships exiting the Gulf after loading join the existing shipping lane mostly in a westerly direction, although there may be small movement in an easterly direction. The route chosen by shipping companies is outside the control of SGPL and is driven by the market. The western shipping lane is over 200 nautical miles from the Head of Bight aggregation area. Southern Right Whales will need to cross this shipping lane during their migration to and from Australia's coastal waters; however the low instances of ship strike suggest that this does not pose a significant threat to the Southern Right Whale. Records for the 2011/2012 financial year identified approximately 1500 ship movements west (data sourced from AMSA cited in Flinders Ports, pers. comm). This will suggest that in the context of current ship movements, the Project will increase ship movements by approximately 18 percent, should all ships travel to the west. This level of movement will only occur should the maximum capacity of the BCEF be reached. It is important to note that these ship movements are following existing shipping lanes which are located well away from the important aggregation areas of Fowlers Bay and Head of Bight (refer to **Figure 14.4b**).

Ships loaded with ore from the proposed BCEF will exit Spencer Gulf, passing through areas of the south-west Marine Region. As part of Australia's National Representative System of Marine Protected Areas, the Federal Government has established the south-west Commonwealth Marine Reserves Network to protect examples of the biodiversity, habitats and ecosystems of the south-west Marine Region. The south-west Marine Region is described in the *Marine Bioregional Plan for the South-West Marine Region* (SEWPaC, 2012b), prepared under the EPBC Act in order to improve the way the marine environment is managed in Commonwealth waters, particularly in relation to matters of national environmental significance. The transiting of vessels is generally permitted through all zones of the south-west Marine Reserve Network, with the exception being during the seasonal closure of the Marine Mammal Protection Zone (located away from main shipping channels) (Director of National Parks, 2013).

There will be up to an additional 277 vessels movements joining the existing shipping lanes. Although well removed from known aggregation areas, whales migrating to and from these coastal aggregation areas will pass through the shipping lanes. The increase in ship numbers as a result of the Project will increase the likelihood of ship-strike occurring, however, given that the current likelihood of ship strike is extremely low, it is unlikely to significantly raise the risk level.

14.4.3.2. Effects of Noise

The primary source of underwater noise as a result of operational activities will be engine noise from vessel movements (tugs and bulk carriers).

Noise from vessels is predominantly caused by ships' propellers; the exception is when operating at very low speeds where hull radiated noise is then dominant. Once operational, noise from bulk carriers will be the dominant source of shipping noise. However, the pre-existence of the Santos wharf means the Port Bonython area is already exposed to shipping noise, and subsequently the additional impacts of shipping are generally due to increased traffic rather than the introduction of a new noise source.

The noise assessment from **Chapter 15, Underwater Noise**, found that:

- Avoidance behaviour from marine mammals may occur at distances of approximately 3000m from the vessel
- At distances greater than approximately 1200m, shipping noise will likely be imperceptible for Cuttlefish. Hence, operational impacts on the Cuttlefish breeding area (located approximately 2500m from the loading berth) are likely to be negligible.

This suggests that operation impacts on marine fauna as a result of shipping noise are likely to be low since whales and possibly seals will move away from the noise source. With no essential habitat for these animals in the affected area, this will not have a significant impact. This avoidance behaviour may also reduce the risk of injury to animals from collisions with ships. The 3000m avoidance zone may encroach on areas identified as high use by dolphins. Given that Dolphins are known to frequent Whyalla harbor, and much busier ports, such as the Port River Dolphins, it is expected that the low frequency noise of large ships pose no threat to the behaviour or use of the area by Dolphins.

Although the movement patterns of Giant Australian Cuttlefish into and away from the aggregation area has not been defined, it is likely that some will move through the zone of effect of shipping noise at the proposed BCEF – as they likely do now for ships berthed at the Santos Facility. This may cause some avoidance behaviour as animals move around the noise source, but will not create an impenetrable barrier.

14.4.3.3. Effects of Light Spill

The effects of artificial light from the proposed BCEF needs to be considered in the context of the adjacent Santos Facility which is an existing source of artificial light. It is likely that local fauna, particularly larger and mobile fauna, are already accustomed to artificial light in the area.

Artificial light can affect behaviour of native fauna including foraging strategies and predator/prey interactions.

During periods when loading activities are not occurring, there will only be a low level of artificial lighting on the jetty and wharf to allow for personnel and marine navigation safety. Where loading occurs at night there will be additional light used to ensure safe loading procedures. It is standard practice to have shielded lights that direct light to the areas where it is need and avoid light spill into the marine environment.

It is expected that any effects of light spill will be localised and with the above measures included as part of the construction design the risk will be low.

14.4.3.4. Marine Pest Introduction

As mentioned in **Section 14.4.2.6**, the control of the spread of marine pests already in Australian waters and preventing the introduction of new ones is a major issue.

Ballast Water

On 1 July 2001, Australia introduced mandatory ballast water management requirements (the requirements) to reduce the risk of introducing harmful aquatic organisms into Australia's marine environment through ballast water from international vessels. These requirements are enforceable under the Quarantine Act 1908. The latest version of the requirements, *Australian Ballast Water Management Requirements (Version 5)* (DAFF 2011) is consistent with the IMO's International Convention for the Control and Management of Ships Ballast Water and Sediments, adopted in 2004. This convention aims to prevent the spread of harmful aquatic organisms from one region to another, by establishing standards and procedures for the management and control of ships' ballast water and sediments.

The mandatory provision of the Australian requirements is that the discharge of high-risk ballast water in Australian ports or waters is prohibited. All internationally plying vessels intending to discharge ballast water anywhere inside the Australian territorial sea are required to manage their ballast water in accordance with Australia's mandatory ballast water management requirements. The Australian Quarantine and Inspection Service (AQIS) deems all salt water from ports and coastal waters outside Australia's territorial sea to be a 'high-risk' and capable of introducing exotic marine pests into Australia.

All vessels arriving in Australia from international waters are required to submit a Quarantine Pre- Arrival Report (QPAR) to AQIS between 12-96 hours prior to entering Australian waters. The QPAR requires Masters to declare whether or not they have complied with Australia's mandatory ballast water management requirements. Masters must also complete the 'AQIS Ballast Water Management Summary'(ABWMS) with details about ballast water uptake ports, ocean exchanges and intended Australian discharge locations. All vessels require AQIS permission to discharge ballast water in Australian waters.

AQIS Officers will conduct ballast water verification inspections on-board vessels to ensure compliance with Australia's ballast water management requirements. AQIS Officers will use the QPAR, the ABWMS and the vessel's deck, engineering and ballast water management logs to verify that the information supplied to AQIS is correct.

Sediments from ballast tanks must not be discharged in Australian waters. If ballast tank sediment is manually removed from tanks, the sedimentary material must not be dumped in Australian ports / waters. Sedimentary material from ballast tanks may be landed as quarantine waste in some Australian ports, or it can be dumped back into the sea in deep water, which is at least 200m deep and outside the 12 nautical miles limit but preferably beyond 200 nautical miles from land.

All vessels utilising the BCEF will be required to comply with these requirements; there will be no dumping or exchange of ballast water or waste disposal at the BCEF.

Biofouling

On a national scale, there are currently plans to implement Australia's National System for the Prevention and Management of Marine Pest Incursions (the National System). The National System aims to prevent new marine pests arriving, guide responses when a new pest does arrive and minimise the spread and impact of pests already established in Australia.

Biofouling is now probably the major risk of pest species transfer. It has been noted by the International Maritime Organisation (IMO) that implementing practices to control and manage ships' biofouling can greatly assist in reducing the risk of the transfer of invasive aquatic species. Individual guidelines have been prepared for the management of biofouling on vessels used for a variety of purposes in Australian waters. The guidelines most relevant to operation of the current Project include:

- *National Biofouling Management Guidelines for Commercial Vessels* (Commonwealth of Australia 2009a) - applicable to bulk carriers
- *National Biofouling Management Guidelines for Non-trading Vessels* (Commonwealth of Australia 2009b) - applicable to tug boats.

As mentioned earlier, these guidelines make reference to the *Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance* (ANZECC 1997) which outlines appropriate preparation and application of antifouling, as well as protocols and occasions when in-water hull cleaning is appropriate.

The International Maritime Organisation (IMO) has published *Guidelines for the Control and Management of Ships' Biofouling to Minimise the Transfer of Invasive Aquatic Species* (IMO 2012), noting that this issue, being of worldwide concern, demands a globally consistent approach to the management of biofouling. These guidelines were adopted in 2011 and have since been revised based on feedback from member States. It is understood that a revision of Australia's national biofouling management guidelines will bring them into line with the latest IMO guidelines.

These IMO procedures will be standard for the BCEF.

Accidental or Deliberate Introduction

The South Australian *Fisheries Management Act 2007*, prohibits the release of any exotic plants or fish into South Australian waters, enforceable with fines of up to $250, 000. It will be required that all crew on visiting ships be made aware of this requirement.

14.4.3.5. Aquaculture and Fisheries

Aquaculture

There will be no effects on aquaculture for the following reasons:

- There will be no loss of available lease area, as the development is in an industrial port area, which, with the existing Santos Facility, makes it unsuitable for aquaculture
- There will be no adverse impacts during construction from turbidity on the nearest aquaculture areas in Fitzgerald Bay, as determined in **Section 14.4.2.7** above
- There are no marine discharges of sewage effluents or any other waste, which could affect water quality
- As indicated above, measures are being taken to prevent stormwater runoff from the site impacting on the near-shore waters. In any case all flows from the Project area are to the south, west of Point Lowly and not to Fitzgerald Bay.

Aquaculture could be impacted by a large oil spill, either by killing stock, tainting of flesh affecting marketability or fouling of pens, with significant clean-up cost implications. However, as discussed in **Chapter 17, Risk and Hazard,** with the measures proposed there will be a low risk.

Aquaculture could also be impacted by new introduced species from shipping using the new port. However, as described above with the strict measures already in place and proposed, there will be a low risk.

Commercial Fisheries

There will be no effects on commercial fisheries for the following reasons:

- There is no loss of seagrass or mangrove habitats, both of which are critically important in the life cycle of many species
- As indicated above any effects on water quality during construction will be localised and transitory, with no long-term impacts on water quality with the operation of the port
- Shipping will be restricted to the main shipping channels.

As for aquaculture, commercial fisheries could be impacted by a large spill if it involved damage to mangrove and seagrass habitats, direct acute or chronic effects on commercial species, or tainting. However, as mentioned above, with the measures proposed there will be a low risk.

As for aquaculture, commercial fisheries could also be impacted by new introduce species from shipping using the new port. However, as described above with the strict measures already in place and proposed, there will be a low risk.

Recreational Fishing

There will be no effects on Recreational fishing for the same reasons as those for commercial fishing above. In addition there will be only a minor restriction on recreational fishing near the jetty with a 50m exclusion zone. Overall the effects on recreational fishing should be negligible.

14.4.3.6. Water Quality

Propeller Wash and Turbidity

Turbidity levels may be increased during operation by propeller-induced re-suspension of sediments by bulk carriers and tugs. Three areas of potential impact are considered:

- The subtidal reef, in the vicinity of the proposed jetty
- Along the shipping channel in the vicinity of Fairway Bank
- Along the shipping channel in the narrows, in the vicinity of Yarraville Shoal.

As outlined in **Chapter 2, Project Description**, at full capacity, the Project aims to export 50Mtpa of iron ore which equates to 277 Cape Class vessels annually with a capacity of 180,000t.

When assessing the potential impacts of shipping as a result of the Project it is important to note:

No dredging is required as part of the Project to maintain passage for shipping

Currently Cape-size vessels up to 180,000t manoeuvre within Spencer Gulf to the boundary of the Port of Whyalla port limit. In addition, LPG vessels up to 110,000t manoeuvre within Spencer Gulf to the Santos Facility at Port Bonython. The recommended Shipping Channel used by Flinders Ports is indicated in **Chapter 2, Project Description**

- The recommended Shipping Channel as per the Admiralty Chart is a track on the deep water route determined to accommodate a maximum seabed level of -20m Chart Depth. One exception to this is Yarraville Shoals (refer to **Chapter 13, Coastal Processes and Water Quality**).

Subtidal Habitat Near the Jetty

Any material mobilised by the maneuvering of vessels offshore from the wharf is likely to be transported in an easterly or westerly direction, depending on the tidal cycle (refer to **Chapter 13, Coastal Processes and Water Quality**). It is unlikely that any suspended material will reach the reef area above what will be expected in ambient conditions. In addition, the transport of any material resuspended as a result of prop wash will also depend on the direction of prop wash-induced currents (dependent on which way the tugs and vessels are facing). Given that the maximum propeller wash induced velocities at the wharf are 0.7m/s, compared to maximum tidal velocities of 1m/s, it is likely that any increase in turbidity caused by vessel movements will be minor and within natural background variation in an area characterised by periodically high turbidity.

Fairway Bank

Fairway Bank likely forms the local source of elevated background turbidity in the area during spring tides (**Chapter 3, Legislation and Planning**). It is possible that the seagrass on this bank also traps some suspended sediments bought down from northern Upper Spencer Gulf during ebbing spring tides.

The preferred approach route for ships comes within approximately 500m of Fairway Bank. However, during the approach the vessels will be unladen, decreasing the influence of propeller wash. During departure, ships will be at least 1km from Fairway Bank, utilising the deep water channel with depths greater than 20m.

During ebbing tides, any material suspended by vessel maneuvering will be carried towards Fairway Bank. It is considered that there will be a negligible impact since:

- Sediments in the departure channel are found to be coarse and will be suspended for only short periods (refer to **Chapter 13, Coastal Processes and Water Quality**)
- Fairway bank, because of its location and tidal velocities, experiences periodic naturally high turbidities (refer to **Chapter 13, Coastal Processes and Water Quality**).

Yarraville Shoal

The designated shipping route up Spencer Gulf to Port Bonython passes Yarraville Shoal. This area forms the shallowest bottom for ship transit of the Upper Spencer Gulf to Port Bonython and transit of this area is subject to special conditions with Flinders Ports requiring passage only during high tide periods. To allow for the highest possible clearance, Flinders Ports regulations require that laden Cape-size vessels depart Port of Whyalla and Port Bonython two hours before high tide.

For a departing laden vessel, the pilot will stay on board until Wallaroo Pilot Ground, well south of Yarraville Shoal.

These procedures are currently in place for Cape-size vessels departing from Whyalla.

The relatively narrow, shallow area of the Yarraville Shoal is exposed to high tidal velocities and as such, is likely to have a reasonably coarse substrate, armoured somewhat against erosion from propellor wash. The closest seagrass area on the Yarraville Shoal is approximately 3km from the shipping route.

It is expected that the contribution of tug and bulk carrier movements to re-suspension of sediments will be low due to the existing high currents in the area and resulting armouring of the seafloor with coarse material. Refer to **Appendix J.2** for more detail on port operations.

Oil Spills

Re-fuelling

The risk profile for re-fuelling of the tugs are the same as outlined for refuelling during the construction phase in Section 14.4.2.3. There will be no refuelling provision for ships utilising the BCEF.

Major Spill Incident

There is a possibility of an oil spill from a ship-to-structure, ship-to-ship, or grounding incident. The impact of a spill will depend on:

- The type of oil involved, e.g. distillates, bunker (foreign or Australian), crude oil, etc.
- The volume of oil spilled
- The weather conditions at the time of the spill
- Location of the spill.

As outlined in **Chapter 17, Hazard and Risk,** spill contingency plans are in place for Port Bonython and the proposed BCEF will operate under this plan. As mentioned in **Chapter 17, Hazard and Risk** in 1992 a ship to ship incident, the 'ERA' spill, resulted in a spill of approximately 300t of bunker oil, which damaged mangrove habitat near Port Pirie. Large spills can potentially have catastrophic consequences; for this reason there are various levels of local and national response. Certainly, the lessons of the 'ERA' spill have been taken on board and procedures improved to prevent a similar incident from occurring.

Overall, although unlikely, with regard to the significance criteria, the impact could be very high giving a 'high' risk rating.

Nutrients and Algal Growth

Algal growth (Phytoplanktonic or Macroalgae) is unlikely to occur as a result of the Project because:

- There will be no effluent discharge to the sea or drainage lines to the coast. As described in **Chapter 2, Project Description** all toilet wastes will be treated and effluent irrigated in accordance with an Irrigation Management Plan (refer **Chapter 19, Environmental Management Plan**)
- Visiting vessels cannot unload waste to shore facilities. Consequently, there is no risk from spillages, pipe rupture or inadequate disposal on land. Vessels cannot discharge waste in port (*Quarantine Act 1908* requirement)
- There will be no stormwater runoff from the Project site up to a one in two year average return interval (ARI). These flows will be stored for use on site in a detention basin as outlined in **Chapter 4, Water Resources**. Most pollutants in stormwater runoff are entrained in the smaller events, usually up to the one in one year ARI. Larger flows will still pass though the basin with reduced residence times. All disturbed areas will be stabilised as soon as possible to prevent erosion and sediment loss
- The enclosed conveyer system and design of the delivery system to the ships holds aims to minimise ore loss by spills or dust generation, which will minimise any ore material reaching the marine environment, refer **Chapter 2, Project Description**. The ores being exported are magnetite and haematite, which are virtually insoluble. For example, it was conservatively estimated that 75kg of iron ore could yield only 1.5 nonogram/Litre (ng/L) of soluble iron in a relatively small volume of 50,000m^3 (Centrex Metals Limited and Golder Associates, 2012). Water quality data in **Chapter 13, Coastal Processes and Water Quality** (**Table 13.4f**) indicates that total iron in waters near Point Lowly (A1 in **Table 13.4f**), range from <5-80 µg/L (median 19.5µg/L) and soluble iron ranges from <5-15.5µg/L. This indicates that the likelihood of iron from loading having any appreciable effect on iron availability to stimulate algal growth is negligible.

Overall the effect of the Project on algal growth will be negligible and the risk rating low.

14.4.3.7. Jetty Shading

The jetty will have some shading effect on the benthic communities; however, this will be minor because of:

- The north-south orientation of the jetty
- The jetty is narrow for the majority of its length, approximately 6m in width and 10m above the high water level to the top of the deck.

The shading effect on any one area of the seabed will be of short duration, and is unlikely to alter relative abundance of species to any significant extent.

14.5. Mitigation Measures

14.5.1. Construction Impact Mitigation Measures

As described earlier, design features and the chosen construction methodology aim to minimise potential impacts. As a result, most of the potential impacts are expected to be minor with a low risk rating. To ensure that this remains the case throughout the construction period, an initial Construction Environmental Management Plan (CEMP) has been prepared (refer to **Chapter 19, Environmental Management Plan**). This will be developed further by the Contractor closer to the commencement of works. This outlines the measures that will be taken to mitigate potential adverse impacts, together with monitoring and reporting requirements.

14.5.1.1. Water Quality

Deterioration in water quality may have an impact on the marine ecological values as discussed in **Section 14.4.2**. Measures to protect water quality are outlined in **Chapter 13, Coastal Processes and Water Quality**.

14.5.1.2. Oil Spill from Re-fuelling

The measures to be contained in the CEMP (refer **Chapter 19, Environmental Management Plan**) are to ensure that there is a low probability of a spill and that the potential effect remains minor with a low risk rating, including:

- Bunding of the fuel transfer area as required
- Ensuring that spill response materials and equipment are always available and response procedures are in place.

14.5.1.3. Oil leaks from Construction Equipment

All construction equipment, particularly where used over water will be regularly inspected and maintained to minimise oil leaks. Where practical this equipment will be sited on a tray or bunded area to reduce the potential for an oil leak to enter the water. Spill kits will be readily available with staff trained in their use. All spills will be reported and remedial action taken to prevent the leak occurring again.

14.5.1.4. Underwater Construction Noise

As outlined in **Chapter 15, Underwater Noise**, mitigation measures to minimise the effects of noise on marine fauna are as follows:

- 'Ramping up' of piling activity to allow fauna to vacate the area
- Enforcement of piling 'safety' or 'observation' zones
- Scheduling of in-shore (or near shore) piling works to avoid the Giant Australian Cuttlefish aggregation season should monitoring determine their presence.

With these mitigation measures employed, the residual risk on marine fauna due to underwater noise is expected to be low.

14.5.1.5. Vessel Strike

During construction, appropriate speed limits will be applied to smaller vessels carrying equipment and personnel to and from the land-based storage area and the jetty construction area. Marine mammal observation and shut down procedures will be observed, as part of acoustic noise impact mitigation measures (as above) which will also reduce the risk of construction vessel strike to a low level.

14.5.1.6. Light Spill

It is intended that a Light Management Plan be prepared, which will:

- Minimise the amount of light to the minimum requirements, also reducing power and greenhouse emissions
- Reduce light spill by shielding and light orientation.

It is unlikely that night time construction will occur, but may be required occasionally to meet construction timeframes.

With the preparation and implementation of the Light Management Plan it is expected that there will be a low risk of environmental impact.

14.5.1.7. Marine Pest Introduction

On a national scale, there are currently plans to implement Australia's National System for the Prevention and Management of Marine Pest Incursions (the National System). The National System aims to prevent new marine pests arriving, guide responses when a new pest does arrive and minimise the spread and impact of pests already established in Australia.

Individual guidelines have been prepared for the management of biofouling on vessels used for a variety of purposes in Australian waters. The guideline document most relevant to the use of construction vessels is:

- *National Biofouling Management Guidelines for Non-trading Vessels* (Commonwealth of Australia, 2009b) - applicable to tug boats.

These guidelines make reference to the *Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance* (ANZECC, 1997) which outlines appropriate preparation and application of antifouling, as well as protocols and occasions when in-water hull cleaning is appropriate.

It is noted that these are voluntary guidelines aimed at helping operators of vessels minimise the risk of translocating and introducing marine pests within Australian waters.

In the absence of any mitigation there is a medium risk to the biological communities. However, construction vessels will have to demonstrate compliance with the *National Biofouling Management Guidelines for Non-trading Vessels* (Commonwealth of Australia 2009b). With this measure the residual rating risk is low.

A marine biological monitoring programme will be established during construction, which will include the occurrence of existing and any new pest species. This is addressed further in **Section 14.5.3** below.

14.5.2. Operations

14.5.2.1. Ship Strike

As described in **Section 14.3.5.2**, the number of Southern Right Whales that utilise Spencer Gulf is low and there are no recorded incidents of ship strike associated with the existing deep water port facilities that have been operational in the area for over 30 years. Notwithstanding this, appropriate controls to minimise harm from ship strike from operation of the BCEF will be put in place where reasonable. In terms of operational vessel movement, SGPL will be responsible for pilotage of vessels within the approach/exit navigational channel. All commercial vessel movement in Gulf water will be monitored by the Flinders Ports control tower (marine communications centre) that monitor all ship movement in the Gulf. Procedures will be put in place where any sighting of a whale will be reported to all vessels in the area and operational notification controls can be implemented. This will ensure that all vessels within the area are aware of the presence of whales.

The *Conservation Plan* (SEWPaC, 2012a) suggests that mortality rates from ship strike are most easily controlled by either reducing vessel speed or separating shipping channels from habitat areas. SEWPaC is currently working with the Australian Maritime Safety Authority, Australian Marine Mammal Centre, Department of Defence and state government agencies to develop a ship strike mitigation strategy.

A vessel's bridge is constantly manned whilst in transit; should a whale be spotted, it is standard procedure that a vessel either steers away from the whale or reduces speed if the whale approaches. The ability of a vessel to undertake evasive action, may be restricted by water depth and other safety issues, however every effort to change both speed and direction is undertaken to avoid contact.

SGPL will maintain a record of ship strikes within the Spencer Gulf and report any incidents in order to establish a baseline. Should the number of strikes increase, a review of management procedures will be undertaken.

With mitigation measures as outlined above, the risk of ship strike will remain low.

14.5.2.2. Light Spill

It is intended that lighting be minimised as much as practicable to minimise power use, greenhouse gas emissions and minimise light spill. This will be achieved by:

- Minimising lighting on the wharf and jetty where practical and safe to do so. During periods when no loading activities are occurring, only essential navigational lighting will be visible on the jetty
- Lighting on the jetty will be shielded to direct the light to the required area and avoid light spill into the marine environment.

It is expected that any effects of light spill will be localised and with the above measures the residual risk will be low.

14.5.2.3. Marine Pest Introduction

Without any management measures, over the long-term there will be a medium to high risk of species introduction impacting on either the reef on benthic communities, and potentially spreading elsewhere in the Upper Spencer Gulf. As noted above, measures are being taken to reduce risk, including:

- The development of the IMO biofouling guidelines, adopted by Australia. All ships transiting the Upper Spencer Gulf to utilise the BCEF will be required to demonstrate compliance with the IMO biofouling guidelines (international vessels) and the National biofouling guidelines (vessels moving within Australia).
- All international vessels will be required to demonstrate compliance with the *Australian Ballast Water Management Requirements*.
- Pest species will be monitored. Following construction a post-construction baseline survey will be undertaken, which will include the existing occurrence and extent of any introduced species.

The Australian Governments (Commonwealth, State and Territory) recognise the importance of ongoing monitoring and surveillance in managing marine pest risks. They have agreed to a species targeted ongoing National Monitoring Strategy (NMS) as part of Australia's National System for the Prevention and Management of Marine Pest Incursions (the National System) to provide for standardised monitoring to detect high risk species at priority locations around Australia. In the context of the NMS, monitoring means regular ongoing sampling of the marine environment to collect information on the presence and absence of target species and to detect species that exhibit invasive characteristics.

Standardised monitoring is achieved through the *Australian marine pest monitoring manual* and *Australian marine pest monitoring guidelines* (National System for the Prevention and Management of Marine Pest Incursions 2010). The primary monitoring objectives are:

- To detect new incursions of established target species at a given location i.e. species already established elsewhere in Australia but not recorded at that location
- To detect target species not previously recorded in Australia that are known to be pests elsewhere.

A monitoring program will be implemented that will conform with the Australian marine pest monitoring manual and guidelines and will be prepared in consultation with stakeholders including:

- Other port users (Santos)
- PIRSA
- AQIS.

The risk of introduction of pest species is expected to be low following adherence to the aforementioned requirements and guidelines.

14.5.2.4. Aquaculture and Fisheries

Risks to aquaculture and fisheries relate to water quality issues and marine pest introduction. Mitigation measures are outlined in **Sections 14.5.2.3** and **14.5.2.5**.

14.5.2.5. Oil Spill from Re-fuelling

Measures to be implemented to reduce the probability of a spill and to ensure that the potential effect remains minor with a low risk rating, include:

- Defining re-fuelling procedures and protocols for tugs at berth
- Bunding as required
- Ensuring that spill response materials and equipment are always available and response procedures are in place.

14.5.3. Marine Monitoring

It is intended that monitoring be undertaken to determine the ecological effects of the construction and operation of the proposed BCEF, in order to confirm the assessment of potential impacts made in the above Sections and/or take remedial action as required. Importantly, the monitoring will be undertaken so as to provide an early warning of developing problems, so that the remedial action is preventative. The monitoring program, which will be developed in consultation with State Government Agencies, will consist of pre-construction and post-construction stages, which are outlined below.

14.5.3.1. Pre-Construction Baseline

Water Quality Baseline

A water quality monitoring program will be undertaken, just prior to construction, to provide accurate data on current quality to assist in determining the effects of the Project. Discussions will be held with agencies, particularly the EPA, on:

- Duration of monitoring prior to construction
- Locations and depths
- Parameters
- Methods, which could include grab samples, continuous monitoring or the use of diffuse gradient thin films.

Biological Monitoring

A biological monitoring program will be undertaken, just prior to construction, to provide up to date information on reef condition, as it may be several years before construction begins. Changes could occur due to a range of factors, including:

- The establishment of the sanctuary zone adjacent to the proposed development, which may lead to an increase in species that were previously fished for and effects on prey populations
- The recorded severe decline in Giant Australian Cuttlefish numbers over the past five years, which may lead to a recovery of Cuttlefish prey items that were reduced

Discussions will be held with agencies including Primary Industries and Resources South Australia (PIRSA – Biosecurity Section), on:

- Habitats monitored and locations (reef, soft bottom benthic communities)
- Duration of this monitoring phase
- Methods, which may involve:
  - Ensuring that the methods are comparable with other monitoring, including that of Santos, State Government (current Giant Cuttlefish Monitoring program) and the use of available manuals including Reef Watch (those for Benthic habitat, Transects, Fish and Invertebrates), and the Australian Marine Pest Monitoring Manual and Guidelines (National System for the Prevention and Management of Marine Pest Incursions 2010a and b)
  - Timing of surveys with regard to seasons and ecological patterns
  - The possible use of indicator species. As a part of the preparation of the South Australian Marine Park network a list of 205 indicator species was compiled. To best represent the changes associated with the declaration of marine parks, and in particular sanctuary (no take) zone, the list focused on 21 species associated with fisheries that had historically been well studied with associated spatial and temporal data. Information reported as part of the marine park process has been used in the current study where appropriate, however, it is important to note that the objectives for indicator species in the current Project differ as they are not focused on the impacts of fishing. Species which may be appropriate are; Razor Fish (*Pinna bicolor*), Hammer Oysters (*Malleus meridianus*) and Purple Urchin (*Heliocidaris erythrogramma*)
  - Razor Fish and Hammer Oysters provide additional hard substrate in areas where mainly soft sediments exist (sand, sandy mud, mud etc.), thus providing a hard surface for the attachment of Epibiota, including *Hormosira banksii, Scaberia agardhii, Caulocystis* sp., *Sargassum* spp., turfing red algae, and a variety of invertebrates, such as Sponges, Ascidians, Mussels and other Molluscs, and Calcareous Tube Worms (Shepherd, 1974 and 1983a; J. Baker, pers. obs.; cited in Baker 2004). Cryptic species, such as small Brittle Stars also use dead Pinna shells as habitat (refer to Shepherd, 1974; cited in Baker 2004), and the presence of Pinna reportedly also promotes increased densities of Sea Urchins in Northern Spencer Gulf. When shells of old Hammer Oysters and Pinna break into fragments, they provide a mobile substrate for stalked fauna (e.g. some bryozoan and ascidian species) that can withstand the strong currents of Northern Spencer Gulf, such as that experienced in the mobile sandwaves/ mega-ripples of the channel areas (Shepherd, 1983b; cited in Baker 2004). As they are filter feeders and immobile, they could be useful in monitoring the effects of elevated turbidities/suspended solids. Razor Fish have also been used in studies of metal contamination, monitoring metal levels in tissues as a result of increases in environmental exposure
  - Purple Urchin (*Heliocidaris erythrogramma*) has been used as indicator species in previous monitoring undertaken for Santos (Marine Science and Ecology, 1988).

14.5.3.2. During Construction

During construction, water quality will occur. Data will be continuously assessed and at the end of the phase the program will be reviewed and modified as necessary.

14.5.3.3. Post-Construction Monitoring

A final monitoring event (water quality and biological) will occur post construction to compare with the pre-construction assessment.

14.6. Risk Assessment Summary

From the above assessments, the risks for the construction and operational phases are summarised in **Table 14.6a**.

Table 14.6a: Risk Assessment Summary

	Initial Assessment With Standard Mitigation (i.e. Statutory Requirements)			
Primary Impacting Processes	Statutory Mitigation Measures Required	Significance Of Impact	Likelihood Of Impact	Risk Rating
Construction				
Loss of habitat for species due to jetty construction	SEB offset through NVM Act	Minor	Unlikely	Low
Habitat fragmentation as a result of construction activities		Minor	Unlikely	Low
Ship strike on marine mammals as a result of construction vessel movements	Observation zones established to mitigate against piling noise will identify marine mammals within the construction area and notify all vessels by radio	Moderate	Highly unlikely	Low
Noise pollution from construction of the Project (particularly piling) significantly affecting listed or iconic species (i.e. disruption of breeding cycle)	Safety zones as per the South Australian *Underwater Piling Noise Guidelines*	Moderate	Possible	Medium
Light pollution from construction significantly affecting a species (particularly listed and iconic species)		Moderate	Unlikely	Medium
Terrestrial runoff from construction on site affecting marine water quality	Erosion control monitoring and management measures outlined in CEMP to satisfy EPA requirements	Minor	Unlikely	Low
Disturbance (e.g. prop wash and piling) as a result of construction activities increasing turbidity and sedimentation		Minor	Unlikely	Low
Introduction of pest organisms and disease as a result of construction activities and plant movement		Moderate	Possible	Medium
Spill of oil from fuelling and leaks or other pollutant as a result of construction activities		Moderate	Unlikely	Medium

Residual Assessment With Additional Mitigation In Place			
Additional Mitigation Measures Proposed	**Significance Of Impact**	**Likelihood Of Impact**	**Risk Rating**
Speed restrictions around construction site as part of CEMP	Moderate	Highly unlikely	Low
Scheduling to avoid Cuttlefish aggregation period	Minor	Unlikely	Low
Light management plan prepared by LCPL. Shielded lights used to ensure minimum spill offshore	Minor	Unlikely	Low
CEMP will ensure plant is cleaned before arriving on site Voluntary compliance with national biofouling and ballast water management guidelines	Moderate	Highly unlikely	Low
CEMP to detail plant and vessel maintenance requirements Flinders Ports operational protocols to reduce likelihood of accident between vessels Spill management plan in place with strategies to minimise potential impacts	Moderate	Highly unlikely	Low

Primary Impacting Processes	Initial Assessment With Standard Mitigation (i.e. Statutory Requirements)			
	Statutory Mitigation Measures Required	Significance Of Impact	Likelihood Of Impact	Risk Rating
Operation				
Habitat fragmentation as a result of jetty presence and operation		Minor	Unlikely	Low
Noise pollution from operation of the Project (e.g. loading activities) significantly affecting listed or iconic species (i.e. disruption of breeding cycle)		Minor	Unlikely	Low
Light pollution from operation affecting a species (particularly listed and iconic species)		Minor	Possible	Medium
Terrestrial runoff from site affecting marine water quality	Rehabilitation measures for disturbed areas and erosion control in Operation Environmental Management Plan (OEMP)	Minor	Unlikely	Low
Disturbance (e.g. prop wash) as a result of operational vessel movements increasing turbidity and sedimentation		Minor	Possible	Medium
Introduction of pest organisms and disease as a result of operational vessel movements	Compliance with the *Australian Ballast Water Management Requirements and Fisheries Management Act 2007*	Moderate	Unlikely	Medium
Ship strike on marine mammals as a result of construction vessel movements		Moderate	Unlikely	Medium
Spill of oil as a result of tug fuelling		Moderate	Unlikely	Medium
Maintenance activities releasing pollutant to marine environment (e.g. hydraulic oil, paint, etc.)	Compliance with *Environment Protection Act 1993*	Minor	Unlikely	Low
Stimulating algal growth		Minor	Unlikely	Low
Jetty shading impacting benthic communities		Minor	Unlikely	Low

Residual Assessment With Additional Mitigation In Place				
	Additional Mitigation Measures Proposed	Significance Of Impact	Likelihood Of Impact	Risk Rating
	Design and operation to minimise light spill	Minor	Unlikely	Low
	OEMP procedures in place, e.g. speed control, pilotage	Minor	Unlikely	Low
	Voluntary compliance with the IMO *Guidelines for the Control and Management of Ships' Biofouling to Minimise the Transfer of Invasive Aquatic Species*	Moderate	Highly unlikely	Low
	Radio communications between ports in Spencer Gulf alerting vessels if sighting occurs	Moderate	Highly unlikely	Low
	OEMP detailing regular inspection and maintenance and implementation of safeguards Port Bonython port protocols and communication Spill management plan in place with strategies to minimise potential impacts	Moderate	Highly unlikely	Low
	OEMP detailing regular inspection and maintenance of plant and machinery as well as correct protocols for maintenance activities on jetty	Negligable/ Minor	Unlikely	Low