



# **DOT307215 Provision of Western Australian Marine Oil Pollution Risk Assessment - Protection Priorities**

Protection Priority Assessment for Zone 4: Swan - Final  
Report

19 October 2017

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West Perth WA 6005  
Australia

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## **Report No: 301320-09591-EN-REP-0009 – DOT307215 Provision of Western Australian Marine Oil Pollution Risk Assessment - Protection Priorities: Protection Priority Assessment for Zone 4: Swan - Final Report**

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## Executive Summary

The Western Australian Department of Transport (DoT) is the Hazard Management Agency (HMA) for marine oil pollution in Western Australia (WA). As the HMA, DoT ensures the capacity of the State to respond to an oil spill is commensurate with the risk.

In order to understand the state's spill risk profile, the DoT is conducting a state-wide marine oil pollution risk assessment. The risk assessment is comprised of two components. The first component identifies the aspects (e.g. fauna, flora, etc.) that are present in each shoreline cell, and evaluates which aspects would be most affected and thus need to be prioritised for protection in the event of an oil spill (i.e. protection priority). These protection priorities were ranked using a five-tier scale, Very Low to Very High (Table 0-1).

**Table 0-1: Protection priority ranking**

Protection Priority	Ranking
Very High	5
High	4
Medium	3
Low	2
Very Low	1

The second component assesses the likelihood, size, location and type of potential marine oil pollution. The second component is being undertaken by Navigatus Consulting (Navigatus). Navigatus is also combining the protection priority component with the spill likelihood component to give an overall marine oil pollution risk profile for the state. This overall risk profile for the state will identify the key environmentally sensitive areas that are most at risk of being affected by an accidental release of marine oil. The output from Navigatus's assessment is not addressed in this report.

The results of this project will be used to decide how to allocate resource on a regional, state and national level, and will undergo scrutiny by regional, state and national agencies. Data collected on protection priorities may assist in decision-making both when preparing and responding to marine oil pollution incidents.

For the purposes of this project, state waters have been divided into seven zones (see Figure 1-1) and each zone has been divided into ~10 km by ~20 km areas called shoreline cells. The project is being rolled out on a zone-by-zone basis over the next two to five years. The first protection priorities zone completed was the Pilbara (Zone 2), which was originally finalised in August 2016, and was followed by assessments of the Midwest zone and Swan zone (Zones 3 and 4). However as the Midwest and Swan zone assessments were being finalised, the protection priority rankings developed during the initial Pilbara zone assessment were resulting in the majority of the shoreline cells in the three zones being prioritised as High or Very High for protection in the event of an oil spill.

While the outcome demonstrates that the WA coastline has many highly vulnerable receptors to marine oil pollution, it does not achieve the objective of the project, which is a state-wide



assessment that identifies the '*key environmentally sensitive areas that are most at risk of being affected by an accidental release of marine oil*'. As a result, a State Wide Overview was undertaken to investigate the drivers for these High and Very High rankings. It was identified that a few key state-wide datasets and their priority rankings were driving the majority of the high rankings. These datasets were for the Protected Fauna and Protection Areas categories.

The outcome of the State Wide Overview assessment was a set of more detailed criteria for assigning protection priority rankings for Protected Fauna and Protection Areas data. These revised rankings have been incorporated into this assessment of the Swan zone; this report presents the revised results following the method developed for the project (Figure 1-2).

This report presents the scope, method and discussion of outputs for the protection priorities identified for environmental, social, cultural and economic areas of significance which may be impacted by a marine oil spill. This report also presents the multi-criteria analysis (MCA) that has been conducted on the geospatial data collected for each category to identify the key areas of protection priority. It also recommends areas for improvement.

The protection priorities assessment for the Swan zone has demonstrated that there are many vulnerable and important receptors that will need to be considered in the event of an oil spill. The cumulative assessment for all five categories for protection from both floating oil and dissolved oil impacts, sees the majority of the Swan zone being ranked Very High (six out of the ten shoreline cells), and the remainder ranked High.

For protection from floating oil impacts, the cumulative rankings across all five categories resulted in six shoreline cells being ranked Very High priority. These are for the protection of Critically Endangered fauna as well as Ramsar wetlands, an economically important port, and seawater intakes for a reverse osmosis seawater desalination plant. Three shoreline cells have been ranked High priority for protection from floating oil for the presence of Strict Nature Reserves (both marine and terrestrial) as well as environmentally vulnerable marsh, swamp and saltmarsh. Finally, one shoreline cell has been ranked Medium priority overall for protection from floating oil for the likely presence of breeding locations for the Endangered loggerhead and leatherback turtle, breeding and calving for the Endangered southern right whale, vulnerable coastal environments such as the clay and sheltered rocky shore, State protected heritage and economic tourism income. The specific sensitivities of each shoreline cell are described in the Results section of this report (Section 7).

For protection from dissolved oil impacts, the cumulative rankings across all five categories resulted in five shoreline cells being ranked Very High priority. These are for the presence of Ramsar wetlands, an economically important port, and seawater intakes for a reverse osmosis seawater desalination plant. The remaining five shoreline cells have been ranked a High priority for protection from dissolved oil due to the known presence of breeding Critically Endangered fauna, economically important West Coast Rock Lobster Managed Fishery, the presence of Strict Nature Reserves (both marine and terrestrial), as well as environmentally vulnerable marsh, swamp and saltmarsh. The specific sensitivities of each shoreline cell are described in the Results section of this report (Section 7).

For preserving Protected Fauna, four of the Swan zone shoreline cells have been ranked Very High for protection from floating oil impacts. These shoreline cells contain known roosting sites for two Critically Endangered birds: the curlew sandpiper (*Calidris ferruginea*); and eastern curlew (*Numenius madagascariensis*). The other six shoreline cells have been ranked Medium for



protection from floating oil, due to the likely presence of breeding areas for the Endangered leatherback turtle (*Dermochelys coriacea*) and loggerhead turtle (*Caretta caretta*), and a known breeding and calf resting area for the Endangered southern right whale (*Eubalaena australis*). For protection from dissolved oil impacts on the same Protected Fauna, four shoreline cells have been ranked High priority and the remaining six have been ranked Low priority. The fauna has been ranked lower because the expected impacts on these fauna are less due to the oil being in a dissolved form.

Three of the ten shoreline cells have been ranked Very High priority for protecting Protection Areas from floating oil, a further six have been ranked High priority, and one has been ranked Medium priority. For protection from dissolved oil, three have been ranked Very High priority, five have been ranked High priority and two have been ranked Medium priority. The Very High priority rankings for protection from both floating oil and dissolved oil are due to two Ramsar wetlands (Peel-Yalgorup System and the Becher Point Wetlands). The High priority rankings for protection from both floating oil and dissolved oil are due to the presence of Nationally Important Wetlands (Swan-Canning Estuary and Rottnest Island Lakes), Fish Habitat Protection Areas, Strict Nature Reserves (both marine and terrestrial), as well as environmentally vulnerable marsh, swamp and saltmarsh. One shoreline cell has been ranked Medium priority for protection from floating oil due to the presence of environmentally vulnerable marsh, swamp and saltmarsh. There are two shoreline cells that have been ranked Medium priority for protection from dissolved oil impacts due to the presence of a multi-user section of the Two Rocks Commonwealth Marine Reserve, and the presence of environmentally vulnerable seagrass beds.

The effect of the ranking of Economic impacts in the Swan zone sees two shoreline cells being ranked Very High for protection from floating and dissolved oil. These are due to the port of Fremantle and other port private activities based out of Kwinana, and the presence of a seawater intake for a major reverse osmosis plant which supplies much of Perth's drinking water. The other economic protection priorities are for the West Coast Rock Lobster Managed Fishery, ranked High priority for protection from dissolved oil in the other eight shoreline cells. There is also an aquaculture site in one of the shoreline cells, which has also been ranked High priority for protection from dissolved oil impacts. For floating oil, there are eight shoreline cells that have been ranked Medium priority for protection of economically important tourism income in the area.

No Cultural Heritage or Social, Amenity and Recreation areas have been identified for protection above a Medium priority in the Swan zone. The ranking of Medium has been attributed to two shoreline cells containing Cottesloe Beach and City Beach, which see more than one million visitors a year. Rottnest Island has not been given a Medium protection priority ranking for Social, Amenity and Recreation, which was different to the expectations of the project team. This is likely due to state-wide equivalent data not being collected for the island, as it is run by its own dedicated management authority who measures different metrics. The majority of Cultural Heritage in the area consists of more than 120 recorded Commonwealth protected shipwrecks and maritime archaeology sites present across the Swan zone.



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Figure A2: Protected Fauna shoreline cell protection priority ranking for dissolved hydrocarbons effects

Figure A3: Protection Areas shoreline cell protection priority ranking for floating hydrocarbons effects

Figure A4: Protection Areas shoreline cell protection priority ranking for dissolved hydrocarbons effects

Figure A5: Cultural Heritage shoreline cell protection priority ranking for floating hydrocarbons effects

Figure A6: Cultural Heritage shoreline cell protection priority ranking for dissolved hydrocarbons effects

Figure A7: Economic shoreline cell protection priority ranking for floating hydrocarbons effects

Figure A8: Economic shoreline cell protection priority ranking for dissolved hydrocarbons effects

Figure A9: Social, Amenity and Recreation shoreline cell protection priority ranking for floating hydrocarbons effects

Figure A10: Social, Amenity and Recreation shoreline cell protection priority ranking for dissolved hydrocarbons effects

## Acronyms and Abbreviations

AFMA	Australian Fishing Management Authority
AMSA	Australian Maritime Safety Authority
BIA	Biologically Important Area
CALM Act	WA State <i>Conservation And Land Management Act 1984</i>
CAMBA	China and Australia Migratory Bird Bilateral Agreement 1986
CAMRIS	Coastal and Marine Resources Information System
CAPAD	Collaborative Australian Protected Areas Database
CD	Conservation Dependent
CR	Critically Endangered
CSMC	Cockburn Sound Management Council
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAA	WA State Department of Aboriginal Affairs
DEC	WA State Department of Environment and Conservation (now called DPaW)
DER	WA State Department of Environment Regulation
DMP	WA State Department of Mines and Petroleum
DoF	WA State Department of Fisheries
DoT	WA State Department of Transport
DotE	Commonwealth Department of the Environment
DPaW	WA State Department of Parks and Wildlife
ELG	Environment Liaison Group
EN	Endangered
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
ESC	Environmental Scientific Coordinator
ESI	Environmental Sensitivity Index
FHPA	Fish Habitat Protection Area
GDP	Gross Domestic Product
GIS	Geospatial Information System
GSP	Gross State Product
HMA	Hazard Management Agency
IMO	International Maritime Organisation
IPIECA	Global oil and gas industry association for environmental and social issues
IUCN	International Union for Conservation of Nature
JAMBA	Japan and Australia Migratory Bird Bilateral Agreement 1974





KEF	Key Ecological Feature
MCA	Multi-Criteria Analysis
MFB	Marine Futures Biodiversity
NOAA	National Oceanic and Atmospheric Administration
OGP	International Association of Oil and Gas Producers
OS	Other Specially Protected Fauna (under the WC Act)
OSRA	Oil Spill Response Atlas
PMST	Protected Matters Search Tool
RIA	Rottneet Island Authority
RoKAMBA	Republic of Korea and Australia Migratory Bird Bilateral Agreement 2004
SNES	Species of National Environmental Significance
TBC	To Be Confirmed
TSA	Tourism Satellite Account
UNESCO	United Nations Educational, Scientific and Cultural Organization
VU	Vulnerable
WA	Western Australia
WAM	Western Australian Museum
WAMSI	West Australian Marine Sciences Institution
WC Act	WA State <i>Wildlife Conservation Act 1950</i>

## Key Terminology

Attribute table	An attribute table has been produced for each shoreline cell summarising the protection priority for each category, for both floating and dissolved hydrocarbons (as the consequence may be different for different forms of a hydrocarbon), and an overall ranking, along with a brief description of the priority. This is the deliverable to the Risk Consultant.
Categories	There are five categories for assessment of protection priority: Protected Fauna; Protection Areas; Cultural Heritage; Economic and Social; Amenity and Recreation.  Each cell has been assessed for its protection priority for each of these five categories from Very Low, Low, Medium, High to Very High. These are provided in the form of an attribute table to the Risk Consultant who will integrate these into their model, along with oil spill likelihood and other hydrocarbon spill characteristics, to develop an overall risk ranking for each shoreline cell.
Coastal compartments	Coastal compartments are a physical framework for marine and coastal planning. They are a hierarchy of planning units based on geological features which has been devised by the Departments of Environment and Conservation, Planning and Transport and have served as a basis for the shoreline cells (Eliot <i>et al.</i> , 2011). There are primary, secondary and tertiary compartments. The tertiary coastal compartments are what the shoreline cells have been based on. The distinction between coastal compartments and shoreline cells has been made to try to avoid confusion when the results of this project are used by the DoT in collaboration with other government agencies that have protocols based on the coastal compartments.
Components	Risk is comprised of two components: consequence and likelihood. Advisian's scope focusses on the first component, while Navigatus is providing the second component and will be combining both components to give an overall risk ranking.
Data	Data refers to geospatial data (shapefiles) that has been collected and processed using a Geospatial Information System (GIS) to rank and process the data based on its attributes as outlined in this report. These data layers have been overlain with the shoreline cells to provide an output of the overall ranking for each category for each shoreline cell. This system has been used to process extensive and complex sets of geographical data layers with a consistent ranking and geographical accuracy.
Risk Consultant	The Risk Consultant is Navigatus Consulting. Navigatus is assessing the likelihood, size, location and type of potential marine oil pollution for state waters. Navigatus is also incorporating the protection priority outputs from the Protection Priority ranking process with the spill characteristics to give an overall risk profile for the state.
Sensitive receptors	Sensitive receptors are those receptors that have been identified as sensitive to marine oil pollution and grouped into the five categories. For example, in Protected Fauna, sensitive receptors are birds, mammals, invertebrates, fish and reptiles.
Shoreline cells	Each zone has been divided into geographical units of approximately 10 km x 20 km that are each analysed for priority ranking based on the protection priorities identified in the cell. There are ten shoreline cells in Zone 4 <i>Swan</i> (Figure 1-3).
Zones	The WA state waters have been divided into seven (7) zones: Zone 1 <i>Kimberley</i> ; Zone 2 <i>Pilbara</i> ; Zone 3 <i>Midwest</i> ; Zone 4 <i>Swan</i> ; Zone 5 <i>South West</i> ; Zone 6 <i>South Coast</i> ; Zone 7 <i>Federal Offshore Features</i> (Figure 1-1).

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# 1 Introduction

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Oil spills in the marine environment can have wide spread impact and long-term consequences on wildlife, fisheries, coastal and marine habitats, human health and livelihood, as well as recreational resources of coastal communities (Gilbert, 1999). In Western Australia (WA), the WA Department of Transport (DoT) is responsible for ensuring the State has the capacity to respond to an oil spill in WA state waters. They are designated as the Hazard Management Agency (HMA) for marine oil pollution in Western Australia. As the HMA, the DoT also ensures the capacity of the State to respond to an oil spill is commensurate with the risk.

To better understand the state's spill risk profile, the DoT is conducting a state-wide marine oil pollution risk assessment. The risk assessment comprises two components. The first component evaluates protection priorities of the receiving environment in order to assess potential consequences of oil pollution. The second component assesses the likelihood, size, location and type of potential marine oil spill. Protection priority outputs from component one will be modelled with spill characteristics from component two to give an overall risk profile for the state.

The results of this project will be used to decide how to allocate resources on a regional, state and national level, and will be scrutinised by regional, state and national agencies. Data collected on protection priorities may assist in decision-making both when preparing and responding to marine oil pollution incidents.

For the purposes of this project, state waters have been divided into seven zones (see Figure 1-1). The project is being rolled out on a zone-by-zone basis over the next two to five years. The first protection priorities zone completed was the Pilbara (Zone 2), which extends south of Ningaloo to east of Dampier. This assessment was finalised in August 2016. The second and third protection priorities zones have been assessed in parallel. These are the Midwest (Zone 3) and the Swan (Zone 4). This report presents the findings of the Swan protection priorities assessment, continuing with the method developed for the initial and second zone. The Swan zone extends from Lancelin, 130 km north of Perth, Western Australia, to Preston Beach, 100 km south of Perth.

This report presents the scope, method and discussion of outputs for the protection priorities identified for environmental, social, cultural and economic areas of significance that may be impacted by a marine oil spill. It also presents the multi-criteria analysis (MCA) that has been done on the geospatial data collected for each category, in order to identify the key areas of protection priority. It also recommends areas for improvement.

Navigatus Consulting (Navigatus) is the Risk Consultant doing the second component of the assessment. They have been engaged to identify and assess the likelihood, size, location and type of potential marine oil pollution that could occur in WA state waters. Navigatus is also combining the protection priority component with the spill likelihood component to give an overall marine oil pollution risk profile for the state.



**Figure 1-1: Western Australian Marine Oil Pollution risk assessment zones**

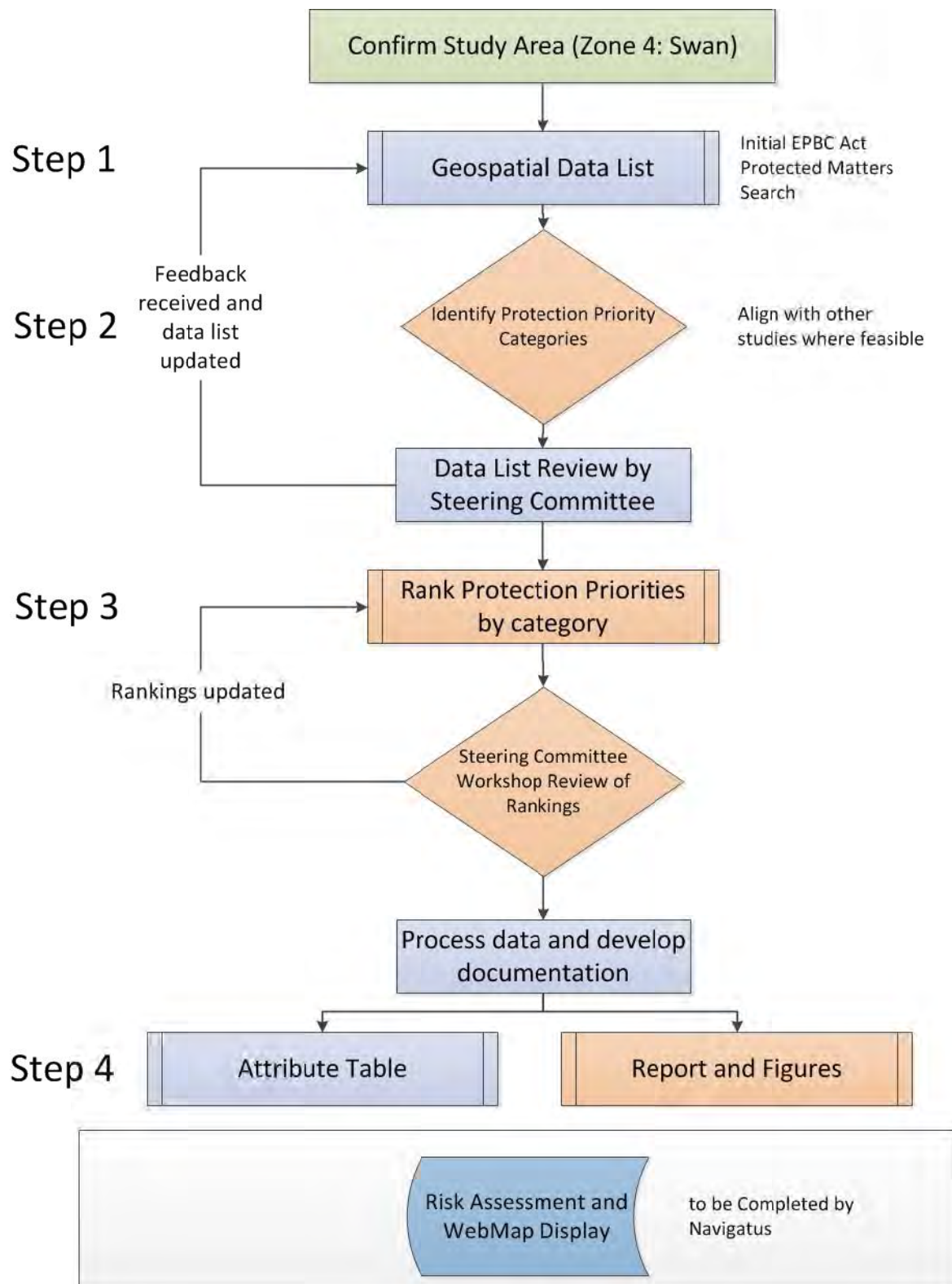
## 1.1 Scope

The scope was broken down into four steps:

1. **Acquire information:** Advisian was required to identify, acquire and collate environmental information to assess the ecological, cultural and economic value of spatial units encompassing state waters. Part of this process was to develop a set of categories that group the data in a simple and logical format for ease of use.
2. **Design a system for presenting information:** Information was required to be compiled as an attribute table and will be uploaded to a WebMap Application being developed by the Risk Consultant. The table summarises the outputs by category for a designated sector of state waters. The sectors are geospatial units that have been developed by the Risk Consultant and termed 'shoreline cells' for this project.
3. **Conduct assessment:** All available, relevant spatial data collected was required to be ranked in order of its protection priority in the occurrence of a marine oil pollution event, and processed using a weighting by area and importance for each shoreline cell.
4. **Provide outputs:** A report has been prepared outlining the method, and an attribute table summarising the outputs of the assessment by shoreline cell. The attribute table will be used by the Risk Consultant to upload protection priority information into a WebMap Application.

In addition to the above, a Steering Committee was introduced to facilitate identifying and collecting relevant data, and ensure appropriate rankings and processing.

The project scope is summarised in a flowchart in Figure 1-2.



**Figure 1-2: Protection priorities project component flowchart**





## 1.2 Protection Priority Categories

The main outcome from step 1 was to develop a set of categories that group protection priorities into categories, following a simple and logical format of similar aspects with respect to vulnerability to a marine oil spill. This approach is based on the Australian Maritime Safety Authority's (AMSA) National Plan for Maritime Environmental Emergencies (the National Plan), as well as similar oil spill risk assessments that have been undertaken.

A number of protection priorities are set out in the National Plan, which is managed by AMSA. The National Plan, along with identifying sensitive receptors, describes how governments and industry will co-operate to respond to shipping casualties and maritime spills. The National Plan has been developed with the Commonwealth and State/Northern Territory government agencies as well as shipping, ports, offshore petroleum production and exploration, oil, salvage and chemical industries. Protection priorities as set out in the National Plan include habitat and cultural resources, rare and/or endangered flora and fauna, commercial resources and amenity areas (AMSA, 2016).

A similar oil spill risk assessment undertaken in New Zealand categorised priorities into five value types (Navigatus, 2005; 2015). These are: species; habitats; social, amenity and recreation; cultural and heritage; and economic. Another similar assessment undertaken in Victoria used the same five categories (Navigatus, 2011).

For Western Australia, five categories were also selected based on the list above, with an amendment from 'habitats' to 'protection areas'. This was changed to allow areas designated for protection (for example a World Heritage Area, or a Key Ecological Feature) to be included. Protection areas identify an area of ecological function beyond the individual habitats that it may comprise, which may not otherwise be included in the assessment.

As an outcome of the above reviews, and taking into account the Western Australian environment, five categories of interest were defined for assessing the effects of a marine oil pollution event for this project. These are:

1. Protected Fauna;
2. Protection Areas;
3. Cultural Heritage;
4. Economic; and
5. Social, Amenity and Recreation.

## 1.3 Shoreline Cells

Step 2 required designing a system for presenting information. This involved dividing Western Australia's state waters into sectors to geospatially summarise the information in a WebMap Application. The sectors are geographical units that have been developed by the Risk Consultant. These units have been termed 'shoreline cells' for this project, and are loosely based on the tertiary planning units (coastal compartments) that have been devised by the Departments of Environment and Conservation, Planning, and Transport (Eliot *et al.*, 2011). These are approximately 10 km x 20 km and have been called 'shoreline cells' to distinguish them from the 'coastal compartments' developed by Eliot *et al.* (2011).



The primary, secondary and tertiary coastal compartments were devised as a physical framework for marine and coastal planning and are currently used by other State departments such as the Department of Parks and Wildlife (DPaW) for oiled wildlife response planning. The coastal compartments define the principal coastal regions and coastal compartments discernible around the Western Australian coast based on known geologic features, landforms, ocean processes and sediment distribution (Eliot *et al.*, 2011). The shoreline cells being assessed for the Swan zone are illustrated in Figure 1-3. There are ten shoreline cells in the Swan zone, making it the smallest of the seven protection priority zones.

The shoreline cells used in this assessment were initially provided to Advisian by Navigatus. The numbering system was subsequently modified by Navigatus, and sent through to Advisian on 23 May 2016.

Some processing errors defining the boundaries of the cells were discovered as part of the Swan zone assessment. These are shown in Figure 1-4, being:

- Cell 203:
  - Within the Swan River, a portion of the Canning River has been truncated; and
  - Around Garden Island, part of the island has been truncated.
- Cell 205:
  - Within the Peel-Harvey Estuary, part of the Peel Estuary and part of the Harvey Estuary have been truncated.

The cells assign an arbitrary boundary in which the protection priorities are assessed. The truncation of the above cells would exclude some protection priorities in each of the two shoreline cells. Therefore a buffer on the protection priorities data has been created to ensure the priorities in these excluded areas are included in this assessment. The cells can be considered a visual representation of the cell boundaries. All protection priorities in the marine and coastal environments have been assessed.

The shoreline cell boundary errors have been raised with Navigatus and the boundaries will be amended and reissued.



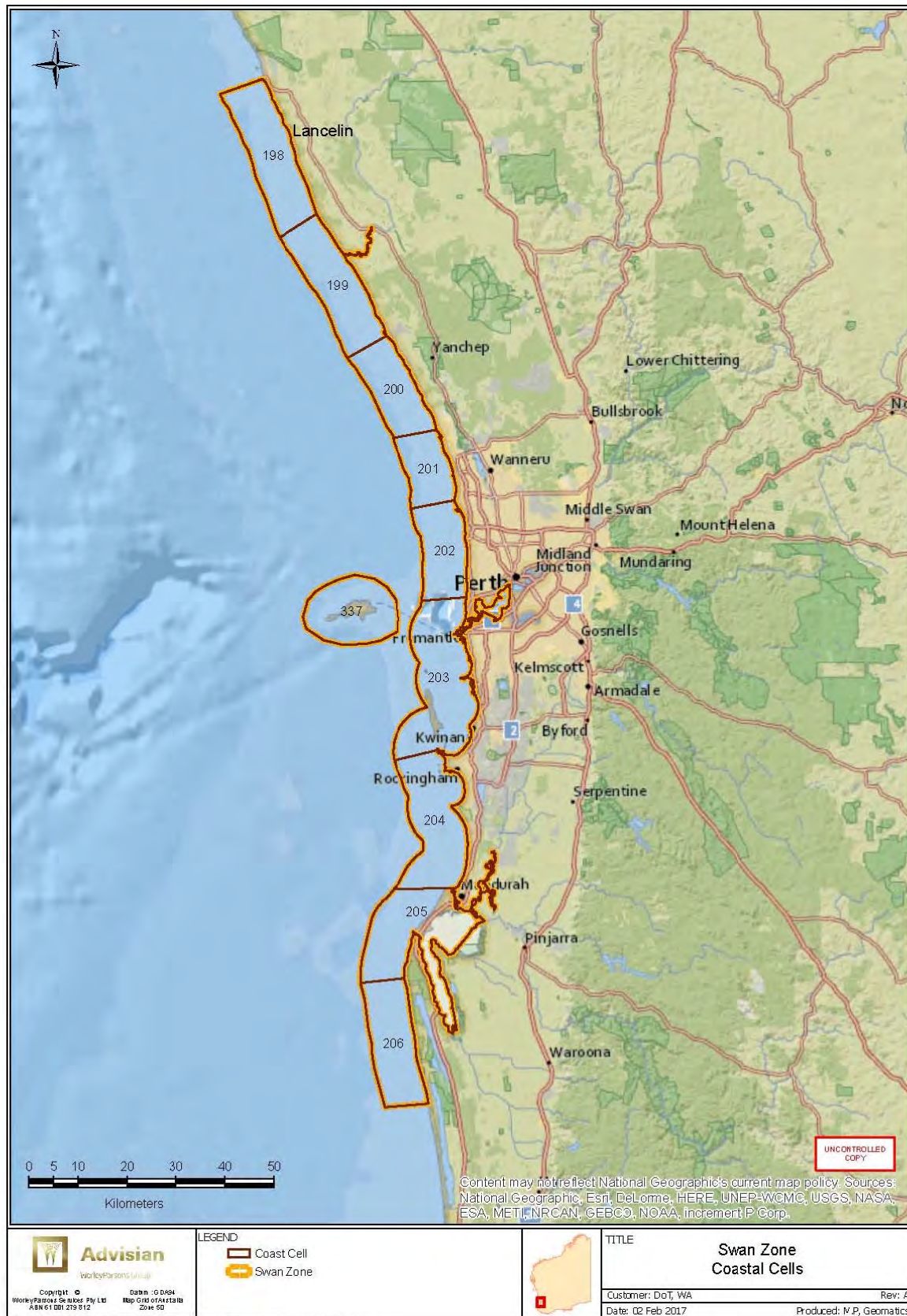
**Advisian**

WorleyParsons Group

**DOT307215 Provision of Western  
Australian Marine Oil Pollution Risk  
Assessment - Protection Priorities**  
Protection Priority Assessment for  
Zone 4: Swan - Final Report

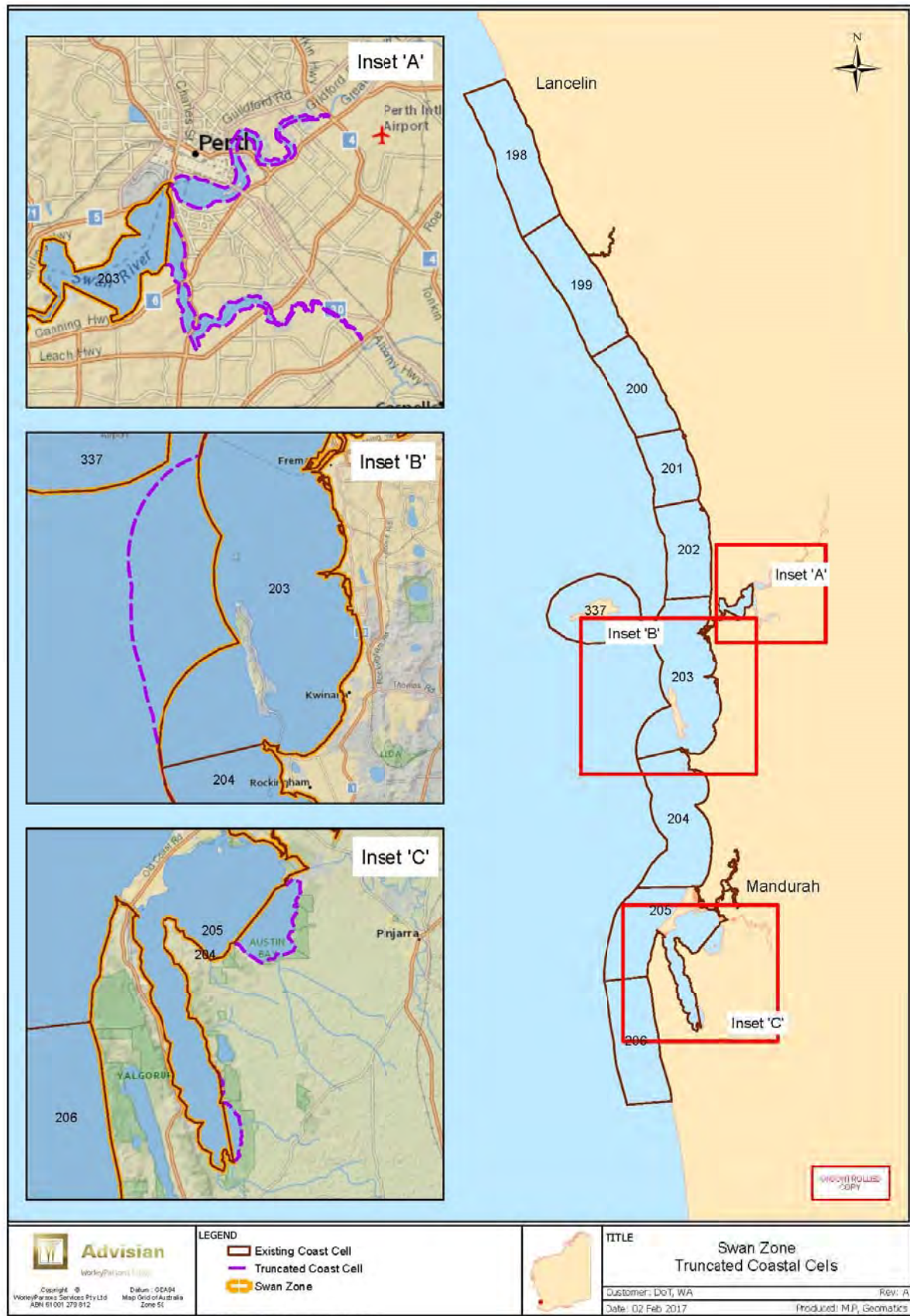


Department of **Transport**



**Figure 1-3: Swan (Zone 4) shoreline cells**





**Figure 1-4: Truncations in Shoreline Cells 203 and 205**

## 1.4 Marine Oil Pollution Effects

The assessment of ranking data (step 3) requires an understanding of vulnerability and susceptibility to marine oil pollution, by the different sensitive receptors identified, in order to give each a ranking of protection priority. This has been challenging because the impact will depend on the sensitivity of the receptor to marine oil, as well as the quantity of oil spilled and the characteristics and properties (type) of oil. The potential effects that have been considered are summarised below.

There are many different types of hydrocarbons that may cause marine pollution, and each has its own complex properties. Oil types range from heavy fuel oils from large shipping vessels to marine diesel from supply vessels, to light condensates and crude oils from offshore and nearshore pipeline or platform leaks, and well blowouts (e.g. Montara). Once released into the marine environment, hydrocarbons are subject to weathering and assimilation in the marine environment (Figure 1-5). The timing for this process depends on their complex properties (physical and chemical characteristics), as well as a number of other variables including the amount spilled, the prevailing climatic and sea conditions, and how long the hydrocarbons remain at sea or wash ashore. Weathering is the process of physically and chemically changing hydrocarbons through spreading, evaporating, dispersing, emulsifying, dissolving, oxidising and biodegrading (French-McCay & Payne, 2001). Oil spill responses can also influence these processes.

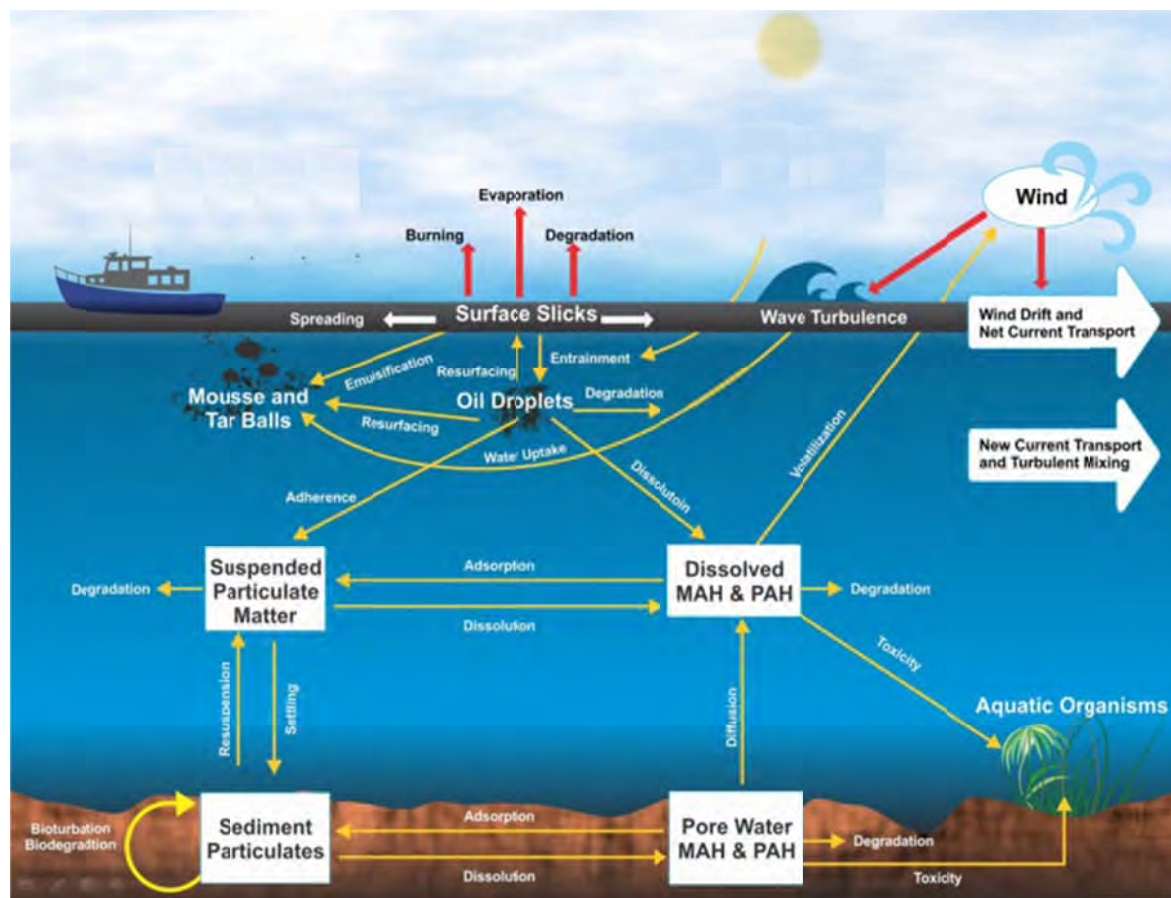


Figure 1-5: Hydrocarbon weathering and biodegradation processes



The effect of each type of hydrocarbon varies, depending on both its physical and chemical properties. In general, there are three different forms modelled and assessed for their effects: floating; entrained; and dissolved. Floating occurs because hydrocarbons are typically lighter than water so they float on the surface, often referred to as a 'slick'. Entrained hydrocarbons are small droplets of oil in the water column. These can be various sizes and occur when the hydrocarbons have been released sub-surface, or where floating oil has been mixed into the water column by waves. 'Dissolved' is the soluble component of a hydrocarbon that presents toxic effects depending on the concentration and duration of exposure. In general, these effects and impacts are summarised below for each of the five categories.

For this assessment, the physical effects of entrained oil are considered to have been captured in the floating component of this assessment. Therefore only two sets of rankings have been used: one for the effects of floating hydrocarbons; and one for the effects of dissolved hydrocarbons.

Hydrocarbons may impact the environment (fauna and flora) by one or more ways (ITOPF, 2011):

- Physical smothering, which impacts physiological functions;
- Chemical toxicity, which causes lethal or sub-lethal effects or impairs cellular functions;
- Ecological changes, primarily losing key organisms from a community and opportunistic species taking over habitats; and/or
- Indirect effects, such as the loss of habitat or shelter and the consequent elimination of ecologically important species.

The impacts of hydrocarbons on a cultural heritage site may include:

- Physically degrading a site; and
- Reducing the amenity and emotion of an environmental site that is protected for Indigenous and European heritage reasons.

From an economic perspective, hydrocarbons can:

- Temporarily disrupt operations, resulting in reduced income, for example a port or an oil & gas facility; and
- Cause long-term economic loss, such as the impact on a fish stock, both through indirect loss of stock and perceived tainting of stock by the oil.

Hydrocarbons may impact on social, amenity and recreational aspects by:

- Reducing the amenity of a site such as a beach or a coral reef;
- Restricting access to a site during clean-up and rehabilitation; and/or
- Giving a perceived loss of amenity due to negative perceptions associated with an 'oil spill'.

## **1.5 Steering Committee**

A Steering Committee was established to facilitate identifying and collecting relevant data, and to ensure appropriate rankings and processing. This developed through DoT's presentation of the project to the Environment Liaison Group (ELG) of which DoT is a member. Feedback from the ELG



on the concept of the project emphasised the importance of the data collection phase. A Steering Committee was therefore established to facilitate liaison with multiple agencies throughout the project. The Steering Committee was comprised of:

- A DoT representative;
- A project team representative(s);
- Multi government agency representatives; and
- Industry representatives (as required).

For the Swan zone, the Steering Committee members comprised largely of the same committee engaged for the initial zone (Pilbara) and the subsequent zone (Midwest). This ensured a consistent approach, with some new members engaged for additional sensitivities found in the Swan. The Steering Committee members for the Swan zone are presented in Table 1-1.

**Table 1-1: Steering Committee members for the Swan zone**

Department	Name	Title
Department of Transport	Emily Gifford	Team Leader Planning and Public Information   Marine Safety
	Ralph Talbot-Smith	Manager Cartographic Services   Coastal Infrastructure
Department of Parks and Wildlife	Stuart Field	Principal Policy Officer in the Office of the Director General
	Steve Rowlands	Parks and Wildlife Data Manager
AMSA	Paul Irving	Senior Scientific Coordinator   Marine Environment Pollution Response
Kwinana Industries Council	Chris Oughton*	Director of the Kwinana Industries Council
DER and Cockburn Sound Management Council	Stephanie Turner*	Cockburn Sound Management Council Coordinator
Department of Fisheries	Carli Telfer	Senior Management Officer   Aquatic Environment Branch
EPA	Gordon Motherwell	Senior Environmental Officer   Infrastructure Assessments Branch

\* Unable to attend the workshop.

Emily Gifford, Ralph Talbot-Smith, Stuart Field, Paul Irving, Carli Telfer and Gordon Motherwell were engaged for the previous Pilbara and Midwest zones assessment.

The Steering Committee was asked to:

- Review the list of collected data to ensure it is the best available and, if gaps were identified or datasets missing completely, advise on possible alternate sources of information;
- Direct Advisian to relevant points of contact for additional data, streamlining the process where possible; and





- Provide advice at a workshop to review the selection and weightings of criterion for multi-criteria analysis.

The Steering Committee was provided with the following documentation:

- Terms of Reference that outlined the engagement and commitments to the project (sent 31 September 2016);
- Interim Discussion Paper – Data Collection for Zone 4: Swan (301012-09591-EN-REP-0005) (sent 14 October 2016) for review and identification of additional data; and
- Workshop Discussion Paper (301012-09591-EN-REP-0007) (sent 11 November 2016).

A workshop was held with the Steering Committee on 17 November 2016 to review the priority ranking process. The priority rankings were further developed, drawing on the rankings assigned for priorities in the Midwest zone and the initial Pilbara zone, and introducing rankings for new sensitivities found in the Swan. The Midwest zone workshop had been held the previous day, and this facilitated the discussions and decisions and continuity of the project process. It was discussed that while one of the project's primary objectives is to be consistent between zones, this was not a hard and fast rule. It was agreed that where appropriate, rankings could differ from those previously agreed, as long as the criteria for the ranking was clearly articulated.

The agreed rankings that have been used for the Swan zone and considered for future zones are provided in Section 3. In the Steering Committee Workshop, some additional data was also identified. This is discussed in Section 2.

The Steering Committee has again provided valuable input, data identification, clarification and experience to the project, and their comments have been incorporated into this project where applicable. As previously anticipated, the composition of the Steering Committee has remained largely consistent with the Pilbara and Midwest zones, and now the Swan zone. This has been hugely beneficial. It has been agreed that as the project moves across the remaining zones, the committee composition will remain largely constant, with local subject matter experts added as appropriate.

In the Workshop on 17 November 2016, the following issues were also discussed:

- Protected fish species – Both Totally Protected and Seasonally Protected fish species were discussed, as these are protected under the *Fish Resources Management Act 1994*. Totally Protected fish species were added as a sensitivity to the Protected Fauna category;
- Furry marine mammals – These mammals are more vulnerable to marine oil than their non-furry counterparts because their fur aggregates and collects the oil. Sea lions are known to visit the Swan coastline, and because they naturally haul themselves onto beaches, they are also more prone to be affected by an oil spill. The fur also means they have significant oiled wildlife response clean up requirements, so it was agreed to adopt a higher ranking for furry marine mammals;
- Ranking of state waters – Discussion was had around whether state waters adjacent to a designated Commonwealth marine park should be given a ranking equivalent to a State marine park, if there was no State marine park designated over the area. The decision was made not to adopt this idea, as the Commonwealth marine park process is still ongoing and is different to the State marine parks criteria. In addition, some Commonwealth marine parks are designed to protect offshore water sensitivities that are not found in state waters.



Therefore, if a State marine park is not proposed for the area, we are not 'creating' a proposed area in state waters. It was also considered whether State parks should be ranked higher if they are next to Commonwealth marine parks. This was also decided against, based on the above discussion that State and Commonwealth marine parks can be created to protect different sensitivities;

- Comparing different forms of data at different resolutions – It was agreed that high resolution data did not necessarily benefit the project, and a more general identification of sensitivities that can be compared across zones is probably more appropriate, particularly in light of the coastal cell compartments being 10 km x 20 km;
- Surrogates for certain value measures across zones – This has not been an issue in the Midwest or Swan zones. Only one surrogate was identified, and that was for specimen shells, which are totally protected under the *Fish Resources Management Act 1994*. Their distribution is not well mapped, however they are synonymous with protected areas that are well known and mapped. Therefore where these areas are protected, these are taken as a proxy for specimen shells, e.g. seagrass. Further surrogates may become a requirement in other zones where the equivalent amount of data does not yet exist, as is anticipated for the Kimberley zone;
- Incorporation of seasonality – Discussion was had on whether to incorporate periods of higher vulnerability for some sensitivities, e.g. fauna nesting periods, migration seasons, temporally protected fishing areas, and other environmental sensitivities that have seasonally higher periods of greater vulnerability. It was agreed that, because an oil spill could occur at any time, the worst consequence would be adopted. As this assessment will feed into the current oil spill response process, the data collected could be used in the initial screening phase to identify any sensitive receptors in the projected oil spill path, and the information used to then call on the local experts to provide the relevant response information. This is particularly relevant where there may also be considerable inter-annual seasonal variability;
- Display of reliability of data – This was previously raised for the Pilbara zone and again in the Midwest zone. This is not seen as a major issue for the Swan zone as the data is all considered quite reliable, but has been included for consistency as it was raised in the workshop. Chris Surman from Halfmoon Biosciences, a well-regarded seabird expert in WA, raised the concern that some of the DPaW dataset consists of sightings of wildlife protected under the *State Wildlife Conservation Act 1950* recorded from as far back as the 1890s. Some of these sightings are not verified, and do put some species well outside their now better understood locations. For the past 26 years, Chris has been monitoring seabird distribution along the WA coast, particularly between the Montebello Islands and Cape Leeuwin through at-sea observations and island visits. More recently he has been tracking seabird migratory patterns and breeding/foraging distributions using tracking devices. Unfortunately, as most of this research is self-funded and unpublished, this data was not available for this project. There are some recommendations regarding this finding in Section 0; and
- How much data is too much – It was recognised that there would be a limit reached where the effort to collect and incorporate more data would add little value or change the outcome of the process. It was agreed that, while some datasets were difficult to obtain, particularly from University institutions that have been involved in government funded programs and therefore held data that would become publically available, these datasets would not necessarily be obtained by extending the data collection period. Nor was there any value added by chasing small and highly detailed studies from multiple organisations.

It was agreed that effort should be concentrated into obtaining engagement early, and adhering to the data cut-off date.

During the initial Pilbara zone assessment, it was noted that there are some more location-specific considerations when preparing to respond to a marine oil pollution incident, including:

- Access and logistics (e.g. boat ramps, roads, mobile phone coverage); and
- Potential dangers to personnel during a response (e.g. crocodile locations, high radiation exposure on the Montebello Islands).

In the Swan zone, the following location-specific considerations were raised:

- Oil spill response for other jurisdictions, e.g. Department of Defence lands (Garden Island).

These are recognised as being outside the scope of this assessment, but have been noted here for completeness.



## 2 Geospatial Data

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To create a system that was both repeatable and would cover a large area, a process to store, manage and manipulate available geospatial data was created in an ArcGIS framework. Initially a list of data sources was identified that could be used for each protection priority category. These datasets are mostly publically available through the Commonwealth Department of the Environment (DotE), or accessible for this project through inter-governmental data share agreements. The Swan zone built on the datasets that were identified and collected during the initial Pilbara zone assessment (see Advisian, 2016a).

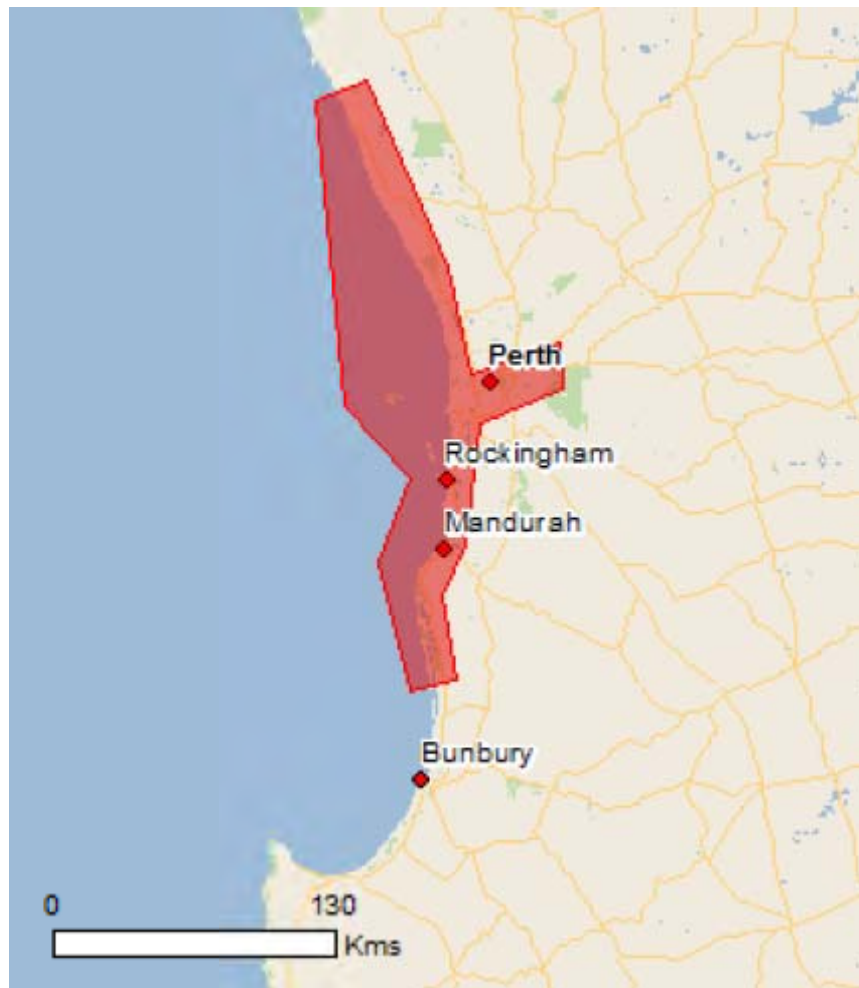
The datasets identified and collected during the initial zone assessment have been updated where applicable to the Swan zone, as they often span the whole of Western Australia and, in the case of Commonwealth datasets, the whole of Australia. As such, these datasets have been clipped to the Swan zone for use. However, if the datasets are updated in the future, the updated datasets will be collected and used for the new zones. Consistency has therefore been readily achievable with these datasets across the zones.

It has also been recognised that this process results in a static assessment using the data available at the time. This is discussed further in the following sections.

### 2.1 EPBC Act Protected Matters Search Tool

An assessment to identify and gather environmentally and culturally important areas was initially done using the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool (PMST). This is an online interactive map maintained by the Commonwealth Department of the Environment (DotE). The search tool was used to generate a report that helped determine whether matters of national environmental significance or other matters protected by the EPBC Act are likely to occur in the area.

The area searched included the Swan zone, from up to 5 km inland to the approximate state waters boundary (Figure 2-1).



**Figure 2-1: EPBC Act Protected Matters Search Tool area of search**

The report provided the following information on the identified matters of national environmental significance:

- World Heritage Properties;
- National Heritage Places;
- Wetlands of International Importance;
- Commonwealth Marine Areas;
- Listed Threatened Ecological Communities;
- Listed Threatened Species; and
- Listed Migratory Species.

Other matters protected by the EPBC Act:

- Commonwealth Land;
- Commonwealth Heritage Places;
- Listed Marine Species;
- Whales and Other Cetaceans;



- Critical Habitats;
- Commonwealth Reserves Terrestrial; and
- Commonwealth Reserves Marine.

Extra information:

- State and Territory Reserves;
- Regional Forest Agreements;
- Invasive Species;
- Nationally Important Wetlands; and
- Key Ecological Features (Marine).

The generated PDF report gives a link to the Resource Data, which was the publically available geospatial data (shapefiles) for each key area identified above. The Resource Data webpage for each dataset also provided metadata, such as an abstract on the data, acronyms and data structure, the creation and revision date, history and access constraints. These datasets were downloaded and incorporated into this assessment.

The EPBC Act PMST Report varies in some instances from the data incorporated in the report. This is likely due to the dataset being constantly updated and refined through fauna distribution and habitat surveys. The raw geospatial data was taken as the most up-to-date information, and used in this report.

## **2.2 Other Data Sources**

Some data sources are not publically available. For example, land tenure for Department of Defence lands is managed separately to other Government Agencies. In the Swan zone, the protection priority data for Garden Island could not be obtained as there is no data share agreement in place for security reasons. In an oil spill, the Department of Defence has developed its own oil spill response plan for its jurisdictional areas, complete with protection priorities and management plans.

Other data sources are not in geospatial format. One example of this was information and ratings of beaches from Surf Life Saving WA. In this instance, beach popularity information was identified and a geospatial shapefile created for the beaches from a google maps location file.

For the Swan zone, the Rottnest Island Authority (RIA) was also approached to share its environmental data collected for Rottnest Island.



## 2.3 Steering Committee Review of Data List

The geospatial layers outlined in Table 2-1 have been included in the assessment for Zone 4 Swan. These data layers were provided to the Steering Committee for review on 14 November 2016, along with the geospatial attributes they represented (e.g. a list of all the protected species that were shown to fall in the Swan zone). Table 2-1 summarises the layers, their high level attributes, and when the data was last updated. The Steering Committee was asked to review the data collected to date and indicate whether:

1. A more up-to-date data layer existed and where it could be sourced from;
2. There was considered to be a data gap and if an alternate source of information for this data existed; and
3. Any data was missing and possible sources for this data.

The data in Table 2-1 has been grouped into the five categories: protected fauna; protection areas; cultural heritage; economic; and social, amenity and recreation. This is to facilitate identifying the type of area use that is being assessed.

Some datasets listed in Table 2-1 appear 'old' with a date more than a decade prior to this assessment. For example, the Fish Habitat Protection Area (2001), the DotE Directory of Important Wetlands in Australia (2008), and the DoT Shipping and Pilotage Ports (2010). These datasets are not out of date; they reflect that the purpose and geospatial extents defined in the dataset have not changed.



**Table 2-1: Data included in this assessment, custodians and data update information**

Layer	Section	Data Source	Last Updated
Protected Fauna			
Birds	3.1.1	<ul style="list-style-type: none"><li>Commonwealth Dept. of the Environment (DotE) Biologically Important Areas (BIA) for marine species</li></ul>	<ul style="list-style-type: none"><li>4 Jan 2016</li></ul>
Mammals	3.1.2		
Invertebrates	3.1.3	<ul style="list-style-type: none"><li>DotE Species of National Environmental Significance (SNES)</li><li>WA’s Department of Parks and Wildlife (DPaW) for fauna</li><li>Rottneet Island Authority (RIA) fauna use area</li><li>WA’s Department of Fisheries (DoF) Seasonally Protected and Totally Protected Fish</li></ul>	<ul style="list-style-type: none"><li>5 Oct 2016</li><li>14 Oct 2016</li><li>8 Nov 2016</li><li>Nov 2016</li></ul>
Fish	3.1.4		
Reptiles	3.1.5		
Protection Areas			
World Heritage Areas	3.2.1	<ul style="list-style-type: none"><li>DotE World Heritage Areas</li></ul>	<ul style="list-style-type: none"><li>14 Oct 2015</li></ul>
Terrestrial Protection Areas	3.2.2	<ul style="list-style-type: none"><li>DotE Collaborative Australian Protected Areas Database (CAPAD) – terrestrial</li><li>DPaW CAPAD terrestrial dataset update</li><li>DPaW Regional Parks</li><li>Department of Defence lands</li></ul>	<ul style="list-style-type: none"><li>30 Jun 2014</li><li>Jun 2016</li><li>15 Nov 2016</li><li>15 Dec 2016</li></ul>
Marine Protection Areas	3.2.3	<ul style="list-style-type: none"><li>DotE CAPAD – marine</li><li>DPaW CAPAD marine dataset update</li></ul>	<ul style="list-style-type: none"><li>30 Jun 2014</li><li>Jun 2016</li></ul>
Ramsar and Nationally Important Wetlands	3.2.4	<ul style="list-style-type: none"><li>DotE Ramsar Wetlands of Australia</li><li>DotE Directory of Important Wetlands in Australia</li></ul>	<ul style="list-style-type: none"><li>16 Feb 2015</li><li>15 Oct 2008</li></ul>
Key Ecological Features	3.2.5	<ul style="list-style-type: none"><li>DotE Marine Key Ecological Features</li></ul>	<ul style="list-style-type: none"><li>16 Sep 2015</li></ul>
Coastal and Intertidal Habitats	3.2.6	<ul style="list-style-type: none"><li>DoT Oil Spill Response Atlas (OSRA) WA shorelines Environmental Sensitivities Index (ESI)</li><li>DPaW Habitats</li><li>Coastal and Marine Resources Information System (CAMRIS) Benthic Substrate dataset</li><li>Cockburn Sound Benthic Habitats</li></ul>	<ul style="list-style-type: none"><li>Apr 2011</li><li>May 2015</li><li>23 Jan 2008</li><li>30 Sep 2014</li></ul>

Layer	Section	Data Source	Last Updated
Coral, Seagrass, Algae and Filter Feeding Communities	3.2.7	<ul style="list-style-type: none"> <li>OSRA ESI (coral, algae)</li> <li>CAMRIS Seagrass</li> <li>Marine Futures Benthic Habitat Mapping</li> <li>RIA Marine Habitats</li> <li>Cockburn Sound Benthic Habitats</li> </ul>	<ul style="list-style-type: none"> <li>Apr 2011</li> <li>10 Mar 2015</li> <li>Aug 2008</li> <li>8 Nov 2016</li> <li>30 Sep 2014</li> </ul>
Fish Habitat Protection Areas (FHPAs) and Fisheries Prohibited Areas	3.2.8	DoF Fish Habitat Protection Areas: <ul style="list-style-type: none"> <li>Cottesloe Reef FHPA</li> </ul> DoF Areas closed to fishing under S43 of <i>Fish Resources Management Act 1994</i> : <ul style="list-style-type: none"> <li>Marmion Marine Park</li> <li>Shoalwater Islands Marine Park</li> <li>Burswood Lake</li> <li>Cockburn Sound and Warnbro Sound</li> <li>Heirisson Island</li> <li>Lake Clifton</li> <li>Rottne Island</li> <li>Saxon Ranger Wreck Site</li> <li>West Coast Bioregion – Demersal Finfish closure 15 Oct to 15 Dec each year</li> <li>Peel-Harvey Estuary: Blue Swimmer Crab closure 1 Sep to 31 Oct each year</li> </ul>	<ul style="list-style-type: none"> <li>Aug 2001<sup>^</sup></li> <li>25 Sep 2015<sup>^</sup></li> <li>9 Oct 2012<sup>^</sup></li> <li>20 Jan 2015<sup>^</sup></li> <li>17 Dec 2007<sup>^</sup></li> <li>6 Jul 2007<sup>^</sup></li> <li>8 Oct 1996<sup>^</sup></li> <li>26 Jun 2007<sup>^</sup></li> <li>6 Sep 2005<sup>^</sup></li> <li>**</li> <li>**</li> </ul>
Protected Areas for Aquaculture and Pearling	3.2.9	<ul style="list-style-type: none"> <li>No protection areas identified</li> </ul>	
Cultural Heritage			
World Heritage Properties	3.3.1	<ul style="list-style-type: none"> <li>DotE World Heritage Areas</li> </ul>	<ul style="list-style-type: none"> <li>15 Oct 2015</li> </ul>
National Heritage	3.3.1	<ul style="list-style-type: none"> <li>DotE National Heritage List</li> </ul>	<ul style="list-style-type: none"> <li>11 Feb 2016</li> </ul>
Commonwealth Heritage Places	3.3.1	<ul style="list-style-type: none"> <li>DotE Commonwealth Heritage – public</li> </ul>	<ul style="list-style-type: none"> <li>23 Feb 2016</li> </ul>
State Protected Heritage	3.3.2	<ul style="list-style-type: none"> <li>State Register</li> <li>Conservation Orders</li> <li>Heritage Agreements</li> <li>Town Planning Scheme ('Heritage List')</li> <li>Municipal Inventory</li> </ul>	<ul style="list-style-type: none"> <li>10 Oct 2016</li> <li>10 Oct 2016</li> <li>10 Oct 2016</li> <li>10 Oct 2016</li> <li>10 Oct 2016</li> </ul>
Shipwrecks and Maritime Archaeology	3.3.3	<ul style="list-style-type: none"> <li>DotE Australian National Shipwrecks</li> <li>WA Museum Recorded Shipwrecks</li> </ul>	<ul style="list-style-type: none"> <li>3 Feb 2016</li> <li>28 Jan 2016</li> </ul>



Layer	Section	Data Source	Last Updated
<b>Economic</b>			
Aquaculture	3.4.1	<ul style="list-style-type: none"> <li>DoF Aquaculture Licences</li> </ul>	<ul style="list-style-type: none"> <li>9 Mar 2016</li> </ul>
State Managed Commercial Fisheries	3.4.2	DoF individual shapefiles for each fishery: <ul style="list-style-type: none"> <li>Abalone Managed Fishery</li> <li>Cockburn Sound Crab Managed Fishery</li> <li>Cockburn Sound (Fish Net) Limited Entry Fishery</li> <li>Cockburn Sound (Line and Pot) Limited Entry Fishery</li> <li>South West Coast Salmon Fishery</li> <li>Mackerel Managed Fishery</li> <li>Marine Aquarium Fish Fishery</li> <li>Octopus Interim Managed Fishery</li> <li>Specimen Shell Managed Fishery</li> <li>Warnbro Sound (Crab) Limited Entry Fishery</li> <li>West Coast (Beach Bait Fish Net) Limited Entry Fishery</li> <li>West Coast Deep Sea Crustacean Managed Fishery</li> <li>West Coast Demersal Gillnet and Demersal Longline Interim Fishery</li> <li>West Coast Demersal Scalefish Fishery</li> <li>West Coast Rock Lobster Fishery</li> <li>West Coast Estuarine Fishery</li> <li>South-West Coast Salmon Fishery</li> <li>West Coast Nearshore Net Fishery</li> <li>Purse Seine Net Development Zone</li> <li>West Coast Purse Seine Limited Entry Fishery</li> </ul>	<ul style="list-style-type: none"> <li>8 Mar 2016</li> <li>4 Feb 2016</li> <li>4 Feb 2016</li> <li>4 Feb 2016</li> <li>3 Nov 2015</li> <li>20 Apr 2015</li> <li>30 Jun 2016</li> <li>6 Oct 2016</li> <li>11 Sep 2015</li> <li>3 Jan 2013</li> <li>9 Sep 2015</li> <li>3 Jan 2013</li> <li>8 Nov 2012</li> <li>24 Mar 2015</li> <li>2 Jun 2015</li> <li>7 Nov 2016</li> <li>25 Oct 2015</li> <li>7 Mar 2013</li> <li>4 Sep 2012</li> <li>1 Jul 2015</li> </ul>
Commonwealth Managed Fisheries	3.4.3	Australian Fishing Management Authority (AFMA): <ul style="list-style-type: none"> <li>Western Tuna and Billfish</li> <li>Western Skipjack</li> <li>Southern Bluefin Tuna</li> </ul>	<ul style="list-style-type: none"> <li>Mar 2016</li> <li>Mar 2016</li> <li>Mar 2016</li> </ul>
Other Commercial Operations	3.4.4	<ul style="list-style-type: none"> <li>None identified</li> </ul>	<ul style="list-style-type: none"> <li>N/A</li> </ul>
Tourism	3.4.7	<ul style="list-style-type: none"> <li>Tourism WA</li> </ul>	<ul style="list-style-type: none"> <li>Aug 2016</li> </ul>
Ports and Shipping	3.4.6	<ul style="list-style-type: none"> <li>DoT Shipping and Pilotage Ports</li> <li>Landgate Port Authorities</li> </ul>	<ul style="list-style-type: none"> <li>25 Oct 2010</li> <li>23 Nov 2016</li> </ul>
Water Intake Locations	3.4.7	<ul style="list-style-type: none"> <li>DoT Water Intake Location</li> </ul>	<ul style="list-style-type: none"> <li>17 Dec 2012</li> </ul>

Layer	Section	Data Source	Last Updated
		<ul style="list-style-type: none"> <li>DoF Water Intake Locations</li> </ul>	<ul style="list-style-type: none"> <li>12 Dec 2016</li> </ul>
Social, Amenity and Recreation			
Beaches	3.5.2	<ul style="list-style-type: none"> <li>Surf Life Saving WA beach popularity information</li> <li>Department of Planning – Town location and population size</li> <li>Beaches listed on Tourism’s ‘Australia’s Best Beaches’ list</li> <li>DPaW yacht clubs, jetties, marinas</li> </ul>	<ul style="list-style-type: none"> <li>May 2016</li> <li>Nov 2016</li> <li>Feb 2016</li> <li>2 Nov 2016</li> </ul>
Recreational Fishing/ Boating Zones	3.5.1	<ul style="list-style-type: none"> <li>DotE CAPAD – marine</li> </ul>	<ul style="list-style-type: none"> <li>30 Jun 2016</li> </ul>

<sup>^</sup> These are the dates of the last amendment to the order for the prohibition under the Act.

<sup>\*\*</sup> Date of commencement of Closure unknown

## 2.4 Data Cut-Off and Summary of Inclusion

The Steering Committee’s initial review of the data list for the Swan zone was intended to identify key additional data and allow time for collection. A data cut-off date of 4 November 2016 was applied in order to consolidate the data collection period. A lesson learned from the initial zone was incorporated into this zone, which was to wait until after the Steering Committee workshop before proceeding with the GIS processing and analysis for the draft report. A number of additional datasets were again identified in the Steering Committee workshop on 17 November 2016, and a final data cut-off date of 12 December 2016 was applied to produce this report. No additional key datasets have been excluded from the Swan zone.

In the future, it is anticipated that when the other zones are assessed over the next two to five years, additional datasets may become available for the Swan zone as well as other zones. When the final zone has been completed, it may be advisable to review the early zones to assess the need to include additional datasets.

To build on the previous zone, Advisian collected the outstanding data identified for the Pilbara zone [identified in Table 2-3 of the previous zone report (Advisian, 2016a)]. This has allowed the datasets to be incorporated into the Swan zone. If the Pilbara zone is revisited once the project is completed, this will allow the assessment to be revised efficiently.

## 2.5 Data Excluded From Swan Zone

During assessment of the first zone, the following datasets were excluded, This precedent will be carried into the remaining zones.

### 1. State Protected Indigenous Cultural Heritage

The WA Department of Aboriginal Affairs (DAA) holds a list of Aboriginal Heritage places protected or assessed under the *WA Aboriginal Heritage Act 1972*. The Aboriginal Heritage Inquiry System details the location and extent of each place protected under the Act. To preserve confidentiality, the exact location and extent of some places are not displayed on the map; however a shaded region (usually with an area of at least 4 km<sup>2</sup>) indicates where the place is generally located.



During the Steering Committee Workshop for the first zone assessed (Pilbara zone), on 16 May 2016, it was raised that the DAA list is largely incomplete, as it only identifies areas that have been registered through Native Title Determinations. The dataset was agreed to be removed to avoid the false impression that this sensitivity is covered.

In the absence of state-specific protection priority data for each shoreline cell, DoT would need to consult with the DAA independently in the event of an oil spill. This precedent is being carried through to the remainder of the zones being assessed.

## **2. Coastal Landforms**

To supplement the OSRA ESI dataset, the WA State Department of Mines and Petroleum (DMP) Coastal Landforms dataset was identified for incorporation into this assessment. On review of the Coastal Landforms dataset, it was determined that it didn't add any value in identifying coastline portions needing protection, so it was omitted. This was because it was difficult to assign a protection priority, as the dataset is not consistent in its interpretation of sandy/rocky and inundated shoreline areas.

## **3. Oil and Gas Operators**

A number of oil and gas operations occur in WA state waters and near the coast, including subsea pipelines. Subsea pipelines were not evaluated as a protection priority as their operation is not expected to be affected in an oil spill. Facilities that operate in state waters may experience economic loss through a safety requirement to shut facilities if an unrelated oil spill enters their operational zone.

Offshore oil and gas facilities have not been included as they do not fall in the shoreline cells. However associated infrastructure aspects are included, namely port facilities and seawater intakes. Refer to Section 3.4.4 and Section 3.4.5.



**Advisian**

WorleyParsons Group

**DOT307215 Provision of Western  
Australian Marine Oil Pollution Risk  
Assessment - Protection Priorities**  
Protection Priority Assessment for  
Zone 4: Swan - Final Report



Department of **Transport**

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## 3 Ranking of Protection Priorities

Each of the sensitive receptors has been given a classification from Very Low to Very High in order to rank their protection priority in the event of an oil spill, for comparison between the sensitivities (Table 3-1). The rankings have a numerical value as well as a classification. The gradation in this ranking has been selected to balance the relative importance of aspects being ranked. Five levels have been deemed appropriate for relative ease of ranking each of the sensitivities.

When assigning a ranking, a key consideration was whether the sensitivity was *vulnerable* and/or *sensitive* to a marine oil spill. These considerations of how vulnerable the receptor may be to floating or dissolved oil, as well as how sensitive it is, have been included below for each receptor. This was critical to assigning correct rankings for the purposes of the project. For example, coral is highly *sensitive* to marine oil, however if the oil is floating on the surface of the sea and it is a calm day, then the coral is not as *vulnerable* to the oil, as the oil will pass above the coral and not affect it. If the oil was dissolved in the water column, then the coral would be *vulnerable* to it. These considerations of different states of vulnerability have been reflected in the occasional differences between the rankings for floating and dissolved oil priorities.

**Table 3-1: Protection priority ranking**

Protection Priority	Ranking
Very High	5
High	4
Medium	3
Low	2
Very Low	1

There were many discussions held in the Steering Committee Workshop (see Section 1.5) regarding these points, and the overall consensus of rankings agreed with the Committee are reflected in the rankings in this report.

### 3.1 Protected Fauna

Australia's shoreline is home to a vast number of fauna, many of which are endemic to Australia and some species are of international, regional and local importance. In WA, threatened fauna are protected under Commonwealth and State legislation as well as International agreements and are listed under the International Union for Conservation of Nature (IUCN) Red List. Key legislation includes:

- Commonwealth EPBC Act which includes nationally significant fauna and fauna protected under the following international agreements:
  - Japan and Australia Migratory Bird Bilateral Agreement (JAMBA) 1974;
  - China and Australia Migratory Bird Bilateral Agreement (CAMBA) 1986; and
  - Republic of Korea and Australia Migratory Bird Bilateral Agreement (RoKAMBA) 2007.
- Western Australian *Wildlife Conservation Act 1950* (WC Act) which includes fauna of regional and local significance to the State.



The proposed protection priority ranking considers the method adopted in the initial zone, which includes assessing the threatened status of a species listed under both the EPBC Act<sup>1</sup> and the WC Act<sup>2</sup>, and taking whichever is highest. The ranking also uses the biological importance of an area to a species, the possible long term consequences the spill can have at a species level, as well as the threatened status of a species.

The Biologically Important Areas (BIA) for species were used in this assessment, as some fauna are more susceptible to being affected by a marine oil spill at different phases of their lifecycle. For example, breeding areas were given the highest importance, while roosting (in the case of birds), feeding and migrating areas were given lower levels of importance, as the likelihood of a bird coming into contact with the oil and the likely effects of oiling decreased during these activities. Similarly, the likelihood of whales being affected during feeding and migrating is lower than when it is active in its breeding and aggregation areas with their young.

The datasets used for the Protected Fauna category provided the opportunity to incorporate data confidence, reliability, accuracy and geospatial extent into the rankings. These are described in the tables for each fauna type in the sections below. In general, for the Species of National Environmental Significance (SNES) data, species that are 'known', 'likely' and 'may be' in an area are given different weightings, with 'known' the highest and 'may be' the lowest. For the DPaW fauna data, the survey method and certainty of identification were used to distribute the weightings (e.g. caught, trapped or sighted and 'Very Certain', 'Western Australian Museum (WAM) Vouchered' or 'Certain', which are provided in the dataset and give the highest confidence, while 'secondary signs' and 'fossil' were the lowest along with 'not sure' and 'not defined'.

The ranking does not exclude species that are not formally protected. In areas with a high concentration of bird species which are both formally protected and not protected, the area is identified for protection as a biologically important area for bird species. In addition, all fauna will be responded to in an oil spill event. The process used in this assessment identifies those areas of greatest priority where there are known high concentration areas of significant fauna requiring protection.

The ranking also takes into account the effect oil can have on the fauna type. For example, where birds are able to be greatly impacted by oil, whales are less likely to be affected at an individual level due to a number of factors. This is discussed more in the sections below.

Where terrestrial protected fauna species appear in a shoreline cell due to geospatial data distribution, at least two reliable information sources have been reviewed to determine if the species would be affected by a marine oil spill. Where it has been deemed that the species is

<sup>1</sup> The EPBC Act has six conservation categories, three of which have been used in this assessment. The six categories are Extinct, Extinct in the Wild, Critically Endangered (CR), Endangered (EN), Vulnerable (VU) and Conservation Dependent (CD). Only CR, EN and VU have been used in this assessment. Extinct and Extinct in the Wild were omitted as, of the seven species listed as Conservation Dependent, these are all fish and no key datasets were located for these species.

<sup>2</sup> Under the WC Act, 11 conservation categories exist. In addition to those listed in the EPBC Act, there are six more used, including CD. The other five are Other specially protected fauna (OS), and Priority species, listed as P1 to P4. For a definition of these please see: [https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/conservation\\_code\\_definitions.pdf](https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/conservation_code_definitions.pdf)



terrestrial only and does not use or have habitat in the marine or intertidal environment, the species has been allocated a priority ranking of Very Low for protection from both floating and dissolved oil, to ensure the correct level of risk is being assigned for marine oil pollution. This has been determined on a species by species basis, and is described in each section below.

### 3.1.1 Birds

#### Description

WA has an enormous number and diversity of bird species. Almost 550 species of birds have been recorded in the state; 387 of these have been recorded breeding (Birdlife WA, 2016). Seventeen (17) of these species are endemic to Western Australia, while many others migrate annually to feed, breed and escape the northern winter. The Swan zone is home to at least 24 legislatively protected bird species, and plays an important role in providing habitat for travelling migratory birds which are protected under JAMBA, CAMBA and/or RoKAMBA.

This assessment includes all legislatively protected bird species and species that have biologically important areas in the Swan zone. Many other non-legislatively protected bird species are in the Swan zone but have not been listed here, nor have they been included in the assessment. The main aim of the assessment is to identify the key areas for protection, therefore the species of national environmental significance and state significance have been used to identify these key areas for birds in the Swan assessment zone.

Bird distribution, species and conservation status (legislated) data was obtained as discrete observation locations from the DPaW's NatureMap database, the DotE Species of National Environmental Significance (SNES) dataset and generalised distribution polygon information from the DotE Biologically Important Areas (BIA) database.

Key species in the Swan zone include two Critically Endangered (CR) birds, which are the curlew sandpiper (*Calidris ferruginea*) and the eastern curlew (*Numenius madagascariensis*); ten Endangered (EN) birds including the Amsterdam albatross (*Diomedea amsterdamensis*), Australasian bittern (*Botaurus poiciloptilus*), Australian painted snipe (*Rostratula australis*), Carnaby's black cockatoo (*Calyptorhynchus latirostris*), northern royal albatross (*Diomedea sanfordi*), southern giant petrel (*Macronectes giganteus*), Hutton's shearwater (*Puffinus huttoni*), black browed albatross (*Thalassarche melanophris*) and the Tristan albatross (*Diomedea dabbenena*); and 16 Vulnerable (VU) species. These include both terrestrial and marine species. The little penguin is another key species of note.

#### Distribution

The CR curlew sandpiper and CR eastern curlew were found in all the shoreline cells of the Swan zone, with habitat known to occur and roosting and foraging behaviour known to occur.

The EN Australian bittern was observed and has habitat which is known to occur in Shoreline Cells 203 to 206, while the EN Amsterdam albatross and the EN Australian painted snipe has habitat which may occur in all the shoreline cells of the Swan zone.

The EN Carnaby's black cockatoo has breeding and foraging habitat which is found in all the shoreline cells while the EN Baudin's cockatoo has been observed in Shoreline Cells 205 and 337.



The EN Hutton's shearwater occurs in Shoreline Cell 203 and the EN Lesser Sand Plover occurs in Shoreline Cells 203, 204, 205 and 337.

The EN northern royal albatross is likely to occur in Shoreline Cells 198 to 205 and 337, and the EN southern giant petrel has habitat which may occur in Shoreline Cells 198, 199, 204, 206 and 337.

The EN Tristan albatross may occur in Shoreline Cells 203 to 206, the EN black browed albatross may occur in Shoreline Cell 203, and the EN sooty albatross is known to occur in Shoreline Cell 205.

The VU Australian fairy tern has breeding and foraging habitat which is found in all the shoreline cells.

The little penguin BIA extends from south along the coast from Rottnest Island and the Swan River, where they are known to forage and provision for their young. The little penguin is not a species of conservation concern (SPRAT, 2017) so it does not appear in the attribute table, however is locally significant.

## Discussion

The bird protection priority ranking considers the threatened status of a species and its biological use of the area, as well as the certainty of the data available. For the SNES data, species that are 'known', 'likely' and 'may be' in an area are given different weightings, while for the DPaW data the survey method and certainty of identification were used (e.g. caught, trapped or sighted and 'Very Certain', 'WAM Vouchered' or 'Certain', which are provided in the dataset). For the threatened status of a species, its highest protection listing under either the EPBC Act or the WC Act has been used. This is because while some species may not be threatened on a National level, they could be on a State level. This process ensures species that are protected only at a State level under the WC Act are included in the assessment.

As outlined in the introduction to Protected Fauna, bird protection priority ranking considers both the threatened status of a species as well as its biological use of the area. The ranking also takes into account the biological importance of an area to a species, elevating the priority of an area that could contain high numbers for that species, and for activities associated with breeding, which is when the species is most vulnerable. This reflects the possible long term consequences the spill can have at a species level if a spill occurred at critical breeding sites during breeding season.

It is also noted that heavy oiling can have a major impact on birds (French-McCay *et al.*, 2002; 2004; 2006). When oiled, bird feathers lose their waterproofness and their insulation, which can lead to hypothermia, dehydration, drowning and starvation. Birds coming into contact with layers of oil on the surface will be significantly affected, so floating oil was deemed to have a greater effect on birds than dissolved oil. Birds can also be poisoned via secondary means such as ingestion through preening or feeding on contaminated prey such as benthic invertebrates.

The protection priority rankings for birds are presented in Table 3-2. The table includes details about data confidence, reliability, survey method type, accuracy and geospatial extent.

Terrestrial-based birds such as the EN Carnaby's black cockatoo and EN Baudin's cockatoo would only be impacted by a marine oil spill where their habitat includes the shoreline, the beach and/or intertidal area. Where terrestrial mammals appear in the shoreline cells due to geospatial data distribution, at least two reliable information sources have been reviewed. Where it has been



deemed that the species is only terrestrial and does not use or have habitat in the marine or intertidal zone, the species has been allocated a priority ranking of Very Low for protection from both floating and dissolved oil, to ensure the correct level of risk is being assigned for marine oil pollution. As the CR curlew sandpiper has aggregation (roosting) areas in Shoreline Cells 205 and 337, it has been ranked High for protection from floating oil and Medium for protection from dissolved oil.

As well as the CR curlew sandpiper, Shoreline Cell 203 includes the EN Indian yellow-nosed albatross, EN black-browed albatross, EN Hutton's shearwater, EN sooty albatross and the EN Australian lesser noddy, which have caused the cell to be ranked High for protection from floating oil and Medium for protection from dissolved oil.

In Shoreline Cell 204, the EN Carnaby's cockatoo, EN Australian lesser noddy, CR curlew sandpiper (known to occur) and the EN eastern curlew have caused the cell to be ranked High for protection from floating oil and Medium for protection from dissolved oil. However, upon further investigation, the Carnaby's cockatoo is a terrestrial species, with the species habitat being woodlands including coastal forests and associated terrestrial vegetation (DoEE, 2017b; DPaW, 2013a). The species is not known to use the marine or intertidal environment. Therefore this species is unlikely to be impacted by a marine oil spill. As such, this species has been ranked Very Low priority for protection from both floating and dissolved oil.

This is also the case with the EN Baudin's cockatoo, which has been observed in Shoreline Cells 205 and 337. This is also a terrestrial-only species, not known to use the marine or intertidal environment (DoEE, 2017c; DEC, 2008). Therefore this species is unlikely to be impacted by a marine oil spill, so has been ranked Very Low priority for protection from both floating and dissolved oil.



**Table 3-2: Bird protection priority ranking**

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Birds			
Critically Endangered species, if: <ul style="list-style-type: none"><li>Breeding, nesting, aggregation or translocated population Known to occur in the area</li><li>Caught, trapped or sighted Very Certain/Western Australian Museum (WAM) Vouchered/Certain</li></ul>	5	4	<b>Species considered:</b> All SNES listed birds, State protected species in the DPaW database, and DotE species listed as having BIAs in the area.  <b>Importance:</b> Birds that have a higher threatened status were ranked higher. The BIAs considered to be the most important/vulnerable for birds are breeding/nesting habitats, while all other areas including foraging, migration and resting areas were ranked as 'known habitat' and given a lower importance. This is to reflect the higher vulnerability of a bird during nesting, including the vulnerability of its young, and also the aggregation of the birds in certain areas during these times.
Critically Endangered species, if: <ul style="list-style-type: none"><li>Breeding, nesting, aggregation or translocated population Likely to occur</li><li>Migration route, foraging, roosting, species or species habitat Known to occur</li><li>Secondary signs Very Certain/WAM Vouchered/Certain</li><li>Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure</li></ul> Endangered species, if: <ul style="list-style-type: none"><li>Breeding, nesting, aggregation or translocated population Known to occur</li><li>Caught, trapped or sighted Very Certain/WAM Vouchered/Certain</li></ul>	4	3	
Critically Endangered species, if: <ul style="list-style-type: none"><li>Migration route, foraging, roosting, species or species habitat Likely to occur in the area</li><li>Hair/skin or unknown method Very Certain/WAM Vouchered/Certain</li><li>Secondary signs Moderately Certain, Not Defined or Not Sure</li></ul> Endangered species, if: <ul style="list-style-type: none"><li>Breeding, nesting, aggregation or translocated population Likely to occur or low density in the area</li><li>Migration route, foraging, roosting, species or species habitat Known to occur in the area</li><li>Distribution, known core range and foraging Known to occur in DPaW database</li><li>Secondary signs Very Certain/WAM Vouchered/Certain</li><li>Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure</li></ul> Vulnerable species, if: <ul style="list-style-type: none"><li>Breeding, nesting, aggregation or translocated population Known to occur in the area</li></ul>	3	2	





Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
<ul style="list-style-type: none"> <li>Caught, trapped or sighted Very Certain/WAM Vouchered/Certain</li> </ul>			
Critically Endangered species, if:	2	1	
<ul style="list-style-type: none"> <li>Migration, connecting habitat and unknown, significant habitat Known to occur, high density</li> <li>Distribution, resting, nesting or foraging Likely to occur/low density</li> <li>Distribution, known core range or foraging May occur</li> <li>Breeding and aggregation Former Range</li> <li>Dead Very Certain/WAM Vouchered</li> <li>Hair/skin or unknown method Moderately Certain, Not Defined or Not Sure</li> </ul>			
Endangered species, if:			
<ul style="list-style-type: none"> <li>Distribution (low density), resting, nesting, foraging Likely, inter-nesting buffer, Known to occur</li> <li>Migration route, foraging, roosting, distribution, known core range, species or species habitat Likely to occur in the area</li> <li>Hair/skin or unknown method Very Certain/WAM Vouchered/Certain</li> <li>Secondary signs Moderately Certain, Not Defined or Not Sure</li> </ul>			
Vulnerable species, if:			
<ul style="list-style-type: none"> <li>Breeding, nesting, aggregation or translocated population Likely to occur or low density in the area</li> <li>Migration route, foraging, roosting, species or species habitat Known to occur in the area</li> <li>Distribution, known core range and foraging Known to occur in DPaW database</li> <li>Secondary signs Very Certain/WAM Vouchered/Certain</li> <li>Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure</li> </ul>			
Conservation Dependent, Other specially protected fauna and P1-P4 species, if:			
<ul style="list-style-type: none"> <li>Breeding, nesting, aggregation or translocated population Known to occur in the area</li> <li>Caught, trapped or sighted Very Certain/WAM Vouchered/Certain</li> </ul>			



Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Critically Endangered species, if: <ul style="list-style-type: none"> <li>Extinct in the area, dead, fossils, subfossil, historical record</li> </ul> All Endangered, Vulnerable and Other species with a conservation code with all other information.	1	1	
Terrestrial birds which do not use the marine or intertidal zone for any instance of their lifecycle, and do not use the marine or intertidal zone as any component of their habitat.	1	1	<b>Importance:</b> This is researched through two sources which cite no use of the marine or intertidal zone.

#### Data List

- DotE Species of National Environmental Significance (SNES) (22 February 2017)
- DPaW Protected Fauna (2 March 2017)
- DotE Biologically Important Areas (BIAs) (26 April 2016)
- Rottneest Island Authority fauna use area (8 November 2016)

### 3.1.2 Mammals

#### Description

Western Australia's coastline spans more than 13,500 km and is home to some of the world's most interesting marine and terrestrial mammals. Many of which are found nowhere else in the world.

Mammal distribution, species and conservation status (legislated) data was obtained as discrete observation locations from the DPaW's NatureMap database, the DotE Species of National Environmental Significance dataset, and generalised distribution polygon information from the DotE Biologically Important Areas database. The Rottneest Island Authority fauna use areas for mammals were also incorporated.

Within the Swan zone, two terrestrial Critically Endangered (CR) species have been recorded: the woylie, or brush-tailed bettong (*Bettongia penicillata ogilbyi*); and the western ringtail possum (*Pseudocheirus occidentalis*). There are also four EN species. Three of these are migratory and marine: the blue whale (*Balaenoptera musculus*) and its subspecies the pygmy blue whale (*Balaenoptera musculus brevicauda*), the southern right whale (*Eubalaena australis*) and fin whale (*Balaenoptera physalus*). One is terrestrial: the numbat (*Myrmecobius fasciatus*).

There are also a number of VU listed species, including three marine mammals: the Australian sea lion (*Neophoca cinerea*), humpback whale (*Megaptera novaeangliae*) and subantarctic fur seal (*Arctocephalus tropicalis*); and two terrestrial mammals: the quokka (*Setonix brachyurus*) and the chuditch or western quoll (*Dasyurus geoffroyi*). Other Specially Protected (OS) species under the WC Act that occur in the Swan zone are the New Zealand fur seal (*Arctocephalus forsteri*).



## Distribution

Marine mammals such as the EN southern right whale are known to migrate along the coastline of the Swan zone, but also have seasonal calving habitat in the coastal waters of the zone. Breeding and seasonal calving is known to occur in all shoreline cells of the Swan zone.

The EN blue whale, pygmy blue whale, and the EN fin whale are known to migrate and forage along the WA coastline between Indonesia and the Antarctic. This means they could also be found in any shoreline cell, depending on the time of year. The data indicates that the blue whale and fin whale are found in all shoreline cells of the Swan Zone.

The VU Australian sea lion is also known to occur in the Swan zone, in Shoreline Cell 198, and is likely to be found in coastal waters and along the coastline, sometimes hauled out on a beach between Lancelin in the north to Garden Island in the south, including Rottnest Island (Shoreline Cells 199 to 203 and 337). This is known and likely feeding behaviour; no known breeding sites have been recorded in the Swan zone.

The VU humpback whale also migrates along the coast of the Swan zone, however no breeding or calf resting areas are known to occur in the zone.

The OS New Zealand fur seal is known to haul out and rest on Rottnest Island (Shoreline Cell 337).

Terrestrial mammals include the CR woylie (*Bettongia penicillata ogilbyi*), which has habitat mapped along the coast from Safety Bay, just south of Rockingham to Secret Harbour and some offshore islands, all in Shoreline Cell 204, as well as inland around the northern extent of the Peel-Harvey Estuary, in Shoreline Cell 205.

The terrestrial CR western ringtail possum has supporting habitat found along the coastline from northern Perth to south around the Swan and Canning rivers, the Peel-Harvey Estuary, and into the South West region. No key breeding areas have been identified, but the species or species habitat can be found in the Swan zone Shoreline Cells 202 to 206.

The terrestrial EN numbat is recorded in one small section of the estuary system that feeds into the Peel-Harvey Estuary in Shoreline Cell 205.

## Discussion

Marine mammals in the Swan zone could come in direct contact with floating oil, or potentially ingest dissolved hydrocarbons when feeding. Physical oiling can burn and irritate the eyes of whales and sea lions. Cetaceans are more likely to be affected when the body of the mammal becomes coated in oil while surfacing to breathe. Cetaceans may also ingest dissolved oil when feeding in open water, but as they are impacted more by direct contact at the surface, floating oil is deemed to have a greater impact on mammals than dissolved oil.

The rankings for protection priority for marine and terrestrial mammals are presented in Table 3-3. The table incorporates data confidence, reliability, survey method type, accuracy and geospatial extent.

The southern right whale is listed as Critically Endangered, with "Breeding, calving or aggregation known to occur in the area", across most of southern Western Australia. Due to the large number



of shoreline cells affected in the Swan zone, it was deemed unlikely that the species would be affected at a species level in an oil spill, as the spill would have to affect the whole southern coast of Australia from Tasmania to Perth. Therefore other species with smaller areas should be prioritised in an oil spill. This single species was re-ranked as lower than the prescribed value, and shoreline cells were ranked Medium for protection from floating oil and Low for protection from dissolved oil for all distributions of the CR southern right whale, including calving, breeding and aggregation areas.

Because no other higher priority Protected Fauna was present to give a higher ranking, all the shoreline cells in the Swan Zone have been ranked Medium for protection from floating oil and Low for protection from dissolved oil for all distributions of the CR southern right whale, including calving, breeding and aggregation areas.

Shoreline Cell 198 is an area where the EN pygmy blue whale is known to occur. The presence of this species in this cell gives it a ranking of Medium for protection from floating oil and Low for protection from dissolved oil.

The VU furry Australian sea lion has given Shoreline Cells 198 to 203 and 337 a priority ranking of Medium for protection from floating oil and Low for protection from dissolved oil.

Terrestrial-based mammals such as the CR western ringtail possum and woylie would only be impacted by a marine oil spill where their habitat includes the shoreline, the beach and/or intertidal area. Where terrestrial mammals appear in the shoreline cells due to geospatial data distribution, at least two reliable information sources have been reviewed. Where it has been deemed that the species is only terrestrial and does not use or have habitat in the marine or intertidal zone, the species has been allocated a priority ranking of Very Low for protection from both floating and dissolved oil to ensure the correct level of risk is being assigned for marine oil pollution.

The western ringtail possum has been geospatially recorded in Shoreline Cells 202 to 206. A literature review showed that its habitat is forests, especially near coastal areas of peppermint (*Agonis flexuosa*) woodland and peppermint/tuart associations (DPaW, 2017a; TSSC, 2013a). The diet of the possum almost exclusively comprises terrestrial plants: peppermint, marri and jarrah. In urban areas, they may also feed on introduced garden species (Jones *et al.*, 1994; Burbidge and Tores, 1998). This species is not known to use the marine or intertidal environment. Therefore this species is unlikely to be impacted by a marine oil spill, and has been ranked Very Low priority for protection from both floating and dissolved oil.

The CR woylie has been geospatially recorded in Shoreline Cell 204 and 205. A literature review showed that it is known to rest during the day in a well-concealed nest, built over a shallow depression that is most commonly constructed of long strands, preferably grasses, but also other material such as strips of bark (in the forest) or dried seagrass and/or triodia (in arid coastal areas) (Christensen and Leftwich, 1980; DEC, 2012a). The seagrass habitat was investigated further and it was determined that, as the seagrass is dried, it is not in the intertidal area. Therefore this species is considered to not have habitat that would be affected by a marine oil spill; it would be above the high water mark. It also forages in the forest, away from the intertidal zone; feeding on a wide range of food types including leaf material, seasonal fruits/berries, roots, tubers, bark, fungi and invertebrates (DEC, 2012a). This species therefore is unlikely to be impacted by a marine oil spill, so has been ranked Very Low priority for protection from both floating and dissolved oil.



The terrestrial EN numbat is geospatially recorded in one small section of the estuary system that feeds into the Peel-Harvey Estuary in Shoreline Cell 205. A literature review showed that its diet consists almost exclusively of termites, which it obtains by uncovering galleries on the forest floor. It nests in hollow logs, tree hollows or in burrows (DoEE, 2017a; DPaW, 2017b). Previously widespread in arid and semi-arid Australia, the species is now restricted to two isolated wild populations in south-west Western Australia and a number of translocations to predator-proof locations (DPaW, 2017b). This information supports that the species does not have habitat that would be affected by a marine oil spill. This species therefore is unlikely to be impacted by a marine oil spill, so has been ranked Very Low priority for protection from both floating and dissolved oil.



**Table 3-3: Mammal protection priority ranking**

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Mammals			
Critically Endangered species, if: <ul style="list-style-type: none"><li>Breeding, calving, congregation, aggregation or translocated population Known to occur in the area</li><li>Caught, trapped or sighted Very Certain/WAM Vouchered/Certain</li><li>Not southern right whale</li></ul>	5	4	<b>Species considered:</b> All SNES listed mammals, State protected species in the DPaW database, and DotE species listed as having BIAs in the area.  <b>Importance:</b> Mammals that have a higher threatened status were ranked higher. The BIAs considered to be the most important/vulnerable for mammals are breeding/aggregation/resting areas due to the presence of large numbers of a species, or the presence of calves and juvenile mammals, while all other areas including foraging and migration areas were ranked as 'known habitat' and given a lower importance.
Critically Endangered species, if: <ul style="list-style-type: none"><li>Breeding, calving, congregation, aggregation or translocated population Likely to occur</li><li>Known breeding for the southern right whale</li><li>Migration route, foraging, species or species habitat Known to occur</li><li>Secondary signs Very Certain/WAM Vouchered/ Certain</li><li>Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure</li></ul> Endangered species, if: <ul style="list-style-type: none"><li>Breeding, calving, congregation, aggregation or translocated population Known to occur</li><li>Caught, trapped or sighted Very Certain/WAM Vouchered/Certain</li></ul>	4	3	
Critically Endangered species, if: <ul style="list-style-type: none"><li>Migration route, foraging, species or species habitat Likely to occur in the area</li><li>Hair/skin or unknown method Very Certain/WAM Vouchered/Certain</li><li>Secondary signs Moderately Certain, Not Defined or Not Sure</li></ul> Endangered species, if: <ul style="list-style-type: none"><li>Breeding, calving, congregation, aggregation or translocated population Likely to occur or low density in the area</li><li>Migration route, foraging, species or species habitat Known to occur in the area</li><li>Distribution, calving buffer, inter-nesting, known core range and foraging Known to occur in DPaW database</li><li>Secondary signs Very Certain/WAM Vouchered/ Certain</li><li>Caught, trapped or sighted Moderately</li></ul>	3	2	





Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Certain, Not Defined or Not Sure Vulnerable species, if: <ul style="list-style-type: none"> <li>Breeding, calving, congregation, aggregation or translocated population Known to occur in the area</li> <li>Caught, trapped or sighted Very Certain/WAM Vouchered/Certain</li> </ul> Southern right whale: all calving information			
Critically Endangered species, if: <ul style="list-style-type: none"> <li>Migration, connecting habitat and unknown, significant habitat Known to occur or high density</li> <li>Distribution or foraging Likely to occur/low density</li> <li>Distribution, calving buffer, known core range or foraging May occur</li> <li>Breeding, calving and aggregation Former Range</li> <li>Dead Very Certain/WAM Vouchered</li> <li>Hair/skin or unknown method Moderately Certain, Not Defined or Not Sure</li> </ul> Endangered species, if: <ul style="list-style-type: none"> <li>Distribution (low density), resting, nesting or foraging Likely, Known to occur</li> <li>Migration route, foraging, distribution, calving buffer, known core range, species or species habitat Likely to occur in the area</li> <li>Hair/skin or unknown method Very Certain/WAM Vouchered/Certain</li> <li>Secondary signs Moderately Certain, Not Defined or Not Sure</li> </ul> Vulnerable species, if: <ul style="list-style-type: none"> <li>Breeding, calving, congregation, aggregation or translocated population Likely to occur or low density in the area</li> <li>Migration route, foraging, species or species habitat Known to occur in the area</li> <li>Distribution, calving buffer, known core range and foraging Known to occur in DPaW database</li> <li>Secondary signs Very Certain/WAM Vouchered/ Certain</li> <li>Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure</li> </ul> Conservation Dependent, Other specially protected	2	1	



Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
fauna and P1-P4 species, if: <ul style="list-style-type: none"> <li>Breeding, calving, congregation, aggregation or translocated population Known to occur in the area</li> <li>Caught, trapped or sighted Very Certain/WAM Vouchered/Certain</li> </ul>			
Critically Endangered species, if: <ul style="list-style-type: none"> <li>Extinct in the area, dead, fossils, subfossil, historical record</li> </ul> All Endangered, Vulnerable and Other species with a conservation code with all other information.	1	1	
Terrestrial mammals which do not use the marine or intertidal zone for any instance of their lifecycle, and do not use the marine or intertidal zone as any component of their habitat.	1	1	<b>Importance:</b> This is researched through two sources which cite no use of the marine or intertidal zone.

**Data List**

- DotE Species of National Environmental Significance (SNES) (22 February 2017)
- DPaW Protected Fauna (2 March 2017)
- DotE Biologically Important Areas (BIAs) (26 April 2016)
- Rottneest Island Authority fauna use area (8 November 2016)

### 3.1.3 Invertebrates

#### Description

Invertebrates are all animals that lack a backbone. They include marine invertebrates such as crustaceans, coral, sponges, jellyfish and octopus (to name a few), as well as terrestrial invertebrates such as snails, bees and spiders. WA is home to numerous invertebrate species, however no invertebrates found in state waters are legislatively protected. While coral is an invertebrate, it is included under Protection Areas as a key benthic habitat (refer to Section 3.2).

Invertebrate distribution, species and conservation category (legislated) data was obtained as discrete observation locations from the DPaW's NatureMap database, the DotE Species of National Environmental Significance (SNES) dataset, and generalised distribution polygon information from the DotE Biologically Important Areas (BIA) database.

Four State protected invertebrates occur in the Swan zone: a P1 land snail (*Bulimulidae Bothriembryon perobesus*); a P1 graceful sun-moth (*Castniidae Synemon gratiosa*), a P1 trapdoor spider (*Idiopidae Arbanitis inornatus*); and a P3 bee (*Colletidae Hylaeus globuliferus*). These are all



listed as 'Priority Species'<sup>3</sup> under the WC Act. No Commonwealth protected invertebrates or BIAs were identified in the zone.

## Distribution

The land snail is recorded from a day sighting at Yanchep and one sighting at the mouth of the Moore River (Shoreline Cell 199). The graceful sun-moth is known from surveys undertaken between Moore River in the north and Preston Beach in the south (Shoreline Cells 199 and 205).

The trapdoor spider is known from a single day sighting at Kings Park in Perth (Shoreline Cell 203). The bee is known from two sightings of caught or trapped specimens in Fremantle in Shoreline Cell 203.

## Discussion

Terrestrial-based invertebrates such as the P1 land snail and P1 graceful sun-moth would only be impacted by a marine oil spill where their habitat includes the shoreline, the beach and/or intertidal area. Where terrestrial mammals appear in the shoreline cells due to geospatial data distribution, at least two reliable information sources have been reviewed. Where it has been deemed that the species is only terrestrial and does not use or have habitat in the marine or intertidal zone, the species has been allocated a priority ranking of Very Low for protection from both floating and dissolved oil, to ensure the correct level of risk is being assigned for marine oil pollution.

As some protected terrestrial invertebrates have habitats along the coast, a protection priority ranking has only been adopted for terrestrial invertebrates where their habitat includes the marine or intertidal environment. The impact on terrestrial invertebrates such as snails, moths, spiders and bees is expected to be fatal if an oil spill washes up on shore and coats their habitat. Dissolved oil will have no effect.

The protection priority rankings adopted for this assessment are presented in Table 3-4.

Shoreline Cells 199 and 205 have records of the P1 graceful sun-moth. This moth is associated with two habitat types: coastal heathland on Quindalup dunes where it is restricted to secondary sand dunes due to the abundance of the preferred host plant *Lomandra maritima*; and Banksia woodland on Spearwood and Bassendean dunes, where the second known host plant *L. hermaphrodita* is widespread (DoEE, 2017c; TSSC, 2013b). This species is not known to use the marine or intertidal environment. Therefore this species is unlikely to be impacted by a marine oil spill, and has been ranked Very Low priority for protection from both floating and dissolved oil.

Shoreline Cell 199 also contains a P1 land snail. There is very limited information available on the *Bulimulidae Bothriembryon perobesus*, and it is known from only a single shell specimen found at the mouth of the Moore River in Shoreline Cell 199 (Breure and Whisson, 2012). With limited information, this land snail has been given a priority ranking of Low for protection from floating oil and Very Low for protection from dissolved oil, in line with the protection priority rankings in Table 3-4. The rankings are reflective of the P1: Poorly-known species definition from the WC Act:

<sup>3</sup> For WC Act Priority conservation code definitions please see:  
[https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/conservation\\_code\\_definitions.pdf](https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/conservation_code_definitions.pdf)



"Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey."

Shoreline Cell 203 shows the presence of a P1 trapdoor spider in Kings Park. As with the P1 land snail above, very little information is known about the *Idiopidae Arbanitis inornatus*. In general, the habitat of trapdoor spiders is open forest vegetation, where it makes an open burrow that may or may not have a trapdoor (Australian Museum, 2015a). Its diet consists of crickets, moths, beetles and grasshoppers, taken near the entrance to the burrow (Australian Museum, 2015a). Based on this information, this species is not likely to use the marine or intertidal environment. Therefore this species is unlikely to be impacted by a marine oil spill, and has been ranked Very Low priority for protection from both floating and dissolved oil.

None of these rankings are the highest in the shoreline cells, so the invertebrates are not included in the attribute table.

**Table 3-4: Invertebrate protection priority ranking**

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Invertebrates			
Critically Endangered species, if: <ul style="list-style-type: none"><li>Breeding, congregation, aggregation or translocated population Known to occur in the area</li><li>Caught, trapped or sighted Very Certain/WAM Vouchered/Certain</li></ul>	5	1	<b>Species considered:</b> No marine invertebrates found in WA state waters are legislatively protected. Therefore, all SNES listed terrestrial invertebrates, State protected species in the DPaW database, and DotE species listed as having BIAS in the area.  <b>Importance:</b> Terrestrial invertebrates may be in the area and tend to be concentrated in highly localised areas. In an oil spill, their coastal habitats may become oiled and this is expected to be fatal. Dissolved oil is
Critically Endangered species, if: <ul style="list-style-type: none"><li>Breeding, congregation, aggregation or translocated population Likely to occur</li><li>Migration route, foraging, species or species habitat Known to occur</li><li>Secondary signs Very Certain/WAM Vouchered/ Certain</li><li>Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure</li></ul>	4	1	
Endangered species, if: <ul style="list-style-type: none"><li>Breeding, congregation, aggregation or translocated population Known to occur</li><li>Caught, trapped or sighted Very Certain/WAM Vouchered/Certain</li></ul>			
Critically Endangered species, if: <ul style="list-style-type: none"><li>Migration route, foraging, species or species</li></ul>	3	1	



Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
<p>habitat Likely to occur in the area</p> <ul style="list-style-type: none"> <li>Hair/skin or unknown method Very Certain/WAM Vouchered/Certain</li> <li>Secondary signs Moderately Certain, Not Defined or Not Sure</li> </ul> <p>Endangered species, if:</p> <ul style="list-style-type: none"> <li>Breeding, congregation, aggregation or translocated population Likely to occur or low density in the area</li> <li>Migration route, foraging, species or species habitat Known to occur in the area</li> <li>Distribution, known core range and foraging Known to occur in DPaW database</li> <li>Secondary signs Very Certain/WAM Vouchered/ Certain</li> <li>Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure</li> </ul> <p>Vulnerable species, if:</p> <ul style="list-style-type: none"> <li>Breeding, congregation, aggregation or translocated population Known to occur in the area</li> <li>Caught, trapped or sighted Very Certain/WAM Vouchered/Certain</li> </ul>			<p>not expected to have an impact.</p> <p>Invertebrates that have a higher threatened status were ranked higher. The BIAs considered to be the most important/vulnerable for invertebrates are breeding/nesting habitats, while all other areas including foraging and migration areas were ranked as 'known habitat' and given a lower importance.</p> <p>This is to reflect the higher vulnerability of an invertebrate during breeding, including the vulnerability of its young, and also the aggregation of the species in certain areas during these times.</p>
<p>Critically Endangered species, if:</p> <ul style="list-style-type: none"> <li>Migration, connecting habitat and unknown, significant habitat Known to occur, high density</li> <li>Distribution, nesting or foraging Likely to occur/low density</li> <li>Distribution, known core range or foraging May occur</li> <li>Breeding and aggregation Former Range</li> <li>Dead Very Certain/WAM Vouchered</li> <li>Hair/skin or unknown method Moderately Certain, Not Defined or Not Sure</li> </ul> <p>Endangered species, if:</p> <ul style="list-style-type: none"> <li>Distribution (low density), nesting or foraging Likely, Known to occur</li> <li>Migration route, foraging, distribution, known core range, species or species habitat Likely to occur in the area</li> <li>Hair/skin or unknown method Very Certain/WAM Vouchered/Certain</li> <li>Secondary signs Moderately Certain, Not Defined or Not Sure</li> </ul>	2	1	



Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
<p>Vulnerable species, if:</p> <ul style="list-style-type: none"> <li>Breeding, congregation, aggregation or translocated population Likely to occur or low density in the area</li> <li>Migration route, foraging, species or species habitat Known to occur in the area</li> <li>Distribution, known core range or foraging Known to occur in DPaW database</li> <li>Secondary signs Very Certain/WAM Vouchered/ Certain</li> <li>Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure</li> </ul> <p>Conservation Dependent, Other specially protected fauna and P1-P4 species, if:</p> <ul style="list-style-type: none"> <li>Breeding, congregation, aggregation or translocated population Known to occur in the area</li> <li>Caught, trapped or sighted Very Certain/WAM Vouchered/Certain</li> </ul>			
<p>Critically Endangered species, if:</p> <ul style="list-style-type: none"> <li>Extinct in the area, dead, fossils, subfossil, historical record</li> </ul> <p>All Endangered, Vulnerable and Other species with a conservation code with all other information.</p>	1	1	
<p>Terrestrial invertebrates which do not use the marine or intertidal zone for any instance of their lifecycle, and do not use the marine or intertidal zone as any component of their habitat.</p>	1	1	<b>Importance:</b> This is researched through two sources which cite no use of the marine or intertidal zone.

#### Data List

- DotE Species of National Environmental Significance (SNES) (22 February 2017)
- DPaW Protected Fauna (2 March 2017)
- DotE Biologically Important Areas (BIAs) (26 April 2016)
- Rottneet Island Authority fauna use area (8 November 2016)

### 3.1.4 Fish

#### Description

Western Australia is home to more than 1,600 fish species. Many are fished for commercial or recreational purposes, but also collected for home and international aquariums.

Fish species, distribution and conservation status (legislated) data was obtained as discrete observation locations from the DPaW's NatureMap database, the DotE Species of National





Environmental Significance (SNES) dataset, and generalised distribution polygon information from the DotE Biologically Important Areas (BIA) database. Information on Totally Protected fish species is sourced from the DoF, however this is not accompanied by geospatial data so the location of species has been drawn from the three previously mentioned geospatial databases.

Protected fish in the Swan zone includes sharks. Three can be found in the Swan zone: the VU great white shark (*Carcharodon carcharias*); grey nurse shark (*Carcharias taurus*); and the whale shark (*Rhincodon typus*). Two other protected fish species under the WC Act are also found: the P1 pouched lamprey (*Geotriidae Geotria australis*); and the P2 leafy sea dragon or 'seahorse' (*Syngnathidae Phycodurus eques*).

'Totally protected' fish and 'seasonally protected, totally protected' fish species, protected under the *State Fish Resources Management Act 1994*, have also been included in this section. In the Swan zone, these include the whale shark and leafy and weedy sea dragons.

It is worth noting here that fish habitat protection areas are included in the Protection Areas category in Section 3.2.8. Also, fishing areas associated with economic and tourism enterprises are included in the Economic category in Section 3.4.

## Distribution

The VU grey nurse shark, great white shark and the whale shark can be found throughout the cooler waters of the Swan zone in Shoreline Cells 198, 200 to 204 and 337.

The P1 pouched lamprey is known from four specimens in the Peel-Harvey Estuary, all in Shoreline Cell 205: three at Halls' Head; and one at West Coolup. The P2 and totally protected leafy sea dragon is known from two specimens collected off the north coast of Rottnest Island (Shoreline Cell 337).

The totally protected weedy sea dragon is found in cooler waters off the Swan zone at Rottnest Island (Shoreline Cell 337).

## Discussion

Fish are affected by hydrocarbons through physical smothering impacting on physiological functions, or by chemical toxicity causing lethal or sub-lethal effects or impairing cellular functions. The worst effects will occur through chemical toxicity on smaller species such as seahorses. This could lead to accumulation of hydrocarbons in tissues, and in the worst instance could lead to mortality or sub-lethal stress.

The species conservation category and its use of the area, such as breeding or aggregation, versus 'normal range', were used to determine its ranking presented in Table 3-5. The rankings also incorporate data confidence, reliability, survey method type, accuracy and geospatial extent.

Freshwater fish species would only be impacted by a marine oil spill where their habitat includes marine water. Where freshwater fish species appear in the shoreline cells due to geospatial data distribution, at least two reliable information sources have been reviewed. Where it has been deemed that the species does not use or have habitat in the marine environment, the species has been allocated a priority ranking of Very Low for protection from both floating and dissolved oil. This ranking reflects that this species is at very low risk of being impacted by a marine oil spill.



Based on the rankings below, because no other priority Protected Fauna was present to give a higher ranking, Shoreline Cells 198, 200 to 205 and 337 have been ranked Low for protection from floating oil and Medium for protection from dissolved oil, due to the confirmed, surveyed presence of the VU grey nurse shark and the VU great white shark in these areas.

Shoreline Cell 337 has been ranked Very Low for protection from floating oil and Low for protection from dissolved oil due to the records of weedy sea dragon in that cell.

The pouched lamprey in Shoreline Cell 305 has given the cell a ranking of Very Low for protection from floating oil and Low for protection from dissolved oil.

The rankings in these shoreline cells are higher due to other aspects, so not all of these fish appear in the attribute table. No freshwater fish species were identified in the Swan zone.



**Table 3-5: Fish protection priority ranking**

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Fish			
Critically Endangered species, if: <ul style="list-style-type: none"><li>Breeding, congregation, aggregation or translocated population Known to occur in the area</li><li>Caught, trapped or sighted Very Certain/WAM Vouchered/Certain</li></ul>	4	5	<b>Species considered:</b> All SNES listed fish, State protected species in the DPaW database, and DotE species listed as having BIAs in the area. <b>Importance:</b> Fish that have a higher threatened status were ranked higher. The BIAs considered to be the most important/vulnerable for fish are breeding/aggregation habitats as oil will have more of an effect on juvenile fish, while all other areas including foraging and normal range areas were ranked as 'known habitat' and given a lower importance.
Critically Endangered species, if: <ul style="list-style-type: none"><li>Breeding, congregation, aggregation or translocated population Likely to occur</li><li>Migration route, foraging, species or species habitat Known to occur</li><li>Secondary signs Very Certain/WAM Vouchered/Certain</li><li>Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure</li></ul> Endangered species, if: <ul style="list-style-type: none"><li>Breeding, congregation, aggregation or translocated population Known to occur</li><li>Caught, trapped or sighted Very Certain/WAM Vouchered/Certain</li></ul>	3	4	
Critically Endangered species, if: <ul style="list-style-type: none"><li>Migration route, foraging, species or species habitat Likely to occur in the area</li><li>Hair/skin or unknown method Very Certain/WAM Vouchered/Certain</li><li>Secondary signs Moderately Certain, Not Defined or Not Sure</li></ul> Endangered species, if: <ul style="list-style-type: none"><li>Breeding, congregation, aggregation or translocated population Likely to occur or low density in the area</li><li>Migration route, foraging, species or species habitat Known to occur in the area</li><li>Distribution, known core range and foraging Known to occur in DPaW database</li><li>Secondary signs Very Certain/WAM Vouchered/Certain</li><li>Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure</li></ul> Vulnerable species, if: <ul style="list-style-type: none"><li>Breeding, congregation, aggregation or translocated population Known to occur in the area</li><li>Caught, trapped or sighted Very Certain/WAM</li></ul>	2	3	



Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Vouchered/ Certain			
Critically Endangered species, if:	1	2	
<ul style="list-style-type: none"> <li>Migration, connecting habitat and unknown, significant habitat Known to occur, high density</li> <li>Distribution or foraging Likely to occur/low density</li> <li>Distribution, known core range or foraging May occur</li> <li>Breeding and aggregation Former Range</li> <li>Dead Very Certain/WAM Vouchered</li> <li>Hair/skin or unknown method Moderately Certain, Not Defined or Not Sure</li> </ul>			
Endangered species, if:			
<ul style="list-style-type: none"> <li>Distribution (low density) or foraging Likely, Known to occur</li> <li>Migration route, foraging, Distribution, known core range, species or species habitat Likely to occur in the area</li> <li>Hair/skin or unknown method Very Certain/WAM Vouchered/Certain</li> <li>Secondary signs Moderately Certain, Not Defined or Not Sure</li> </ul>			
Vulnerable species, if:			
<ul style="list-style-type: none"> <li>Breeding, congregation, aggregation or translocated population Likely to occur or low density in the area</li> <li>Migration route, foraging, species or species habitat Known to occur in the area</li> <li>Distribution, known core range and foraging Known to occur in DPaW database</li> <li>Secondary signs Very Certain/WAM Vouchered/Certain</li> <li>Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure</li> </ul>			
Conservation Dependent, Other specially protected fauna and P1-P4 species, if:			
<ul style="list-style-type: none"> <li>Breeding, congregation, aggregation or translocated population Known to occur in the area</li> <li>Caught, trapped or sighted Very Certain/WAM Vouchered/ Certain</li> </ul>			
Critically Endangered species, if:	1	1	
<ul style="list-style-type: none"> <li>Extinct in the area, dead, fossils, subfossil, historical record</li> </ul>			
All Endangered, Vulnerable and Other species with a conservation code with all other information.			



Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Freshwater fish which do not use the marine or intertidal zone for any instance of their lifecycle, and do not use the marine or intertidal zone as any component of their habitat.	1	1	<b>Importance:</b> This is researched through two sources which cite no use of the marine or intertidal zone.

#### Data List

- DotE Species of National Environmental Significance (SNES) (22 February 2017)
- DPaW Protected Fauna (2 March 2017)
- DotE Biologically Important Areas (BIAs) (26 April 2016)
- Rottnest Island Authority fauna use area (8 November 2016)

### 3.1.5 Reptiles

#### Description

Western Australia's marine and coastal environment contains unique, diverse and fragile ecosystems and species – from tropical waters in the north, to temperate waters in the south. Within the more temperate waters in the Swan zone, reptile distribution, species and legislated protection classification data was obtained at discrete observation locations from the DPaW's NatureMap database. This data is contained in the SNES dataset obtained from DotE, and generalised distribution polygon information is obtained from the Biologically Important Areas (BIA) database. Other data has also been sourced from the RIA fauna use dataset.

Reptiles found in the Swan zone include four species of marine turtles: the EN loggerhead (*Caretta caretta*); EN leatherback (*Dermochelys coriacea*); VU green (*Chelonia mydas*); and the VU flatback (*Natator depressus*). There are also four terrestrial reptiles: the VU Lancelin Island skink (*Ctenotus Lancelini*); the VU Rottnest Island bobtail (*Scincidae Tiliqua rugosa konowi*); VU Rottnest Island dugite (*Elapidae Pseudonaja affinis exilis*); and the P4 black striped snake (*Neelaps calonotos*).

#### Distribution

The EN loggerhead and leatherback turtles as well as the VU green and flatback turtles have breeding beaches along most of the Swan zone coastline. This includes almost all the islands. All four turtle species also have foraging, feeding and normal range habitat covering the marine waters of all the shoreline cells. The majority of the key known breeding sites are further north, however the protected and susceptible marine reptiles can breed along the Swan coastline.

The VU Lancelin Island skink has only been recorded on Lancelin Island (Shoreline Cell 198), and the VU Rottnest Island bobtail and dugite have only been recorded on Rottnest Island (Shoreline Cell 337).



## Discussion

The assessment for impacts on reptiles considered that physical oiling by floating oil irritates sensitive organs such as eyes. There is a chance for chemical toxicity via ingestion, particularly for marine reptiles such as turtles that feed or aggregate in shallow water habitats where oil can accumulate. As a result, floating oil was deemed to have more of an effect on reptiles than dissolved oil. This is also because reptiles hold their breath underwater and are unlikely to ingest dissolved oil directly.

In the protection priority ranking table for reptiles (Table 3-6), the conservation category as well as the above considerations have been taken into account. The species' key uses such as nesting and breeding have been also considered. Note too that the SNES dataset uses the terminology nesting/breeding which implies aggregation of a species. 'Aggregation' is used in the BIA dataset and is referenced in the other Protected Fauna rankings used in this category. Aggregation of a species in a single area allows for a large number of the species to be impacted if that area is affected, for example by an oil spill. Therefore the nesting/breeding areas (aggregation) have a higher ranking than foraging and inter-nesting areas.

On the other hand, terrestrial reptile species would only be impacted by a marine oil spill where their habitat includes marine water. Where terrestrial reptile species appear in the shoreline cells due to geospatial data distribution, at least two reliable information sources have been reviewed. Where it has been deemed that the species does not use or have habitat in the marine environment or intertidal zone, the species has been allocated a priority ranking of Very Low for protection from both floating and dissolved oil. The ranking reflects that this species is at very low risk of being impacted by a marine oil spill.

Based on the priority rankings in Table 3-6 and the reptile species found in the Swan zone, Shoreline Cells 198 and 199 have been ranked Medium for protection from floating oil and Low for protection from dissolved oil because EN loggerhead and EN leatherback turtle breeding is likely to occur in the area.

Shoreline Cells 200, 201, 203, 204 and 337 have been ranked High for protection from floating oil and Medium for protection from dissolved oil, due to known aggregation habitat for the EN loggerhead turtle and EN leatherback being recorded in those shoreline cells.

The VU Lancelin Island skink has only been recorded on Lancelin Island (Shoreline Cell 198), and the VU Rottnest Island bobtail and dugite have only been recorded on Rottnest Island (Shoreline Cell 337). All three are terrestrial based species. The Lancelin Island skink occurs in all major vegetated habitat types on the island (DoEE, 2017d; DPaW, 2000). Preferred substrates were sand and shallow soil over limestone. The area with the highest density was the dune and swale behind the eastern beach (DPaW, 2000). The species is therefore deemed to be terrestrial only and does not use or have habitat in the marine or intertidal zone. This means the species has been allocated a priority ranking of Very Low for protection from both floating and dissolved oil to ensure the correct level of risk is being assigned for marine oil pollution.

The VU Rottnest Island bobtail is a terrestrial reptile with limestone heath, settlement, woodland and coastal habitat on Rottnest Island (Rottnest Island, 2017). Its diet consists of plant material (especially fruit), insects, slugs, snails, eggs, faeces and dead animal carcasses including maggots (Rottnest Island, 2017). It is therefore concluded that this species is terrestrial only and does not use or have habitat in the marine or intertidal zone. This means the species has been allocated a



priority ranking of Very Low for protection from both floating and dissolved oil to ensure the correct level of risk is being assigned for marine oil pollution.

VU Rottnest Island subspecies of dugite (*Elapidae Pseudonaja affinis exilis*) has only been recorded on Rottnest Island (Australian Museum, 2015b). Its terrestrial habitat includes coastal, temperate sand dunes with grassland, low shrubland, open forest, open heath and woodland vegetation. It is a carnivorous species which eats a variety of vertebrate prey including frogs, lizards, snakes, birds and mammals (Australian Museum, 2015b). This species is terrestrial only and is not reported to use or have habitat in the marine or intertidal zone. As such, the species has been allocated a priority ranking of Very Low for protection from both floating and dissolved oil to ensure the correct level of risk is being assigned for marine oil pollution.

The P4 black striped snake (*Neelaps calonotos*) is a terrestrial reptile that lives in Banksia woodlands and sandy areas of the Perth region (WA Museum, 2017). This species is terrestrial only and is not reported to use or have habitat in the marine or intertidal zone. As such, the species has been allocated a priority ranking of Very Low for protection from both floating and dissolved oil to ensure the correct level of risk is being assigned for marine oil pollution.





**Table 3-6: Reptile protection priority ranking**

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Reptiles			
Critically Endangered species, if: <ul style="list-style-type: none"><li>Breeding, congregation, aggregation or translocated population Known to occur in the area</li><li>Caught, trapped or sighted Very Certain/WAM Vouchered/Certain</li></ul>	5	4	<b>Species considered:</b> All SNES listed reptiles, State protected species in the DPaW database, and DotE species listed as having BIAs in the area.  <b>Importance:</b> Reptiles that have a higher threatened status were ranked higher. The BIAs considered to be the most important/vulnerable for reptiles are breeding/nesting habitats and aggregation areas, while all other areas including foraging, migration and inter-nesting were ranked as 'known habitat' and given a lower importance. This is to reflect the higher vulnerability of a reptile during nesting, including the vulnerability of its young, and also the aggregation of the reptiles in certain areas during these times.
Critically Endangered species, if: <ul style="list-style-type: none"><li>Breeding, congregation, aggregation or translocated population Likely to occur</li><li>Migration route, foraging, species or species habitat Known to occur</li><li>Secondary signs Very Certain/WAM Vouchered/Certain</li><li>Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure</li></ul> Endangered species, if: <ul style="list-style-type: none"><li>Breeding, congregation, aggregation or translocated population Known to occur</li><li>Caught, trapped or sighted Very Certain/WAM Vouchered/Certain</li></ul>	4	3	
Critically Endangered species, if: <ul style="list-style-type: none"><li>Migration route, foraging, species or species habitat Likely to occur in the area</li><li>Hair/skin or unknown method Very Certain/WAM Vouchered/Certain</li><li>Secondary signs Moderately Certain, Not Defined or Not Sure</li></ul> Endangered species, if: <ul style="list-style-type: none"><li>Breeding, congregation, aggregation or translocated population Likely to occur or low density in the area</li><li>Migration route, foraging, species or species habitat Known to occur in the area</li><li>Distribution, inter-nesting, known core range and foraging Known to occur in DPaW database</li><li>Secondary signs Very Certain/WAM Vouchered/Certain</li><li>Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure</li></ul> Vulnerable species, if: <ul style="list-style-type: none"><li>Breeding, congregation, aggregation or</li></ul>	3	2	



Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
translocated population Known to occur in the area			
<ul style="list-style-type: none"> <li>Caught, trapped or sighted Very Certain/WAM Vouchered/Certain</li> </ul>			
Critically Endangered species, if:	2	1	
<ul style="list-style-type: none"> <li>Migration, connecting habitat and unknown, significant habitat Known to occur, high density</li> <li>Distribution, resting, nesting, foraging or inter-nesting buffer Likely to occur/low density</li> <li>Distribution, inter-nesting, known core range or foraging May occur</li> <li>Breeding and aggregation Former Range</li> <li>Dead Very Certain/WAM Vouchered</li> <li>Hair/skin or unknown method Moderately Certain, Not Defined or Not Sure</li> </ul>			
Endangered species, if:			
<ul style="list-style-type: none"> <li>Distribution (low density), nesting, foraging Likely, inter-nesting buffer, Known to occur</li> <li>Migration route, foraging, distribution, inter-nesting, known core range, species or species habitat Likely to occur in the area</li> <li>Hair/skin or unknown method Very Certain/WAM Vouchered/Certain</li> <li>Secondary signs Moderately Certain, Not Defined or Not Sure</li> </ul>			
Vulnerable species, if:			
<ul style="list-style-type: none"> <li>Breeding, congregation, aggregation or translocated population Likely to occur or low density in the area</li> <li>Migration route, foraging, species or species habitat Known to occur in the area</li> <li>Distribution, inter-nesting, known core range and foraging Known to occur in DPaW database</li> <li>Secondary signs Very Certain/WAM Vouchered/Certain</li> <li>Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure</li> </ul>			
Conservation Dependent, Other specially protected fauna and P1-P4 species, if:			
<ul style="list-style-type: none"> <li>Breeding, congregation, aggregation or translocated population Known to occur in the area</li> <li>Caught, trapped or sighted Very Certain/</li> </ul>			

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
WAM Vouchered/Certain			
Critically Endangered species, if: <ul style="list-style-type: none"> <li>Extinct in the area, dead, fossils, subfossil, historical record</li> </ul> All Endangered, Vulnerable and Other species with a conservation code with all other information.	1	1	
Terrestrial reptiles which do not use the marine or intertidal zone for any instance of their lifecycle, and do not use the marine or intertidal zone as any component of their habitat.	1	1	<b>Importance:</b> This is researched through two sources which cite no use of the marine or intertidal zone.

#### Data List

- DotE Species of National Environmental Significance (SNES) (22 February 2017)
- DPaW Protected Fauna (2 March 2017)
- DotE Biologically Important Areas (BIAs) (26 April 2016)
- Rottneest Island Authority fauna use area (8 November 2016)

## 3.2 Protection Areas

Protection areas consist of habitats and ecosystems that are important for protection (such as unique ecosystems), or for supporting locally, regionally and internationally important flora and fauna. Habitats include mangroves, coral, seagrass, wetlands, fish spawning grounds, or Key Ecological Features (KEF). Protection areas include both formally protected areas through State or Commonwealth legislation, as well as important habitats identified through ecological and scientific literature, e.g. seagrass, mangroves and coral.

During the assessment of the first zone, it was recognised that, due to a number of political, land tenure, time and funding constraints, there may be areas that are equivalent to one of the protection area categories but do not have the legal status of a protected area. It was agreed that if an area has been recommended as a marine park or national park, but for legal or land tenure (or other) reasons is not yet (at the time of the assessment) legally designated as one, it should be included in the assessment for protection under the marine park/national park, etc., protection ranking. Also, if an area cannot legally become a marine park/national park, etc., for similar reasons outlined above, but it has been demonstrated that the area has the ecological value equivalent to a formally recognised park, it should be included in the assessment.

There were two such areas identified in '*A Representative Marine Reserve System for Western Australia*', a report by the Marine Reserves Selection Working Group (Wilson *et al.*, 1994). These are the Shoalwater Islands Marine Park extension and the Peel-Harvey Inlet. These are discussed further in Section 3.2.3, Marine Protection Areas.



### 3.2.1 World Heritage Areas

#### Description

Australia has 14 World Heritage areas. These are places or areas that the United Nations Educational, Scientific and Cultural Organization (UNESCO) has agreed are worthy of special protection, because they represent the best examples of the world's cultural and natural heritage and are considered to be of outstanding value to humanity (UNESCO, 2008).

There are two categories for heritage protection: cultural heritage; and natural heritage. Some UNESCO World Heritage areas are classed as either one category or the other, while some are classed under both categories. This section includes World Heritage areas that are listed for their natural heritage value only, and those that are listed for both their natural and cultural heritage values. Areas listed on the UNESCO World Heritage List for only their cultural heritage have been included in the Cultural Heritage priority ranking (see Section 3.3.1).

The DotE World Heritage Areas dataset was used to delineate the World Heritage areas in the Swan zone. One World Heritage area is located near the Swan zone, the Australian Convict Site, which became Australia's 18<sup>th</sup> World Heritage Listed place on 31 July 2010. However as it is only next to the zone and not in any of the shoreline cells, it has not been included in this assessment.

The UNESCO World Heritage Council does not list areas *nominated* for World Heritage Listing. At the time of this report, there are 44 World Heritage area nominations, with 40 assessed and four incomplete. There are a further 37 proposed for review in 2017 (UNESCO, 2017). No known proposed World Heritage areas have been identified in the Swan zone.

#### Distribution

The DotE World Heritage Areas dataset was used to delineate the World Heritage areas in the Swan zone. No World Heritage areas (natural heritage *only*, or *both* natural and cultural heritage) are located in the Swan zone.

#### Discussion

There are ten criteria against which a site can be nominated for inclusion in the list of World Heritage areas. While some sites fulfil more than one criterion, for the purposes of the overall assessment, all recognised World Heritage areas have been ranked equally (highest ranking), as it is considered that a loss or impact on the site would be a loss or impact of global significance.

Because there are no World Heritage areas in the Swan zone, there are no shoreline cells with the protection priority ranking listed in Table 3-7.



**Table 3-7: World Heritage Properties protection priority ranking**

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
World Heritage Properties (Natural and Natural & Cultural Heritage)			
All World Heritage Areas	5	5	<b>Importance:</b> World Heritage areas have the highest priority for protection from the effects of both floating oil and dissolved oil.

**Data List**

- DotE World Heritage Areas (14 October 2015)

### 3.2.2 Terrestrial Protection Areas

#### Description

Terrestrial protection areas are those specified in Commonwealth or State law, such as national parks, nature reserves, conservation parks, Indigenous protected areas and miscellaneous reserves, to preserve the natural and cultural characteristics of an area. Nearly two thirds of the protected areas in Australia are publicly owned and managed by the Australian government or State and Territory governments. This includes over 9,700 protected areas covering more than 103 million hectares or 13.4 per cent of Australia (DotE, 2013). The largest component of this is in WA where 35.64 million hectares are protected across 1,562 areas, which is 34.51% of the total National Reserve Network (DotE, 2013). The majority of this land is managed by DPaW.

Terrestrial protection areas have been identified through the DotE Collaborative Australian Protected Areas Database (CAPAD). The dataset is updated every two years and, while the previous version is dated 2014, DPaW was able to provide an updated marine and terrestrial dataset for lands vested in its department (from July 2016). Within the CAPAD dataset, the conservation areas under the *WA Conservation and Land Management Act 1984* (CALM Act) include IUCN protected areas categories. IUCN is the International Union for Conservation of Nature which has created a set of categories that have been internationally adopted as the standard for defining and recording protected areas. The conservation categories listed in the CALM Act are:

**IA (Strict Nature Reserve):** Protected areas that are strictly set aside to protect biodiversity and also possibly geological/geomorphological features, where human visitation, use and impacts are strictly controlled and limited to ensure protection of the conservation values. Such protected areas can serve as indispensable reference areas for scientific research and monitoring.

**IB (Wilderness Area):** Protected areas that are usually large unmodified or slightly modified areas, retaining their natural character and influence, without permanent or significant human habitation, which are protected and managed to preserve their natural condition.

**II (National Park):** Protected areas that are large natural or near-natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible spiritual, scientific, educational, recreational and visitor opportunities.



III (National Monument): Protected areas that are set aside to protect a specific natural monument which can be a landform, sea mount, sub-marine cavern, geological feature such as a cave, or even a living feature such as an ancient grove. They are generally quite small protected areas and often have high visitor value.

IV (Habitat/Species Management Area): Protected areas that aim to protect particular species or habitats and whose management reflects this priority. Many Category IV protected areas will need regular, active interventions to address the requirements of particular species or to maintain habitats, but this is not a requirement of the category.

V (Protected Landscape/Seascape): Protected areas where the interaction of people and nature over time has produced an area of distinct character with significant ecological, biological, cultural and scenic value, and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values.

VI (Protected area with sustainable use of natural resources): Protected areas that conserve ecosystems and habitats, together with associated cultural values and traditional natural resource management systems. They are generally large, with most of the area in a natural condition, where a proportion is under sustainable natural resource management and where low-level, non-industrial use of natural resources compatible with nature conservation is seen as one of the main aims of the area.

Other types of reserves including 5(1)(g) Reserves: Within the meaning of the CALM Act: land reserved under the *Land Act 1933* which is vested in the Conservation Commission of WA that is not a national park, conservation park, nature reserve, marine park or marine nature reserve. Immediately before the commencement of the CALM Act: was vested in, or under the control and management of the National Parks Authority but not as a national park. (On the proclamation of the CALM Act, all these reserves were automatically vested in the Conservation Commission of WA). These reserves have a wide variety of purposes, but are normally related to recreation, wildlife conservation, infrastructure and historical features. These are managed by the WA Department of Parks and Wildlife and can have any of the above IUCN classifications for management.

5(1)(h) Reserves: Within the meaning of the CALM Act: land reserved under the *Land Administration Act 1997* which is vested in the Conservation Commission of WA that is not a national park, conservation reserve, nature reserve, marine park or marine nature reserve. Immediately before the commencement of the CALM Act: was vested in, or under the control and management of, the National Parks Authority but not as a National Park. (On the proclamation of the CALM Act, all these reserves were automatically vested in the Conservation Commission of WA). These reserves have a wide variety of purposes, but are normally related to recreation, wildlife conservation, infrastructure and historical features. These are managed by the WA Department of Parks and Wildlife and can have any of the above IUCN classifications for management.

Indigenous Protected Areas: Indigenous community owned and managed lands in Australia. They form the second largest component of the National Reserve System covering three per cent of Australia. These can have any of the above IUCN classifications for management.



Miscellaneous Reserves: Defined by the WA Department of Mines and Petroleum in its description of land type categories in TENGGRAPH® as Freehold land held by the Executive Director of DPaW. Under Section 131 of the CALM Act, this freehold land can be sold by DPaW. These can have any of the above IUCN classifications for management.

Regional Parks: Only found in the Swan zone, areas of regional open space in the Perth metropolitan region that are identified by planning procedures as having regionally significant conservation, landscape and recreation values. Regional parks may consist of lands with a variety of tenures and reserve purposes. There are currently 11 regional parks.

## Distribution

Within the Swan zone, there are 16 nature reserves (including Shoalwater Bay (IA), Carnac Island (IA) and Austin Bay (IA) to name a few), one national park (Yalgorup National Park (II)), no miscellaneous reserves, four conservation parks (including Penguin Island (III) and Len Howard Conservation Park (II)), two 5(1)(h) reserves and three 5(1)(g) reserves including Matilda Bay (IV) and Keanes Point (IV). There are also three of the 11 regional parks in the Swan zone.

The several terrestrial protected areas in the Swan and Canning River area (Shoreline Cell 203) include Matilda Bay Reserve (IV), Keanes Point Reserve (IV), Shoalwater Bay Island Nature Reserve (IA), Carnac Island Nature Reserve (IA), Alfred Cove Nature Reserve (IA), an unnamed 5(1)(g) reserve (IV), an unnamed 5(1)(h) reserve (II) and an unnamed conservation park (II). The other shoreline cell with significant terrestrial reserve content is Shoreline Cell 204, which contains part of the Shoalwater Island Nature Reserve (IA), Penguin Island Conservation Park (III), Port Kennedy Scientific Park (IA) as well as other protected parks.

Shoreline Cell 205 contains the Peel-Harvey Estuary which houses 11 nature reserves (all IA), a Conservation Park (Len Howard (II)) and an unnamed 5(1)(h) reserve (VI). It also borders on the coastal Yalgorup National Park (II).

Further south, Shoreline Cell 206 also sits adjacent to the large and continuous coastal Yalgorup National Park (II). This national park covers 13,052 ha.

Shoreline Cell 199 contains the coastal portion of an unnamed conservation park (II), and to the north, Shoreline Cell 198 shares part of the small (8.6 ha) Lancelin and Edwards Island Nature Reserve (IA).

Regional parks in the Swan zone consist of the Woodman Point, Beeliar and Rockingham Lakes in Shoreline Cell 203. Rockingham Lakes Regional Park also bounds Shoreline Cell 204.

## Discussion

The land tenure of the conservation parks, national parks and nature reserves has a long standing protection status in Australian legislation. The proposed ranking for these legislated terrestrial protection areas is presented in Table 3-8. As noted in Section 3.2, it has been recognised that due to a number of political, land tenure, time and funding constraints, there may be areas that are proposed or scientifically recognised to be important areas, but are yet to become or will never be able to become formally protected, and therefore are not legally recognised as such. These would have been included in this assessment as their equivalent legal protection category, if any had





been identified. However no proposed or equivalent terrestrial protection areas have been identified in the Swan zone.

In the first zone assessed, it was highlighted that the designated boundary of a terrestrial protection area may be either to the high water mark, or to the low water mark. If the boundary was to the low water mark, the area for protection included the intertidal zone. Therefore consideration of the effects of marine pollution in the intertidal zone needed to be incorporated into the terrestrial area assessment. In response, the terrestrial parks in this assessment have been divided into parks that include the intertidal zone and those that have a boundary to the high water mark (terrestrial only), and the potential impacts ranked accordingly.

When processing and reviewing the data in the Swan zone, the following areas were deemed to include the intertidal zone:

- Shoreline Cell 198: The Lancelin and Edwards Islands Nature Reserve (IA);
- Shoreline Cell 204: Shoalwater Bay Islands Nature Reserve (IA), Penguin Island Conservation Park (III) and an unnamed nature reserve (IA); and
- Shoreline Cell 205: Within the Peel-Harvey Estuary, Goegrup Lake Nature Reserve (IA), Austin Bay Nature Reserve (IA) and two unnamed nature reserves (both IA).

Based on the rankings in Table 3-8 below, IA and IB areas have been ranked High for protection from floating oil, and Medium for protection from dissolved oil. These include Shoreline Cells 198, 204 and 205 for the protection areas listed above.



**Table 3-8: Terrestrial Protection Areas protection priority ranking**

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
National and State Terrestrial Protection Areas			
All conservation areas and proposed conservation areas as defined under the <i>WA Conservation and Land Management Act 1984</i> (conservation park, national park, nature reserve) ranked IUCN IA (Strict Nature Reserve) and IB (Wilderness Area) <i>Includes the intertidal zone</i>	4	3	<b>Importance:</b> A Strict Nature Reserve is mainly managed for scientific research. Wilderness Areas are managed for their wilderness protection. Both are key examples of unspoilt areas of wilderness with restricted human access. These pristine areas are the most important to protect from anthropogenic impacts such as an oil spill.
Same as above but: <i>Does not include the intertidal zone</i>	3	N/A	
All conservation areas and proposed conservation areas as defined under the <i>WA Conservation and Land Management Act 1984</i> ranked IUCN II (National Park), III (National Monument), IV (Habitat/Species Management Area), V (Protected Landscape/Seascape) <i>Includes the intertidal zone</i>	3	2	<b>Importance:</b> National Parks, National Monuments, Habitat/Species Management Areas and Protected Landscape/Seascape are typically larger areas protected to preserve a larger ecosystem or feature. Therefore the impacts from an oil spill are expected to be less as the areas are larger.
Same as above but: <i>Does not include the intertidal zone</i>	2	N/A	
All conservation areas and proposed conservation areas as defined under the <i>WA CALM Act 1984</i> ranked IUCN VI (Managed Resource Protected Area) and all other types: 5(1)(g) reserves, 5(1)(h) reserves, Indigenous Protected Areas, Miscellaneous Reserves <i>Includes the intertidal zone</i>	2	1	<b>Importance:</b> All other reserved areas have land tenure not as secure as conservation areas described as above. Managed Resource Protected Areas typically have a level of human interaction and recreation. Managed mainly for conservation, they still have an element of disturbance through sharing their natural resources with the public.
Same as above but: <i>Does not include the intertidal zone</i>	1	N/A	

**Data List**

- DotE CAPAD Terrestrial and Marine dataset (30 June 2014)
- DPaW CAPAD Terrestrial dataset update (30 June 2016)



### 3.2.3 Marine Protection Areas

#### Description

Marine protection areas in WA state waters are areas specified in State law such as state marine parks, state marine reserves, Fish Habitat Protection Areas (FHPAs) and reef protection areas. Marine protection areas are used alongside fisheries management to conserve aquatic biodiversity and contribute to a sustainable marine environment. Commonwealth protected areas may also be put in place for commonwealth waters, adjacent to the state waters boundary. While these are in waters between three and 200 nautical miles off the WA coast managed under Commonwealth legislation (i.e. adjacent to state waters), they can also fall in the shoreline cells, as the cell boundaries do not always strictly stop at the state waters boundary.

Marine protection areas have been sourced from the Commonwealth DotE CAPAD Marine dataset. The CAPAD Marine dataset provides both spatial and text information about government, Indigenous and privately protected areas for continental Australia. State and Territory conservation agencies supplied the DotE with data current to 30 June 2014 for inclusion. It is updated by the DotE every two years, however DPaW was able to provide an updated marine and terrestrial dataset for lands vested in its department. The WA DoF has also provided updated datasets for areas managed for fisheries. Protected areas offshore include:

- 5(1)(g) Reserves;
- Fish Habitat Protection Areas;
- Marine Management Areas;
- Marine Nature Reserves;
- Marine Parks; and
- Nature Reserves.

These reserves are then classified by the IUCN system described above for terrestrial protection areas. FHPAs are described, along with Closed Waters areas, in Section 3.2.8.

There are four legislated marine parks in the Swan zone, some with different management areas. The State managed parks are: Marmion Marine Park (IUCN Category II and VI), Swan Estuary Marine Parks (II, IV and VI) and Shoalwater Islands Marine Park (VI). There are no marine conservation reserves, but there is one Commonwealth marine reserve: Two Rocks Commonwealth Marine Reserve (II and VI).

As discussed in the introduction to this section (Section 3.2), areas that are proposed for marine park protection status have also been included in this section. Two such areas have been identified in 'A Representative Marine Reserve System for Western Australia', a report of the Marine Reserves Selection Working Group (Wilson *et al.*, 1994). These are the proposed Shoalwater Islands Marine Park extension and the Peel-Harvey Inlet.



The Shoalwater Island Marine Park (IUCN VI) extension is proposed to include Carnac Island (Nature Reserve), the western side of Garden Island, and the waters out to the state waters limit. The extension to the Shoalwater Islands Marine Park, which currently contains Shoalwater Bay, Warnbro Sound and Penguin Island, was declared an A-Class Marine Park in 1990 because:

- It contains geomorphology of a major distinctive coastal type;
- There is a series of limestone ridges on the seabed offshore to the west of Garden and Carnac Islands, generally parallel to the coast. Between them are deeply undercut and cavernous sandy gutters. The largest ridge is called Five Fathom Bank, and is one of the major structural features of the central West Coast;
- The seagrass meadows of the Parmelia Bank are exceptionally dense and prolific, and represent one of the best examples of this community type on the West Coast;
- The intertidal flora and fauna of Carnac and Garden Islands are rocky platform communities different from Rottnest Island, and are considered representative of this habitat type on the central West Coast; and
- The offshore limestone ridges are important fishing grounds for the rock lobster fishery and also for recreational fishing.

The Peel-Harvey Inlet is one of the three large estuarine systems found on the West Coast. It has been proposed for conservation because it is:

- One of WA's most important recreational areas;
- A site of significant recreational and commercial fisheries; and
- Listed under the Ramsar Convention as an internationally important wetland, which obliges the State to adequately protect the environment against changes that may be detrimental to its function as a wetland habitat.

The two proposed marine parks have been given the following equivalent protection status:

- Shoalwater Islands Marine Park extension: Marine Park (IUCN VI); and
- Peel-Harvey Inlet: Marine Management Area (IUCN IV).

## **Distribution**

Within the Swan zone, the Swan Estuary Marine Park areas are all in Shoreline Cell 203. Marmion Marine Park straddles two shoreline cells (Shoreline Cells 201 and 202) and so does Shoalwater Islands Marine Park (Shoreline Cells 203 and 204).

The Two Rocks Commonwealth Marine Reserve has two sections: the IUCN Category VI section is found in Shoreline Cells 199, 200 and 201; and a small portion classed IUCN Category II is in Shoreline Cell 201.

The recommended Shoalwater Islands Marine Park extension (VI) straddles the same two shoreline cells as the current Marine Park (Shoreline Cells 201 and 202); the recommended Peel-Harvey Inlet (IV) is in Shoreline Cell 205.



## Discussion

The land tenure for marine nature reserves, marine parks or marine management areas has a long-standing protection status in Australian legislation. The proposed rankings for marine protection areas are presented in Table 3-9. As discussed in Section 3.2.2 (Terrestrial Protection Areas), the designated boundary of a marine protection area may be either to the high water mark or to the low water mark, and thus may or may not include an intertidal zone. As such, the potential impact could be different depending on the boundary. Therefore the marine parks have been divided into parks that include the intertidal zone (i.e. that have a boundary to the high water mark), and those that only go to the low water mark (i.e. subtidal only). This is reflected in the ranking table (Table 3-9).

Marine parks that go to the high water mark and include the intertidal zone include the Swan Estuary Marine Park areas, Marmion Marine Park and Shoalwater Islands Marine Park (Shoreline Cells 203 and 204). Therefore Shoreline Cells 201, 202 and 203 have been ranked High for protection from both floating oil and dissolved oil, as they each contain an IUCN Category IA marine park.

Shoreline Cell 204 containing the Shoalwater Island Marine Park (VI) has been given a ranking of Low for protection from both floating oil and dissolved oil.

The Two Rocks Commonwealth Marine Reserve is in commonwealth waters so does not have an intertidal portion. A small portion of IUCN Category II is found in Shoreline Cell 201, which has therefore been ranked Medium for protection from dissolved oil and Low for protection from floating oil. Shoreline Cells 199 and 200 contain a portion of IUCN Category VI marine reserve, so they have been ranked Low for protection from both floating oil and dissolved oil.

As noted in Section 3.2, it has been recognised that due to a number of political, land tenure, time and funding constraints, there may be areas that are proposed to become marine protected areas but are not yet legally recognised as such. Two areas have been identified and described above for consideration as marine parks in the future, and these have been included in the assessment.

The recommended Shoalwater Island Marine Park extension does not include any land or intertidal areas, however the recommended Peel-Harvey Inlet Marine Management Area does. The Peel-Harvey Inlet Marine Management Area is located in Shoreline Cell 205, and as no other protection priority is present, this shoreline cell has been ranked High for protection from floating oil and dissolved oil.



**Table 3-9: Marine Protection Areas protection priority ranking**

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
National and State Marine Protection Areas			
All conservation areas and proposed conservation areas as defined under the <i>WA Conservation and Land Management Act 1984</i> (marine nature reserve, marine park or marine management area) ranked IUCN IA (Strict Nature Reserve) and IB (Wilderness Area) <i>Includes intertidal zone</i>	4	4	<b>Importance:</b> Strict Nature Reserves are mainly managed for scientific research. Wilderness Areas are managed for their wilderness protection. They are key examples of unspoilt areas of wilderness with restricted human access. These pristine areas are the most important to protect from anthropogenic impacts such as an oil spill.
A-Class Reserve vested under the <i>Fish Resources Management Act 1994</i>	4	4	
Same as above, but: <i>Subtidal only</i>	3	4	
All conservation areas and proposed conservation areas as defined under the <i>WA Conservation and Land Management Act 1984</i> ranked IUCN II (National Park), III (National Monument), IV (Habitat/Species Management Area), V (Protected Landscape/Seascape)	3	3	<b>Importance:</b> The land tenure of the conservation parks, national parks and nature reserves have a long standing protection status in Australian legislation. National Parks, National Monuments, Habitat/Species Management Areas and Protected Landscape/Seascape are typically larger areas protected to preserve a larger ecosystem or feature. Therefore the impacts from an oil spill are expected to be less as the areas are larger.
Same as above, but: <i>Subtidal only</i>	2	3	
All conservation areas and proposed conservation areas as defined under the <i>WA Conservation and Land Management Act 1984</i> ranked IUCN VI (Managed Resource Protected Area) and all other types (existing and proposed): 5(1)(g) reserves, 5(1)(h) reserves, Indigenous Protected Areas, Miscellaneous Reserves	2	2	<b>Importance:</b> All other reserved areas have land tenure not as secure as conservation areas described above. Managed Resource Protected Areas typically have a level of human interaction and recreation. Managed mainly for conservation, they still have an element of disturbance through sharing their natural resources with the public.
Same as above, but: <i>Subtidal only</i>	1	2	

**Data List**

- DotE CAPAD Terrestrial and Marine dataset (30 June 2014)
- DPaW CAPAD Terrestrial dataset update (30 June 2016)
- Proposed Marine Parks (Wilson *et al.*, 1994)



### 3.2.4 Wetlands

#### Description

There are two levels of protected wetlands in Australia: Ramsar wetlands; and Wetlands of National Importance.

Ramsar wetlands are wetlands of international importance identified under the Ramsar Convention for conservation and sustainable use and management. The Ramsar Convention aims to halt the worldwide loss of wetlands and to conserve, through wise use and management, those that remain. Ramsar wetlands are protected in Australia under the EPBC Act as a matter of national environmental significance. They are wetlands identified as representative, rare or unique, or important for conserving biological diversity, and are often recognised for supporting international and migratory bird species. Under the Ramsar Convention, a wide variety of natural and human-made habitat types, ranging from rivers to coral reefs, can be classified as wetlands. Wetlands include swamps, marshes, billabongs, lakes, salt marshes, mudflats, mangroves, coral reefs, fens, peat bogs, or bodies of water – whether natural or artificial, permanent or temporary. There are even underground wetlands.

Nationally important wetlands are those wetlands that are recognised for their national significance. In Australia, these are also protected under the EPBC Act and are listed for one or more of six reasons:

1. It is representative of a biogeographic region in Australia;
2. It plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex;
3. It is important as the habitat for animal taxa at a vulnerable stage in their lifecycles, or provides a refuge when adverse conditions such as drought prevail;
4. It supports 1% or more of the national populations of any native plant or animal taxa;
5. It supports native plant or animal taxa or communities which are considered endangered or vulnerable at the national level; and/or
6. It is of outstanding historical or cultural significance.

Ramsar wetlands were identified using the DotE Ramsar Wetlands of Australia geospatial dataset, and nationally important wetlands were identified using the Directory of Important Wetlands in Australia spatial database.

#### Distribution

In the Swan zone there are two Ramsar wetlands: the Peel-Yalgorup System and Becher Point Wetlands. Under Nationally Important Wetlands, there are also many sections of the Swan-Canning Estuary, three lakes on Rottnest Island, Lake McLarty System, many areas in the Peel-Harvey Estuary and the Yalgorup Lakes System.

No proposed or recommended wetlands were identified in the Swan zone.



The Ramsar listed Peel-Yalgorup System wetland is very extensive, covering 26,664 ha. It is found along the coastline of Shoreline Cells 205 and 206. The Ramsar listed Becher Point Wetlands are smaller (only 677 ha) and are found along the coastline in Shoreline Cell 204.

The nationally important Swan-Canning Estuary wetland consists of many different watercourse systems in the Swan and Canning River systems. These are all in Shoreline Cell 203. The Peel-Harvey Estuary consists of a lake, a swamp and areas subject to inundation. These are all in Shoreline Cell 205. The Lake McLarty system is also in Shoreline Cell 205. It is smaller, consisting of several swamps adjacent to the Peel-Harvey Estuary. The three Rottnest Island lakes are all on Rottnest Island in Shoreline Cell 337.

## Discussion

Ramsar wetlands are wetlands of international importance protected under the EPBC Act for management and protection as a matter of national environmental significance. As a site selected for its international importance, and because a wetland is likely to be significantly affected in the long term due to its complex remediation, it has been given the highest priority for protection from both floating oil and dissolved oil. Nationally important wetlands have been given the second highest ranking for the same reasons. These rankings are presented in Table 3-10.

There is some duplication between the listings of Ramsar wetlands and nationally important wetlands. Wetlands are also included as a shoreline type in the OSRA ESI dataset. However, where coastline characteristics (e.g. a wetland) are identified as nationally or internationally significant, this higher ranking has prevailed.

With the rankings in Table 3-10, Shoreline Cells 204, 205 and 206 have been given a ranking of Very High for protection from both floating oil and dissolved oil due to the presence of Ramsar wetlands (Peel-Yalgorup System and Becher Point Wetlands). Shoreline Cells 203 and 337 have been given a ranking of High for protection from floating oil and dissolved oil due to the presence of nationally important wetlands.

**Table 3-10: Ramsar and Nationally Important Wetlands protection priority ranking**

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Ramsar Wetlands			
All Ramsar wetlands	5	5	<b>Importance:</b> Wetlands of international importance protected under the EPBC Act for management and protection as a matter of national environmental significance.
All nationally important wetlands	4	4	<b>Importance:</b> Wetlands which are classified as nationally important.

### Data List

- DotE Ramsar Wetlands of Australia (16 February 2015)
- DotE Directory of Important Wetlands in Australia (15 October 2008)



### 3.2.5 Key Ecological Features

#### Description

Marine Key Ecological Features (KEFs) are elements of the marine environment that, based on current scientific understanding, are considered to be regionally important, either for the region's marine biodiversity or for ecosystem function and integrity. KEFs have been identified in this assessment using the National Key Ecological Features geospatial database obtained from the DotE. While all KEFs are in commonwealth waters, the shoreline cell boundaries overlap with some commonwealth waters, and KEFs are therefore found in some Swan zone shoreline cells.

The two KEFs in the Swan zone are the 'western rock lobster' and 'Commonwealth marine environment in and adjacent to the west coast inshore lagoons'.

The commonwealth marine environment in and adjacent to the west coast inshore lagoons is defined as a KEF for its high productivity and aggregations of marine life. Both benthic and pelagic habitats in the feature have conservation value.

The western rock lobster (*Panulirus cygnus*) is the dominant large benthic invertebrate in the South West bioregion. It is also an important part of the food web on the inner shelf, particularly as a juvenile, when it is preyed upon by octopus, cuttlefish, baldchin groper, blue groper, dhufish, pink snapper, wirrah cod and breaksea cod. The western rock lobster is also particularly vulnerable to predation during seasonal moults in November-December, and to a lesser extent during April-May. The high biomass of western rock lobster and its vulnerability to predation suggest it is an important trophic pathway for a range of inshore species that prey upon juvenile lobsters. The western rock lobster is defined as a key ecological feature due to its presumed ecological role on the west coast continental shelf.

#### Distribution

The spatial boundary of the commonwealth marine environment in and adjacent to the west coast inshore lagoons KEF, is based in waters less than 30 m deep, in commonwealth waters, from Kalbarri to slightly south of Mandurah. The lagoons overlap with all shoreline cells in the Swan zone except Rottnest Island (Shoreline Cell 337).

The spatial boundary of the western rock lobster KEF includes commonwealth waters in the South West marine region, to a depth of 150 m, north of Cape Leeuwin. It overlaps with all shoreline cells in the Swan zone.

#### Discussion

KEFs are considered to be regionally important, either for the region's marine biodiversity or for ecosystem function and integrity, and as such are given the rankings proposed in Table 3-11.

Based on these rankings, and that all the shoreline cells in the Swan zone contain a portion of either the 'Commonwealth marine environment in and adjacent to the west coast inshore lagoons' KEF and/or the 'western rock lobster' KEF, all shoreline cells have been given a ranking of Low for protection from floating oil and Medium for protection from dissolved oil. These rankings are lower than the ones assigned given to them from other aspects in the shoreline cell, so the KEF information is not reflected in the attribute table.



**Table 3-11: Key Ecological Features protection priority ranking**

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Key Ecological Features			
Key ecological features	2	3	<b>Importance:</b> As a site selected for regional marine importance, KEFs are given the third highest priority protection for protection from dissolved oil, as all features are submerged. They are given a lower priority for floating oil.

**Data List**

- Commonwealth Marine Key Ecological Features (16 September 2015)

### 3.2.6 Coastal and Intertidal Habitats

#### Description

WA has many unique and nationally, regionally and locally important coastal and intertidal habitats. These include ecologically important mangroves in the north to white sandy beaches in the south, and rocky landscapes to sheltered intertidal flats in between.

The data representing coastal habitats predominantly came from the Oil Spill Response Atlas (OSRA) developed by AMSA and maintained by the DoT. These layers are represented by 'WA Shoreline ESI' data where ESI stands for Environmental Sensitivities Index. The spill contingency planning requirements of the USA *Oil Pollution Act of 1990*, and similar legislation passed by many states in the United States, require information on the location of sensitive resources to be used as the basis for establishing protection priorities. As such, a standardised system has been developed in the United States known as the ESI. The ESI categorises the shoreline into its type and sensitivity to marine oil pollution. It is widely accepted around the world as the standard for rating sensitivity when planning a response to shoreline contact from an oil spill.

For the various types of shoreline (and riverine or lacustrine) ecosystems, the widely accepted ESI can be adapted for each country. The ESI, ranging from 1 (low sensitivity) to 10 (very high sensitivity), integrates the:

- Shoreline type (grain size, slope), which determines the capacity of oil penetration and/or burial on the shore, and movement;
- Exposure to waves (and tidal energy), which determines the natural persistence time of oil on the shoreline; and
- General biological productivity and sensitivity.

For this assessment, the ten levels of the ESI have been adopted from the IPIECA/IMO/OGP (2012).

Shorelines of sheltered tidal flats that incorporate mangrove and swamp habitats are more susceptible to the long term impacts of both floating and dissolved oil, while rocky exposed shorelines are the least susceptible. Shorelines which include beaches and sandy areas are considered to be moderately difficult to rehabilitate, moderately ecologically sensitive, and also are



likely to contain areas used for human resources purposes such as beaches and archaeological sites.

The Marine Futures Biodiversity (MFB) project (Government of Australia, 2008) mapped the biodiversity of five key regions along the WA coastline, including Abrolhos Island, Broke Inlet, Geographe Bay, Jurien Bay, Middle Island (Recherche Archipelago), Point Ann (Fitzgerald National Park), Rottnest Island and Southwest Capes. One of these areas falls in the Swan zone: Rottnest Island. This data is available online through the SeaMap Australia project, which is hosted on the Australian Ocean Data Network ([aodn.org.au](http://aodn.org.au)) which is maintained by the University of Tasmania.

The MFB substrate data comprises distributions of reef, sand, mixed reef and sand, and no clarity. Only sand was used here; reef was incorporated into the Corals section that follows (Section 3.2.7). The dataset is valuable for the shoreline cells that it falls into, and has been incorporated into the classification below based on the National Oceanic and Atmospheric Administration (NOAA) and IPIECA/International Maritime Organisation (IMO)/International Association of Oil and Gas Producers (OGP) ESI. Where the OSRA dataset overlapped the distribution presented by MFB data, the OSRA ESI weighting prevailed.

The MFB dataset was supplemented by the DPaW Marine Habitat dataset which consists of broad-scale regional marine habitats of selected areas in Western Australia, mostly in existing and proposed marine conservation reserve areas. Diverse classifications and habitat descriptions were standardised to the DPaW broad-scale Shallow-Water Marine Habitat Classification scheme (Bancroft, 2003). Habitats are classified to the broad-scale ecological community level (Bancroft, 2003).

The Coastal and Marine Resources Information System (CAMRIS) data was also incorporated, which shows the distribution of ten different types of coastal sea floor sediment in the Australian region. It was derived from data collected and mapped by the Ocean Sciences Institute, University of Sydney.

Location specific benthic habitat studies and associated geospatial datasets were also sourced for Cockburn Sound, provided by the Cockburn Sound Management Council (CSMC), and Rottnest Island, provided by the Rottnest Island Authority (RIA).

The Department of Mines and Petroleum (DMP) Coastal Landforms dataset was also identified for inclusion in this section, however as described in Section 2.5, this was excluded from the first zone assessment. This was because it was difficult to assign a protection priority, as the dataset was not consistent in its interpretation of sandy/rocky and inundated shoreline areas equivalent to the ESI or DPaW Marine Habitat datasets above. The same approach has been adopted for the Swan zone.

The DPaW marine habitats dataset shows predominantly areas of seagrass and coral, which are included in the following section on Coral, Seagrass, Algae and Filter Feeding Communities.

## **Distribution**

The coastal characteristics of the Swan zone are dominated by fine to medium grained sand beaches and small and discontinuous rocky areas, particularly on the offshore islands including Rottnest Island.

There are no mangroves or intertidal flats, except in the very upper reaches of the Swan River.



Shoreline Cell 199 (north of Yanchep) includes ESI 10A Salt and brackish water marshes, 10B Freshwater marshes and 10C Swamps.

The other shoreline cells in the Swan zone have been ranked Medium for protection from floating oil and dissolved oil due to the presence of 8A Sheltered scarps in bedrock, mud or clay and sheltered rocky shore in all of the shoreline cells.

## **Discussion**

Shoreline Cell 199 has been ranked High for protection from both floating oil and dissolved oil due to the presence of salt and brackish water marshes, freshwater marshes and swamps.

All the other shoreline cells in the Swan zone have been ranked Medium for protection from both floating and dissolved oil due to the presence of 8A Sheltered scarps in bedrock, mud or clay and sheltered rocky shore.



**Table 3-12: Coastal and Intertidal Habitat protection priority ranking**

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Coastal and Intertidal Habitats			
ESI 10: 10A Salt and brackish water marshes; 10B Freshwater marshes; 10C Swamps; 10D Mangroves with >3,000 ha per shoreline cell.	4	4	<b>Importance:</b> Based on the NOAA and IPIECA/IMO/OGP Environmental Sensitivities Index, the classifications and rankings have been adopted from the above and take into account:  1. Shoreline Classification – ranked according to a scale relating to sensitivity, natural persistence of oil, and ease of clean up.  2. Biological Resources – including oil-sensitive animals and rare plants; and habitats, which are used by oil-sensitive species or are themselves sensitive to oil spills, such as submersed aquatic vegetation and coral reefs.  3. Human-Use Resources – specific areas that have added sensitivity and value because of their use, such as beaches, parks, marine sanctuaries, water intakes and archaeological sites.  See <a href="http://response.restoration.noaa.gov/sites/default/files/ESI_Guidelines.pdf">http://response.restoration.noaa.gov/sites/default/files/ESI_Guidelines.pdf</a> for further discussion regarding the classifications.
ESI 7, 8 and 9: 7 Exposed tidal flats; 8A Sheltered scarps in bedrock, mud or clay and sheltered rocky shore; 8B Sheltered, solid man-made structures; 8C Sheltered riprap; 8D Sheltered rocky rubble shores; 8E Peat shorelines; 9A Sheltered tidal flats >3,000 ha per shoreline cell; 9B Vegetated low banks; 9C Hypersaline tidal flats; 10D Mangroves with between 1,000 and 3,000 ha per shoreline cell.	3	3	
ESI 3, 4, 5 and 6: 3A Fine- to medium-grained sand beaches; 3B Scarps and steep slopes in sand; 4 Coarse-grained sand beaches; 5 Mixed sand and gravel beaches; 6A Gravel beaches (granules and pebbles); 6B Riprap structures and gravel beaches (cobbles and boulders). CAMRIS marc, calcareous clay, gravel, sand silt, mud pelagic clay and volcanic grit; 10D Mangroves <1,000 ha per shoreline cell; 9A Sheltered tidal flats with between 1,000 ha and 3,000 ha per shoreline cell.	2	2	
ESI 1 and 2: 1A Exposed rocky shore; 1B Exposed, solid man-made structures; 1C Exposed rocky cliffs with boulder talus base; 2A Exposed wave-cut platforms in bedrock, mud or clay; 2B Exposed scarps and steep slopes in clay; and 9A Sheltered tidal flats with <1,000 ha per shoreline cell.	1	1	

**Data List**

- DoT OSRA ESI dataset (April 2011)
- DPaW Marine Habitat dataset (May 2015)



### 3.2.7 Coral, Seagrass, Algae and Filter Feeding Communities

#### Description

Corals are significant benthic primary producers that play a key role in the ecosystem of many reef environs and have an iconic status in the environment. Corals are invertebrates, typically forming colonies of individual polyps. They contain photosynthetic unicellular algae called zooxanthellae and are therefore reliant on sunlight for their survival. Corals can be grouped into the following categories:

- Scleractinian corals (hard corals) – reef building corals;
- Non-scleractinian corals (sometimes referred to as calcified soft corals) – generally not considered to be reef building; and
- Soft corals belonging to the order *Alcyonacea* – non-reef building.

Seagrasses are important primary producers in tropical inshore waters as they provide energy and nutrients for detrital grazing food webs. They are also directly grazed by protected animals such as dugongs and green turtles, and provide refuge areas for fishes and invertebrates (DEC 2007).

Algae are important primary producers and support diverse and abundant fauna of small invertebrates that are the principal food source for many inshore fish species.

Filter feeding communities include areas of sponges, and are a sub-group of suspension feeding animals which feed by straining suspended matter and food particles from water. This category was added as an additional important benthic community in the Midwest zone Steering Committee Workshop on the 16 November 2016 and adopted for the Swan zone.

Coral, seagrass, algae and filter feeding community distribution has been determined from the OSRA ESI data layer, the DPaW Marine Habitat dataset, and the CAMRIS Seagrass dataset. Rottnest Island data was obtained from the RIA Coastal Habitats dataset, and the Cockburn Sound distribution was assessed using the CSMC dataset.

It is noted that seagrass and algae fall under the definition of 'fish' in the *Fish Resources Management Act 1994*, however all mapped seagrass and algae have been included in this section rather than in Section 3.2.8.

#### Distribution

Coral reefs are predominantly found around Rottnest Island (Shoreline Cell 337), with few other significant areas of coral reefs recorded elsewhere in the Swan zone. Seagrass distribution is abundant across the northern portion of the zone, with significant seagrass meadows mapped across Shoreline Cells 198 to 204 and 337 (Rottnest Island).

Algae including macroalgae have been extensively mapped across Shoreline Cells 198 to 202, with smaller areas found in Shoreline Cells 203 and 204 and small patches off the eastern end of Rottnest Island (Shoreline Cell 337). Filter feeding community distribution has not been extensively mapped, with limited geospatial data available. The available data shows no significant filter feeding communities in the Swan zone.





## Discussion

Corals are sensitive to dissolved hydrocarbons because they are affected by toxicity at a cellular level. Unless the coral reef is routinely exposed during tides, a greater impact is noticed from dissolved oil compared to floating oil. The negative effects of an oil spill in coral include:

- Increased algal growth;
- Slower growth rates;
- Lower fecundity;
- Localised tissue rupture;
- Premature explosion of larvae; and
- Excessive mucous production (Hayes *et al.*, 1992).

Corals which have a greater sensitivity to oil spills include those which are fringing reefs and intertidal reef flats, where direct contact with floating oil is likely and in shallow waters 1-5 m deep (Hayes *et al.*, 1992).

How an oil spill affects coral depends on the species and maturity of the coral (e.g. early stages of life are very sensitive to oil) as well as the means and level of exposure to oil. Exposing coral to small amounts of oil for an extended period, can be just as harmful as large amounts of oil for a brief time. These considerations have resulted in coral being given the highest protection priority ranking in Table 3-13.

Seagrasses in intertidal areas are at greater risk of impact from oil and are an important food source for associated fauna. Taylor and Rasheed (2011) found that seagrass meadows are not significantly affected by an oil spill when compared to the non-impacted, reference seagrass meadow. For this reason, seagrass has been ranked lower than coral, but still ranked Medium as it provides important habitat for threatened turtles, fish and invertebrates.

Algae typically colonises an area in response to mortality of coral because of an oil spill. The impacts of dissolved oil are greater than floating oil in the cellular level poisoning of algae growth, but the impacts on algae are secondary as the algae support fauna species and provide food sources for fish. The literature appears to support the observation that the direct impacts on algae from oil are limited and they recover readily following an oil spill event (Lobban and Harrison, 1994). For these reasons, algae has been given a ranking below that of coral and seagrass.

Filter feeding communities play important roles in purifying water, creating habitat and controlling shoreline erosion. These communities are often wide spread and diverse, with impacts from a spill including degradation, impaired reproduction and growth development.

Due to the low distribution of coral in the Swan zone, Shoreline Cell 337 has been ranked Medium for protection from floating oil and High for protection from dissolved oil.

Seagrass is quite abundant and results in Shoreline Cells 198, 199 and 201 to 204 being ranked Low for protection from floating oil and Medium for protection from dissolved oil. Algae and filter feeding communities found in the same cells are given lower rankings and therefore the highest rankings prevail.

**Table 3-13: Coral, Seagrass and Algae protection priority ranking**

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Coral, Seagrass and Kelp			
Coral	3	4	<b>Importance:</b> Corals are particularly sensitive to dissolved hydrocarbons.
Seagrass	2	3	<b>Importance:</b> Seagrasses are grazed by protected animals and provide refuge areas for fish and invertebrates.
Algae and filter feeding communities	1	2	<b>Importance:</b> Algae and filter feeding communities including sponges are important primary producers and support diverse and abundant fauna of small invertebrates that are the principal food source for many inshore fish species.

**Data List**

- Coral Reef data in the OSRA ESI data layer (April 2011)
- DPaW Marine Habitat dataset (May 2015)
- CAMRIS Coastal Seafloor Distribution (23 January 2008)

### 3.2.8 Fish Habitat Protection Areas and Closed Waters

#### Description

The WA DoF is responsible for managing commercial fisheries off the coast of WA in state and commonwealth waters (under the Offshore Constitutional Agreement). Fish and their habitats in a particular area can also be given special protection and management by including them in a Fish Habitat Protection Area. These areas are set aside under section 115 of the *Fish Resources Management Act 1994* for the following purposes:

- The conservation and protection of fish, fish breeding areas, fish fossils or the aquatic ecosystem;
- The culture and propagation of fish and experimental purposes related to that culture and propagation; and/or
- The management of fish and activities relating to the appreciation or observation of fish.

The distribution information has been determined from the CAPAD fish habitat protection areas data and the DoF habitat protection areas.

In addition, areas can be closed under section 43 of the *Fish Resource Management Act 1994*. This prohibition can include closed waters (Marine Reserves), gear restrictions, species restrictions and designated fishing zones.



## Distribution

There is one fish habitat protection area (FHPA) that falls in the Swan zone. This is Cottesloe Reef FHPA in Shoreline Cell 203.

There are nine areas closed to fishing under section 43 of the *Fish Resources Management Act 1994* which fall in the Swan zone. These are:

1. Marmion Marine Park which straddles Shoreline Cells 201 and 202;
2. Shoalwater Islands Marine Park which is predominantly in Shoreline Cell 204 but also has a small portion in Shoreline Cell 203;
3. Burswood Lake adjacent to the Swan River in Shoreline Cell 203;
4. Cockburn Sound and Warnbro Sound in Shoreline Cell 203;
5. Heirisson Island in Shoreline Cell 203;
6. Lake Clifton which is a large coastal lake system in Shoreline Cell 205;
7. Rottnest Island in Shoreline Cell 337;
8. Saxon Ranger Wreck Site in Shoreline Cell 204; and
9. Peel-Harvey Estuary blue swimmer crab closure 1 September to 31 October each year, in Shoreline Cell 205.

## Discussion

FHPAs protect the continuing sustainability of a particular species, or multiple species. Fish in a key habitat exposed to dissolved aromatic hydrocarbons are at risk of toxic effects. Fish are less likely to become physically oiled by floating oil. Areas closed under section 43 of this Act are protected for environmental conservation, and all areas have a prohibition of fishing equivalent to a sanctuary and are therefore given a higher ranking for protection. These rankings are presented in Table 3-14.

Based on these rankings, Shoreline Cells 201 to 205 and 337 have been ranked High for protection from both floating oil and dissolved oil, because various areas closed to fishing are in each of these shoreline cells.

Shoreline Cell 202 has been ranked Medium for protection from floating oil and dissolved oil due to the presence of the Cottesloe Reef FHPA.



Table 3-14: Fish Habitat Protection Areas protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Fish Habitat Protection Areas			
Areas closed under section 43 of the <i>Fish Resource Management Act 1994</i>	4	4	<b>Importance:</b> Areas closed under section 43 of this Act prohibit fishing. (This prohibition can include closed waters (Marine Reserves), gear restrictions, species restrictions and designated fishing zones.
Fish habitat protection areas	3	3	<b>Importance:</b> Fish habitat protection areas protect the continuing sustainability of a particular species, or multiple species. Fish in a key habitat exposed to dissolved aromatic hydrocarbons are at risk of toxic effects. Fish are less likely to become physically oiled by floating oil.

**Data List**

- CAPAD Fish Habitat Protection areas (June 2014)
- DoF FRMA (1994) Prohibition on Commercial Fishing areas (November 2016)

### 3.2.9 Aquaculture and Pearling Areas

#### Description

Aquaculture is defined as the cultivation of marine and freshwater organisms for human use or consumption. Aquaculture in Western Australia includes abalone, barramundi, black bream, coral, live rock, marine finfish, marron, mussels and oysters, pearls, prawns, redclaw crayfish, silver perch, trout and yabbies (Aquaculture Council of WA, 2016). Protection areas for aquaculture would include livestock collection locations, for example wild spat collection for cultivating pearls.

Aquaculture areas identified for protection either legally or informally were sought from the WA DoF.

Note that the economic assessment of aquaculture licence areas is included in the Economic section (Section 3.4).

#### Distribution

There are no legally protected aquaculture or pearling areas in WA waters. No informal aquaculture protection areas have been identified in the Swan zone.

#### Discussion

Aquaculture wild stocks would be for abalone, coral, live rock, mussels, and wild spat for pearls. These are sessile, so would be impacted more by dissolved oil than by floating oil because they are filter feeders.



All other wild aquaculture stocks for fish, prawns, crayfish, trout and yabbies could be resourced from a number of areas and even from other aquaculture farms. The rankings for future inclusion of areas are presented in Table 3-15.

No shoreline cell have been ranked as no protection areas for aquaculture were identified in the Swan zone.

**Table 3-15: Aquaculture and Pearling Areas protection priority ranking**

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Aquaculture and Pearling Areas			
Wild stocks for aquaculture	2	3	<b>Importance:</b> Aquaculture wild stock would be impacted more by dissolved oil than by floating oil because aquaculture these wild stocks are sessile filter feeders.

**Data List**

- None identified.

### 3.3 Cultural Heritage

Defining cultural heritage for inclusion in this heading for this project has been challenging. This is due to our evolving understanding of what heritage is. This definition continues to expand as people come to realise that cultural and natural heritage are closely integrated. Heritage is still regarded as consisting of 'special places', but there is an emerging recognition by Indigenous and non-Indigenous Australians of intangible heritage and cultural landscapes, and of the importance of heritage as a part of people's locality and identity (Beeton *et al.*, 2006).

From a cultural heritage perspective, there is currently strong interest in recognising intangible heritage, gaining a better understanding of how Indigenous people value land and landscape, and involving communities in identifying strong and special associations with place (Beeton *et al.*, 2006). For this assessment, the current cultural heritage listing of places has been used, as identified by Australian legislation.

There are different levels of heritage listing in Australia – world, national, state/territory and local. At the highest level are places on the World Heritage List which are protected for their contribution to the global natural or cultural heritage or both. For example, Uluru-Kata Tjuta National Park is protected for both its natural and cultural heritage contribution. On a local heritage list there might be a local nature reserve protected for local Indigenous cultural purposes or the local Post Office (AHC, 2009).

There are many heritage lists in Australia. Some are kept by the different levels of government while other lists are maintained by community or professional organisations. The main government list for WA is outlined in Table 3-16 (taken from AHC, 2009).

**Table 3-16: Australian heritage lists by level of administration**

Level of Administration	Heritage List
UNESCO	World Heritage – the list is maintained by the World Heritage Centre of the United Nations Educational, Scientific and Cultural Organisation (UNESCO), based in Paris
Commonwealth	National Heritage Commonwealth Heritage <i>[Register of the National Estate (which was phased out in 2012 and is now an historic list)]</i> Historic Shipwrecks Register
State and Territory	WA – Register of Heritage Places Generally – some states and territories also maintain a separate Indigenous site register WA state protected shipwrecks
Local	WA – Municipal Inventory

In addition to meeting different levels of criteria for protection (a collection of principles, characteristics and categories used to help decide if a place has heritage value), there is also a question of the threshold for heritage listing. The threshold is the level of heritage value that a place must demonstrate to be included on a heritage list. The heritage lists at each level use different thresholds to decide what places to include. These levels have been used to determine their level of protection priority. Examples of the thresholds used at different levels are indicated in Table 3-17. These are discussed further in each section below.

**Table 3-17: Threshold levels for heritage lists in Australia**

Level of Administration	Heritage List	Threshold
UNESCO	World Heritage	Outstanding universal value
Commonwealth	National Heritage Commonwealth Heritage	Outstanding heritage value to the nation Significant heritage value
State and Territory	State and Territory Heritage	Importance or significance in the state or territory
Local	Local Heritage	Importance or significance to the local community

### 3.3.1 Commonwealth Protected Heritage

#### Description

Commonwealth protected heritage is that which has outstanding heritage value to the nation of Australia. There are three types of properties which are Commonwealth protected in Australia:

1. World Heritage Areas (Cultural);
2. National Heritage Areas; and
3. Commonwealth Heritage Places.



The datasets used to determine the distribution of Commonwealth protected heritage properties included the DotE's World Heritage List, National Heritage List and Commonwealth Heritage List which are publicly accessible.

It is noted that heritage places can be on multiple lists. Values of places on the Commonwealth Heritage List might be protected under more than one provision of the EPBC Act. For example, a Commonwealth Heritage Place might also be on the National Heritage List or the World Heritage List.

In this context, the cultural aspect means the Indigenous cultural aspect, the non-Indigenous cultural aspect, or both.

## **Distribution**

In the Swan zone there are no World Heritage areas that fall in the shoreline cells, however there is one adjacent to Shoreline Cell 203. This is the Australian Convict Sites, which became Australia's 18<sup>th</sup> World Heritage Listed place on 31 July 2010. It was designated for cultural heritage values. However as it is only next to the zone and not in any of the shoreline cells, it has not been included in this assessment.

There are no National Heritage listed places.

There is one Commonwealth listed site in the Swan zone: Garden Island, which is located in Shoreline Cell 203. This place is listed for its natural heritage.

## **Discussion**

### **World Heritage Areas**

In 2005, Australia had 14 World Heritage areas. These are places or areas that UNESCO has agreed are worthy of special protection because they represent the best examples of the world's cultural and natural heritage.

Due to two categories for protection – cultural heritage; and natural heritage – only World Heritage areas listed for their cultural heritage values have been included in the assessment under this section. Areas listed on the UNESCO World Heritage List for their natural heritage only and joint natural and cultural heritage have been included in the Protection Areas priority ranking (refer to Section 3.2.1). The rankings for World Heritage areas are presented in Table 3-18.

There are no World Heritage areas in the Swan zone. One is located near the coast, being the Australian Convict Sites in Fremantle Prison, however, it is not in a shoreline cell, and would not be impacted in an oil spill so has not been included in this assessment.

### **National Heritage Places**

Data on National Heritage List properties has been sourced from the DotE. This data provides location and attribute information for places nominated to and included in the National Heritage List, as determined by the Australian Government and managed by the DotE Wildlife Division. As described in Table 3-17, National Heritage listed properties are protected for their outstanding





heritage value to the nation, so they require a high level of protection, only one level below World Heritage areas.

The National Heritage List of properties includes the place name, class (Indigenous, natural, historic) and status. Places subject to confidentiality agreements are included in this data but the location is generalised to the bounding 250k map sheet. Note that all confidentiality agreements are inland and do not affect the outcome of this project. The location data for nominated places that have been rejected, are ineligible, removed or destroyed, are not included in this assessment.

There are no National Heritage List properties found in the Swan zone, therefore no shoreline cells have been given a protection priority ranking from Table 3-18.

### **Commonwealth Heritage Places**

The Commonwealth Heritage List includes natural, Indigenous and historic heritage places owned or controlled by the Australian Government and protected under the EPBC Act. Places with Commonwealth Heritage values are protected under section 26 of the EPBC Act ("Protection of environment from actions involving Commonwealth land") which protects against "significant impact on the environment in...Commonwealth land", which specifies that "the heritage values of a place are part of the environment". These include places connected to defence, communications, customs and other government activities that also reflect Australia's development as a nation. As described in Table 3-17, Commonwealth Heritage Places are protected for their significant heritage value to the nation and are therefore considered to be of a Medium priority ranking, behind National Heritage places and World Heritage areas (Table 3-18).

The data for places currently nominated or being assessed for Commonwealth Heritage listing are not included in the list, so they have been excluded from this assessment as they are not yet protected under the EPBC Act. Places subject to confidentiality agreements are not included in this data.

Heritage areas which are comprised of artefacts relating to the rock or ground surface are ranked higher for protection from floating oil compared to dissolved oil, however those sites which are associated with the natural environment are ranked equally high for protection from the impacts of floating oil and dissolved oil.

There is one Commonwealth Heritage place in the Swan zone: Garden Island. This is found in Shoreline Cell 203, so this cell has been ranked Medium for protection from both floating oil and dissolved oil due to being listed for its natural cultural heritage, in line with Table 3-18.



Table 3-18: Commonwealth Protected Heritage Properties protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
World Heritage Properties (Cultural Heritage)			
All World Heritage areas	5	5	<b>Importance:</b> As a site selected for its outstanding universal value, all World Heritage areas have been given the highest priority for protection from both floating and dissolved oil.
National Heritage Places			
Indigenous and historic heritage places	4	3	<b>Importance:</b> As a site selected for its outstanding cultural value to the nation, these National Heritage Areas have been given a high priority for protection from floating oil as these sites are nationally important and could be impacted physically by floating oil. A slightly reduced priority ranking for protection from dissolved oil has been given, as these sites are less likely to be affected by dissolved oil.
Natural heritage places	4	4	<b>Importance:</b> As a site selected for its outstanding natural heritage value to the nation, these National Heritage Areas have been given a high priority for protection from both floating and dissolved oil, as these sites are nationally important and could be impacted physically by either floating or dissolved oil.
Commonwealth Heritage Places			
Indigenous and historic heritage places	3	2	<b>Importance:</b> As a site selected for its significant cultural heritage value, these Commonwealth Heritage Areas have been given a medium priority protection for floating oil as these sites are nationally significant and could be impacted physically by floating oil. A slightly reduced ranking for protection priority for dissolved oil has been given as these sites are less likely to be affected by dissolved oil.
Natural heritage places	3	3	<b>Importance:</b> Due to the importance as a site selected for its significant natural heritage value, these Commonwealth Heritage Areas have been given a medium priority protection for floating and dissolved oil as these sites are nationally significant and could be impacted physically by either floating or dissolved oil.

**Data List**

- DotE National, Commonwealth and Natural Heritage (Public) (January 2016)
- DotE World Heritage Areas (October 2016)

### 3.3.2 State Protected Heritage

#### Description

Places are listed for protection at a state level under the *Heritage of Western Australia Act 1990*. There are a number of different types of listings under the Act. Those included in this assessment are intended to include the places on the State Register, Conservation Order and Heritage Agreement lists. The different types of WA State Statutory Listings are provided in Table 3-19.

**Table 3-19: Western Australia state statutory listings and other listings**

Type	Organisation	Legislation	What is Listed	No. of Places in WA
State Statutory Listings				
State Register	Heritage Council (assisted by the State Heritage Office)	<i>Heritage of Western Australia Act 1990</i>	Places of state significance included in the State Register of Heritage Places	1,400
Conservation Order	Heritage Council (assisted by the State Heritage Office)	<i>Heritage of Western Australia Act 1990</i>	Places of state significance or potential State significance (special cases)	5
Heritage Agreement	Heritage Council (assisted by the State Heritage Office)	<i>Heritage of Western Australia Act 1990</i>	Places protected by long-term agreement between the parties	100
Town Planning Scheme ('Heritage List')	Local Governments	<i>Planning and Development Act 2005</i> ; Local Planning Schemes	Places of local heritage significance	9,000
Other Listings				
Local Government Inventory (Municipal Inventory)	Local Governments	Mandated under the <i>Heritage of Western Australia Act 1990</i> but controlled by Local Governments	Places of local significance	20,000
List of Classified Places	The National Trust of Australia (WA)	<i>The National Trust of Australia (WA) Act (1964)</i>	Places of local, state or national significance	2,300

Town Planning Scheme 'Heritage Listed' places, Municipal Inventory places and those on the List of Classified Places have been excluded, as there are too many (>30,000 in total).

Places listed on the State Register, Conservation Order list and Heritage Agreement list along with their geospatial datasets were sourced from [data.wa.gov.au](http://data.wa.gov.au) provided by the State Heritage Office.

The DAA's Aboriginal Heritage listed places dataset was also identified for inclusion in this section. However, as described in Section 2.5, this was deliberately excluded from the first zone assessed



(Pilbara zone) due to the DAA list being largely incomplete, as it only identifies areas that have been registered through Native Title Determinations. The dataset was agreed to be removed to avoid a false impression that this sensitivity is covered. This precedent has been carried forward to the Swan zone.

In the absence of state-specific protection priority data for each shoreline cell, DoT would need to consult with the DAA independently in the event of an oil spill. This precedent is being carried through to the remainder of the zones being assessed.

## **Distribution**

There are 21 State Registered sites in the Swan zone. Five of these are on Rottnest Island (Shoreline Cell 337): the Bathurst Lighthouse and Quarters; Kingstown Barracks; Oliver Hill Battery; Rottnest Island Light Station; and Thomson Bay Settlement. Twelve (12) are in Shoreline Cell 203 along the coast of the city and Swan/Canning Rivers: Cottesloe Beach Precinct; Round House and Arthur Head Reserve; Narrows Bridge; South Fremantle Power Station; Cottesloe Beach Pylon; Old Swan Brewery Precinct; South Beach Horse Exercise Area; former Quarantine Station at Woodman Point; Fremantle Traffic Bridge and Ferry Capstan Base; Freshwater Bay Boatsheds at Peppermint Grove; Victoria Quay; and Heathcote Hospital.

The remaining four are found in Shoreline Cell 205 along the Peel-Harvey Estuary. These are the former Cooper's Mill, former Peninsula Hotel, Boatsheds and Stingray Point, Hall's Cottage, and Sutton's Farm and Graveyard.

There are also two Conservation Order listed sites. These are the site of Long Jetty in Fremantle (Shoreline Cell 203) and the Cockburn Sound Anti-Submarine Boom Remnant in Cockburn Sound (also in Shoreline Cell 203).

There are no Heritage Agreement sites in the Swan zone.

## **Discussion**

The majority of State protected heritage are buildings or man-made historical places protected for their value to state history. However, there are some natural sites, so the terrestrial and marine sites have been ranked equally high for protection from the impacts of floating oil and dissolved oil. The rankings for protection priority for these sites are presented in Table 3-20.

Based on these rankings, Shoreline Cells 203, 205 and 337 have been ranked Medium for protection from both floating oil and dissolved oil due to State protected heritage places in these cells.



**Table 3-20: State Properties protection priority ranking**

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
State Heritage Places			
State protected heritage places, Heritage Agreement, Conservation Order	3	3	<b>Importance:</b> As a site selected for its significant natural heritage value, these State Heritage Areas have been given a Medium priority ranking for protection from floating oil and dissolved oil, as these sites are significant to the state and could be impacted physically by either floating or dissolved oil.

**Data List**

- DotE National Heritage (Public) (22 January 2016)
- State Heritage Office State Register dataset (October 2016)
- Conservation Orders dataset (October 2016)
- Heritage Agreement dataset (October 2016)

### 3.3.3 Shipwrecks and Maritime Archaeology

#### Description

The *Commonwealth Historic Shipwrecks Act 1976* protects all shipwrecks that are more than 75 years old. The Australian National Shipwrecks Database records all known Maritime Cultural Heritage (shipwrecks, aircraft, relics and other underwater cultural heritage) in Australian waters. Historic shipwrecks (>75 years) are protected under the *Historic Shipwrecks Act 1976*. Other wrecks that are not yet historic are protected under the *Navigation Act 2012*. This data has been sourced from the DotE and was last updated 3 February 2016. All shipwrecks have been recorded in this dataset, so this assessment only used ships wrecked prior to 1941.

The *State Maritime Archaeology Act 1973* protects pre-1900 maritime archaeological sites on state lands and in state waters, such as protected bays, harbours and rivers. Maritime archaeological sites include shipwrecks, early maritime infrastructure, land sites associated with exploration, maritime industries (such as whaling and pearling camps) and shipwreck survivor camps.

The WA Museum is responsible for administering both Acts in WA, so these datasets were sourced from them.

#### Distribution

There are over 120 Commonwealth protected shipwrecks and marine archaeology sites along the Swan coastline. Most are also protected under State legislation. A large number of these wrecks (71) are found along the Swan River and coastline immediately south of Fremantle, all in Shoreline Cell 203. A further 14 are found around Rottnest Island in Shoreline Cell 337. Fourteen (14) are also found in Shoreline Cell 204, including the *Saxon Ranger*, a trawler that has prohibitions on fishing under section 43 of the *Fish Resource Management Act 1994* (see Section 3.2.8). Other shipwrecks date back to 1830, such as the *Thames* sailing vessel from England and the *James* sailing vessel from the USA.

Nine maritime listed archaeological sites are found in Shoreline Cell 198, and a further nine in Shoreline Cell 199. Other shoreline cells with Commonwealth and State protected maritime sites are Shoreline Cells 200, 201, 202 and 206.

## Discussion

All shipwrecks, aircraft, relics and other underwater cultural heritage provide national heritage history, however it is not anticipated that floating oil or dissolved oil will destroy the wrecks. A shipwreck protected under Commonwealth Maritime Cultural Heritage means it has been ranked higher than under State protection mechanisms, which is reflected in the rankings given in Table 3-21. Given the below rankings and distribution of maritime archaeology in the Swan zone, all shoreline cells except Shoreline Cell 205 are ranked Medium for protection from both floating oil and dissolved oil.

No Commonwealth or State protected shipwrecks are located in Shoreline Cell 205.

**Table 3-21: Shipwrecks protection priority ranking**

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Nationally Protected Shipwrecks			
Commonwealth maritime cultural heritage	3	3	<b>Importance:</b> All shipwrecks, aircraft, relics and other underwater cultural heritage provide national heritage history, but it is not anticipated that floating or dissolved oil will destroy the wrecks, so they have been ranked as Medium priority for protection from both dissolved oil and floating oil.
State Protected Shipwrecks			
WA protected shipwrecks and maritime archaeology	2	2	<b>Importance:</b> These shipwrecks provide state heritage history but it is not anticipated that floating or dissolved oil will destroy the wrecks or maritime archaeology, so they have been ranked as Low priority for protection from both dissolved oil and floating oil.

### Data List

- DotE Australian National Shipwrecks Database (3 February 2016)
- WA Museum State Protected Shipwrecks (June 2016)

## 3.4 Economic

Western Australia sources a great deal of wealth from its coastal assets. For example, WA's shipping exports were worth an estimated \$127 billion in 2015/16. This was a 38 per cent contribution to the nation's exports, with more than half of Australia's total trade tonnage handled by WA ports (DoT, 2016). Aquaculture and fisheries also bring in significant profits to the state and are considered for protection in this assessment.

The following information has been assessed for economic factors in each zone:

- Aquaculture;



- State Managed Fisheries;
- Commonwealth Managed Fisheries;
- Other Commercial Operations;
- Tourism;
- Ports and Shipping; and
- Water Intake Locations.

To standardise the comparison, a ranking system was devised using the economic value per year, in relation to Western Australia's gross state product (GSP). The GSP was \$249 billion in 2014-15, contributing 15% of Australia's gross domestic product (GDP) (DSD, 2015). The economic estimates presented here have not allowed for any changes in pricing, and have been used as an indication at the time of this assessment. This is summarised in Table 3-22 which presents the assumed priority ranking based on economic value per year.

**Table 3-22: Economic determination used to priority rank economic values**

Economic Annual Value	Ranking	Description
> \$1B (>0.5% of State GDP) Or \$501M-\$1B (0.25-0.5% of State GDP) and recovery of species is >11 years	5	State managed commercial fisheries, Commonwealth managed commercial fisheries, ports and shipping, marine aquaculture and tourism.  State Managed Fisheries are reported per region. Therefore the economic value for the fishery for that region is what has been used.
\$501M-\$1B (0.25-0.5% of State GDP) and recovery of species is <10 years Or \$101M-\$500M (0.05-0.25% of State GDP) and recovery of species is >11 years	4	
\$101M-\$500M (0.05-0.25% of State GDP) and recovery of species is <10 years Or \$21M-\$100M (0.01-0.05% State GDP) and recovery of species is >11 years	3	
\$21M-\$100M (0.01-0.05% State GDP) and recovery of species is <10 years Or <\$20M (<0.01% State GDP) and recovery of species is >11 years	2	
<\$20M (<0.01% State GDP) and recovery of species is <10 years	1	

### 3.4.1 Aquaculture

#### Description

Aquaculture is defined as the cultivation of marine and freshwater organisms for human use or consumption. Aquaculture in Western Australia includes abalone, barramundi, black bream, coral, live rock, marine finfish, marron, mussels and oysters, pearls, prawns, redclaw crayfish, silver perch, trout and yabbies (Aquaculture Council of WA, 2016).





Aquaculture in WA is managed through the licencing of permits through the Department of Fisheries (DoF), so licence areas and geospatial locations were obtained from them. Within the Swan zone there are six aquaculture licenced areas. It should be noted that, for confidentiality reasons, the type of aquaculture being undertaken in each of these six licence areas could not be provided. Therefore ranking and assessment has been undertaken for aquaculture in general. This is described more in the Discussion section (Section 8).

## Distribution

Western Australia is broken down into bioregions in which aquaculture licences are managed. There are six managed bioregions that cover WA. The Swan zone is in the West Coast Bioregion which extends from Black Point to the Zuytdorp Cliffs, north of Kalbarri.

Within the Swan zone there are six aquaculture licenced areas. Four are in Shoreline Cell 203, with three in Cockburn Sound and one in Fremantle. A further two aquaculture sites are in Warnbro Sound in Shoreline Cell 204. These include both existing and proposed locations.

## Discussion

The economic impact of disruption to aquaculture depends on the marine stock being cultured, with different stock having different recovery rates. Depending on the type of aquaculture, the effects of an oil spill will also vary. For pearl oysters, it is acknowledged that an oil spill is unlikely to affect all licence areas at once. If an oil spill affects an oyster fishery, it is likely that the year's catch will be impacted and the fishery will take three to four years to recover (DoF, 2013e). However for finfish, it may take six to ten years following an oil spill for hatching to mature and reach a size appropriate for market. As the type of aquaculture being cultured in each licence area was unable to be provided, the most widely known cultivated species in the bioregion has been used. In the case of the Swan zone, this is finfish (DoF, 2016a). The rankings are based on the value of the aquaculture in the bioregion, and the duration of recovery, as outlined in Table 3-22 above.

The value of the aquaculture in the West Coast Bioregion is \$17 million (DoF, 2016a). Therefore for this assessment, all aquaculture licence areas have been given a single protection priority ranking (Table 3-23). In an oil spill, dissolved oil is expected to have the highest impact, however the total impact will depend on their age and maturity.

As aquaculture licences are located in Shoreline Cells 203 and 204, these cells are given a ranking of Low for protection from floating oil and Medium for protection from dissolved oil.

**Table 3-23: Aquaculture protection priority ranking**

Value Measure	Ranking		Description
	Floating	Dissolved	
Aquaculture			
> \$1B (>0.5% of State GDP) Or \$501M-\$1B (0.25-0.5% of State GDP) and recovery of species is >11 years	4	5	Aquaculture income is reported by the WA DoF per bioregion per year.  This has been coupled with the time it will take for the most widely cultivated species in the bioregion to recover. This recovery time is typically taken as the number of years to reach maturity and reproduce, which allows for the cultured species to reach the market.
\$501M-\$1B (0.25-0.5% of State GDP) and recovery of species is <10 years Or \$101M-\$500M (0.05-0.25% of State GDP) and recovery of species is >11 years	3	4	
\$101M-\$500M (0.05-0.25% of State GDP) and recovery of species is <10 years Or \$21M-\$100M (0.01-0.05% State GDP) and recovery of species is >11 years	2	3	
\$21M-\$100M (0.01-0.05% State GDP) and recovery of species is <10 years Or <\$20M (<0.01% State GDP) and recovery of species is >11 years	1	2	
<\$20M (<0.01% State GDP) and recovery of species is <10 years	1	1	

**Data List**

- DoF Aquaculture Licence areas (March 2015)

### 3.4.2 State Managed Commercial Fisheries

#### Description

WA State managed commercial fisheries occur in all WA state waters, and contributed \$1.5 billion to WA's Gross State Product from commercial and recreational fishing sectors in 2014-15 (DoF, 2015e). \$490 million was the value of the State's commercial fisheries, which includes aquaculture production. A total of 2,191 commercial fishing licences were issued in 2014-15 (DoF, 2015e).

State managed commercial fisheries are administered by the WA Department of Fisheries (DoF), so individual shapefiles for each fishery were sourced from them for this assessment.

The following State managed commercial fisheries are in the Swan zone:

- Abalone Managed Fishery;
- Cockburn Sound (Crab) Managed Fishery;
- Cockburn Sound (Fish Net) Limited Entry Fishery;
- Cockburn Sound (Line and Pot)
- West Coast (Beach Bait Fish Net) Limited Entry Fishery;
- West Coast Deep Sea Crustacean Managed Fishery;
- West Coast Demersal Gillnet and Demersal Longline Interim Fishery;



- Limited Entry Fishery;
- Mackerel Managed Fishery;
- Marine Aquarium Fish Fishery;
- Octopus Managed Fishery;
- South West Coast Salmon Fishery;
- Specimen Shell Managed Fishery;
- Warnbro Sound (Crab) Limited Entry Fishery;
- West Coast Demersal Scalefish Fishery;
- West Coast Estuarine Fishery;
- West Coast Purse Seine Limited Entry Fishery;
- West Coast Purse Seine Net Development Zone; and
- West Coast Rock Lobster Fishery.

The commercial information for each State managed commercial fishery includes data around its annual value in millions of dollars (AU), unless three or less licences have been issued. In this case, the value is not publically available. This information is available from the DoF, contained in the Status of Fisheries Annual Reports.

## Distribution

The catch target species and location for each fishery is outlined in Table 3-24.

The West Coast Rock Lobster Fishery targets the western rock lobster, on the west coast of WA between Shark Bay and Cape Leeuwin, using baited traps (pots) (DoF, 2015c). The West Coast Rock Lobster Fishery is an important sector of the WA economy, with the commercial catch from the current reporting season valued ex-vessel at \$359M. Employment is now year round. During the year, four main processing establishments, located in the Perth metropolitan area (two), Geraldton (one) and Cervantes (one), service practically every location where fishing occurs (DoF, 2015c). The rock lobster matures at six to seven years old, so is expected to take 12-15 years to recover. The West Coast Rock Lobster Fishery is distributed across all of the shoreline cells in the Swan zone.

Abalone Managed Fishery income was \$1.2M in 2014. The fishery operates in shallow coastal waters along WA's western and southern coasts. Roe's abalone is found in commercial quantities from the South Australian border to Shark Bay, although it is not uniformly distributed throughout this range. Roe's abalone will take 10-20 years to fully recover to natural levels. It can translocate in some cases, e.g. in Kalbarri after the 2011 heatwave that killed 99.9% of the population (Australian Seafood Cooperative Research, Council 2016). The Abalone Managed Fishery is distributed across all of the shoreline cells in the Swan zone.

The West Coast Estuarine Fishery operates in the Swan/Canning Rivers, Peel-Harvey Estuary and the Hardy Inlet. It is a multi-species fishery targeting blue swimmer crabs and numerous finfish species including southern garfish, whitebait and Australian herring. The blue swimmer crab component of the fishery is reported in the West Coast Blue Swimmer Crab Fishery status report. The methods used by commercial fishers to target finfish in West Coast Bioregion estuaries are gill nets and seine nets. The estimated value of \$1M-\$5M is for finfish only. As a proxy, over 95% of all herring are mature by the end of their 4th year (DoF, 2013). This gives an estimated four to ten years for stock to recover. Due to their limited catch range and shallow water habitats in estuarine environments, they are considered susceptible to a spill of dissolved oil, so they have been ranked Low for protection from dissolved oil due to their economic value. The West Coast Estuarine Fishery is found in Shoreline Cells 199, 203 and 205.



## Discussion

To determine the economic impact of an oil spill on a commercial fishery, fish stock recovery time was assessed to determine the overall impact of an oil spill on the fish stock, and the net loss the fishery would encounter as a result.

The recovery time of fish and crustacean fishing stocks depends on the lifecycle of the catch, as well as the form of impacting oil. A fishery will not be affected greatly by floating oil, but will be affected by dissolved oil. Some stock will take two years or more to recover, such as lobsters which take four years to reach maturity, in which case it will have an economic loss of more than one year depending on the species.

Annual value has been indicated below, with recovery of fisheries also considered and ranked in reference to Table 3-22.

The West Coast Rock Lobster Managed Fishery overlaps all shoreline cells in the Swan zone. Therefore all shoreline cells have been ranked Medium for protection from floating oil and High for protection from dissolved oil, using the rankings in Table 3-24. In Shoreline Cell 198, this is the highest ranked aspect under the Economic category.

The West Coast Estuarine Fishery has been ranked Low for protection from dissolved oil and Very Low for protection from floating oil due to the economic value of the fishery. This is found in Shoreline Cells 199, 203 and 205.

The Abalone Managed Fishery has been ranked Low for protection from dissolved oil and Very Low for protection from floating oil due to the economic value of the fishery. This is found in all the shoreline cells of the Swan Zone.



**Table 3-24: State Managed Commercial Fisheries protection priority ranking**

Value Measure	Ranking		Description
	Floating	Dissolved	
State Managed Fisheries			
>\$1B (>0.5% of State GDP) Or \$501M-\$1B (0.25-0.5% of State GDP) and recovery of species is >11 years And three shoreline cells or less	4	5	State Managed Fisheries income is reported by the WA DoF per region per year.  This has been coupled with the time for a species to recover, typically taken as number of years to reach maturity and reproduce, which allows sustainable commercial fishing to recommence.  If the catch area (i.e. the area that catch is actually taken from in the license area) described in the Status of Fisheries report is greater than ten shoreline cells (the size of the smallest zone), then the ranking is lowered by one level.
\$501M-\$1B (0.25-0.5% of State GDP) and recovery of species is <10 years Or \$101M-\$500M (0.05-0.25% of State GDP) and recovery of species is >11 years And more than three shoreline cells	3	4	
\$101M-\$500M (0.05-0.25% of State GDP) and recovery of species is <10 years Or \$21M-\$100M (0.01-0.05% State GDP) and recovery of species is >11 years	2	3	
\$21M-\$100M (0.01-0.05% State GDP) and recovery of species is <10 years Or <\$20M (<0.01% State GDP) and recovery of species is >11 years And more than three shoreline cells	1	2	
<\$20M (<0.01% State GDP) and recovery of species is <10 years And more than three shoreline cells	1	1	

**Data List**

- Abalone Managed Fishery (8 March 2016)
- Cockburn Sound Crab Managed Fishery (4 February 2016)
- Cockburn Sound (Fish Net) Limited Entry Fishery (4 February 2016)
- Cockburn Sound (Line and Pot) Limited Entry Fishery (4 February 2016)
- South West Coast Salmon Fishery (3 November 2015)
- Mackerel Managed Fishery (20 April 2015)
- Marine Aquarium Fish Fishery (30 June 2016)
- Octopus Interim Managed Fishery (6 October 2016)
- Specimen Shell Managed Fishery (11 September 2015)
- Warnbro Sound (Crab) Limited Entry Fishery (3 January 2013)
- West Coast (Beach Bait Fish Net) Limited Entry Fishery (9 September 2015)
- West Coast Deep Sea Crustacean Managed Fishery (8 November 2012)
- West Coast Demersal Gillnet and Demersal Longline Interim Fishery (24 March 2015)
- West Coast Demersal Scalefish Fishery (2 June 2015)
- West Coast Rock Lobster Fishery (3 January 2013)
- West Coast Estuarine Fishery (7 November 2016)
- South-West Coast Salmon Fishery (25 October 2015)



Value Measure	Ranking		Description
	Floating	Dissolved	
<ul style="list-style-type: none"><li>West Coast Nearshore Net Fishery (7 March 2013)</li><li>Purse Seine Net Development Zone (4 September 2012)</li><li>West Coast Purse Seine Limited Entry Fishery (1 July 2015)</li><li>DoF Annual Fisheries Report (2014-15)</li></ul>			

### 3.4.3 Commonwealth Managed Fisheries

#### Description

Commonwealth fisheries contributed approximately \$400 million in gross value of product to Australia in 2015-16 (AFMA, 2016). The fisheries are typically in commonwealth waters (from the state waters boundary to the Exclusive Economic Zone, 200 nautical miles from land) and administered by the federal Australian Fishing Management Authority (AFMA).

The permit area for each fishery is often a very large portion of Australia's Exclusive Economic Zone, so the area of concentrated effort for each fishery has been obtained from AFMA for the years of 2000 to 2015. This data allows a smaller area of economic importance for the fishery to be identified, rather than the entire permit area.

There are three Commonwealth managed fisheries which overlap the Swan zone. These are:

1. Western Tuna and Billfish Fishery;
2. Western Skipjack Tuna Fishery; and
3. Southern Bluefin Tuna Fishery.

#### Distribution

The Western Tuna and Billfish Fishery covers the sea area west from the tip of Cape York in Queensland, around Western Australia, to the border between Victoria and South Australia. Fishing occurs in both the Australian Fishing Zone and adjacent high seas (AFMA, 2016). Annual revenue is not known but there was a very low volume of catch in 2014-15 (299 t) (AFMA, 2016). This fishery harvests striped marlin, swordfish, albacore, bigeye tuna and yellowfin tuna. The concentrated areas of fishing effort include the Swan zone, with fishing for tuna and billfish occurring in all shoreline cells of the Swan zone.

The Skipjack Tuna Fishery covers the entire sea area around Australia, out to 200 nm from the coast. It is split into two sectors: the Eastern Skipjack Tuna Fishery and the Western Skipjack Tuna Fishery. There has been no fishing effort in either of the skipjack tuna fisheries since the 2008-09 fishing season due to the variability in the availability of stock and the prices received for the product. There are 14 Western Skipjack Fishery permits, however no Australian boats are currently fishing for skipjack (AFMA, 2016). While this fishery is not currently active, the total annual value varied in previous years from \$0 to \$8.1M. Therefore no shoreline cells in the Swan zone contain areas of fishing for skipjack tuna.

The Southern Bluefin Tuna Fishery covers the entire sea area around Australia, out to 200 nm from the coast. The catch is reported for the entire fishery area including areas outside of the zone. The fishery had a total value of \$36.8M in 2014-15, spread over the entire coastline of Australia. Given the large extent, the area has been ranked Low for protection from both floating and dissolved oil. They are most commonly caught off the New South Wales coastline, and no areas of concentrated fishing effort overlap with any shoreline cells in the Swan zone.

## Discussion

The Concentrated Fishing Effort data has provided more meaningful information when setting protection priority rankings. The data has shown no significant efforts of catches occur for these fisheries in the Swan zone. Even for the Western Tuna and Billfish Fishery, which does overlap the Swan zone, all shoreline cells combined contribute less than 1% of the total area fished for this fishery. Therefore, using the rankings from Table 3-25, all shoreline cells in the Swan zone have been ranked Very Low for protection from both floating and dissolved oil due to the presence of Commonwealth managed fisheries.

**Table 3-25: Commonwealth Managed Fisheries protection priority ranking**

Value Measure	Ranking		Description
	Floating	Dissolved	
Commonwealth Managed Fisheries			
>\$1B (>0.5% of State GDP) Or \$501M-\$1B (0.25-0.5% of State GDP) and recovery of species is >11 years	4	5	Commonwealth Managed Fisheries income is reported by the Australian Fisheries Management Authority (AFMA) annually.  This has been coupled with the time for a species to recover, typically taken as number of years to reach maturity and reproduce, which allows sustainable commercial fishing to recommence.  Effort of fishing has also been provided by AFMA on a 10 km by 10 km grid for each fishery.
\$501M-\$1B (0.25-0.5% of State GDP) and recovery of species is <10 years Or \$101M-\$500M (0.05-0.25% of State GDP) and recovery of species is >11 years	3	4	
\$101M-\$500M (0.05-0.25% of State GDP) and recovery of species is <10 years Or \$21M-\$100M (0.01-0.05% State GDP) and recovery of species is >11 years	2	3	
\$21M-\$100M (0.01-0.05% State GDP) and recovery of species is <10 years Or <\$20M (<0.01% State GDP) and recovery of species is >11 years	1	2	
<\$20M (<0.01% State GDP) and recovery of species is <10 years	1	1	

### Data List

- Fishing effort for Western Tuna and Billfish Fishery (March 2016)
- Fishing effort for Western Skipjack Tuna Fishery (March 2016)
- Fishing effort for Southern Bluefin Tuna Fishery (March 2016)
- Commonwealth Managed Fisheries concentrated areas of fishing effort and fishery status report (AFMA, 2016)





### 3.4.4 Ports and Shipping

#### Description

Ports are used to import and export goods, and generate substantial economic income for WA. WA's exports accounted for more than 876 million tonnes in 2015-16; a total of 41 per cent of Australia's merchandise exports that year (DoT, 2016). Exports to China alone were worth \$54.1 billion.

Western Australia's trading ports are managed by either port authorities governed by the *Port Authorities Act 1999* or non-port authorities ports governed by the *Shipping and Pilotage Act 1967* and the *Marine Harbours Act 1981*. The boundaries for each port were sourced from the WA DoT.

Shipping channels have not been included in this assessment. They are primarily in open-ocean, so are not captured in the shoreline cells. In addition, vessels can generally manoeuvre around a spill, so their impact is difficult to quantify. However, where a shipping channel enters a port, this has been included in the assessment.

#### Distribution

There is one major industrial port in the Swan zone, being the Port of Fremantle, which is the State's biggest general cargo port and Australia's fourth largest container port. The port is located in Shoreline Cells 202 and 203, and has a small section that overlaps with the northern extent of Shoreline Cell 337. This port has two components:

1. The Inner Harbour: At Fremantle, this port handles almost all of the container trade for Western Australia. It also provides facilities for livestock exports, motor vehicle imports, other general cargo trades, cruise ships and visiting naval vessels.
2. The Outer Harbour: At Kwinana, about 22 km to the south, one of Australia's major bulk cargo ports handles grain, petroleum, liquid petroleum gas, alumina, mineral sands, fertilisers, coal, sulphur, iron ore and other bulk commodities.

#### Discussion

Ports are used for importing and exporting goods. The impact of an oil spill on ports relates to the safety requirement to reduce or cease operating to allow spill recovery activities to occur. This results in a direct net loss to the operators in a port. The same rankings have been given for protection from both floating oil and dissolved oil, as either would shut down the port operations.

Fremantle Ports is a Western Australian Government trading enterprise that strategically manages the Port of Fremantle. The port is a mix of facilities and services managed by Fremantle Ports and private operators. Fremantle Ports provides and maintains shipping channels, navigation aids, cargo wharves at common user areas and leased terminals, the Fremantle Passenger Terminal, road and rail transport infrastructure in the port area, moles and seawalls, and other port infrastructure such as storage sheds, water, power and public amenities.

Services such as towage, pilotage (under contract to Fremantle Ports), line boats and bunkering are provided by the private sector. Fremantle Ports also cooperates with Commonwealth Government agencies responsible for customs, quarantine and maritime safety. Three of the jetties in the Outer



Harbour are operated by private companies, generally under Special Agreement Acts with the State. They are the Alcoa, BP and CBH jetties. The Kwinana Bulk Jetty and the Kwinana Bulk Terminal are operated by Fremantle Ports. There is a proposal to expand the Kwinana Outer Harbour once the Inner Harbour reaches capacity, although the timing of this is uncertain.

Economic values are not publically available for all ports in Western Australia. The annual reports are based on tonnes of export and import. As such, the annual reported total throughput for each port has been used as a basis of ranking. The ports in the Swan zone have been given protection priority rankings as presented in Table 3-26.

Based on these rankings, Shoreline Cells 202, 203 and 337 have been ranked Very High for protection from both floating oil and dissolved oil due to the distribution of the Port of Fremantle.

**Table 3-26: Ports protection priority ranking**

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Ports			
>401 million tonnes annually	5	5	<b>Importance:</b> Significant import and export for the state, resulting in an estimated very high economic value equivalent to >\$1B annually, in line with Table 3-22.
101-400 million tonnes annually	4	4	<b>Importance:</b> Major import and export for the state, resulting in an estimated high economic value equivalent to \$501M-\$1B annually, in line with Table 3-22.
11-100 million tonnes annually	3	3	<b>Importance:</b> Medium import and export for the state, resulting in an estimated moderate economic value equivalent to \$101M-\$500M annually, in line with Table 3-22.
1.1-10 million tonnes annually	2	2	<b>Importance:</b> Minor import and export for the state, resulting in an estimated low economic value equivalent to \$101M-\$500M annually, in line with Table 3-22.
<1 million tonnes annually	1	1	<b>Importance:</b> Very minor import and export for the state, resulting in an estimated very low economic value equivalent to <\$20M annually in line with Table 3-22.

**Data List**

- DoT Annual Report – WA Ports (2014)
- Department of Planning and Infrastructure Port Authorities (October 2010)



### 3.4.5 Water Intake Locations

#### Description

In some industries, seawater is sucked from the ocean for various processes. These include potable water created via reverse osmosis, cooling water for large machinery, and fresh seawater for aquaculture. Oil sucked into an intake can damage the operating facility and, depending on the facility, this damage could be significant. The DoT has created a dataset of known locations of prescribed premises that intake ocean water. The dataset includes locations of known major outfalls and proposed major industrial developments that may require seawater intakes.

This dataset has been supplemented with DoF aquaculture and research facility seawater intake locations.

In this assessment, only intake locations were deemed to be potentially affected by an oil spill, so outfalls have not been included in this assessment.

#### Distribution

There are 11 intake locations in the Swan zone: one for a desalination plant; one for an oil refinery; one for a power station; and seven for aquaculture research centres.

One aquaculture research centre is based in Fremantle in Shoreline Cell 203, with the oil refinery, power station and desalination plant located in Cockburn Sound, also in the same shoreline cell.

The other six aquaculture intakes are located either in Watermans Marine Reserve or in Hillary's Boat Harbour, both of these facilities being in Shoreline Cell 202.

There are no seawater intakes for salt works in the Swan zone.

#### Discussion

Water intakes will generally stop operating to limit the impact the oil spill will have on their facility. The impact will vary depending on the type of facility and its sensitivity to contamination, as well as the location of the intake in the water column. This would be particularly relevant with respect to a reverse osmosis plant creating potable drinking water. The proposed protection priority rankings for water intakes are presented in Table 3-27.

Based on these rankings, Shoreline Cell 203 has been ranked High for protection from floating oil and Very High for protection from dissolved oil, due to the presence of a major reverse osmosis plant.

Shoreline Cell 202 has been ranked Low for protection from both floating oil and dissolved oil due to the presence of aquaculture research centres in the cell.



**Table 3-27: Seawater Intake Locations protection priority ranking**

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Water Intake Locations			
Reverse osmosis potable water plant seawater intakes	4	5	<b>Importance:</b> The seawater intake points in WA are positioned at the mid water depth and normally offshore, to reduce the potential for an oil slick to be drawn in. These intakes can be shut down and rely on dams to supply product for short periods, however, they are very vulnerable to oil destroying the membranes. It is estimated that it would cost \$20M-\$100M to replace all membranes in a reverse osmosis plant, and cost the State many more millions of dollars to source drinking water while it is being replacd.
Cooling water intakes for power stations	3	3	<b>Importance:</b> Cooling water intakes are far less sensitive and can keep running during light oiling. Where they are at the surface, a boom around the intake would be enough to keep them running; where they are below the surface, it is assumed that the dissolved or entrained oil would be at a low enough concentration that they can keep running.
Salt works seawater intakes	2	2	<b>Importance:</b> If an oil spill occurred, salt water intake would cease and production would stall until the potential for contamination had passed. A salt works facility has detectors on the intakes to screen for any contamination, to allow pumping into the evaporation ponds to cease and not contaminate the salt being produced.
Aquaculture seawater intakes	2	2	<b>Importance:</b> Onshore aquaculture facilities would lose their stock. This is expected to have a 'low' economic impact as the onshore aquaculture facilities are small.
Seawater intakes for LNG facilities	2	2	<b>Importance:</b> These are proposed intakes only and not operational, so have been ranked lower than operational cooling water intakes. LNG facilities use seawater for cooling. Cooling water intakes are less sensitive and can keep running during light oiling. Where they are at the surface, a boom around the intake would be enough to keep them running; where they are below the surface, it is assumed that the dissolved or entrained oil would be at a low enough concentration that they can keep running.

**Data List**

- OSRA Seawater Intake Locations and Types (April 2011)
- DoF Aquaculture and Research Facility Intake and Outfall Locations (December 2016)



### 3.4.6 Other Commercial Operations

A number of other commercial operations occur in WA state waters and near the coast. This includes oil and gas operations, salt works, power stations and mining facilities. Subsea pipelines have not been included in this assessment as their operation is not expected to be affected by an oil spill.

Oil and gas facilities in state waters may experience economic loss through a safety requirement to shut facilities if an unrelated oil spill enters their operational zone. Offshore oil and gas facilities have not been included as they do not fall in the shoreline cells, however associated infrastructure aspects are included.

Other commercial operations such as salt works and power stations have been accounted for through their infrastructure associated with the marine environment, which are port facilities and seawater intakes. Refer to Section 3.4.4 and Section 3.4.5. Salt works are covered under seawater intakes, as are power stations and other facilities that use seawater either in a cooling process or for other purposes.

It was not feasible to capture proposed (future) oil and gas developments in this study because there was no way to determine the scale of the impact and thus determine a protection priority ranking.

### 3.4.7 Tourism

#### Description

Tourism is a key economic driver, generating more than 97,000 jobs and injecting \$10 billion into the Western Australian economy by Gross State Product (Tourism WA, 2016). Coastal and waters tourism is a significant portion of this income due to the majority of the towns, infrastructure and sites located along the coast. A distinction has been made in this assessment between activities that draw tourists to a site and generate economic income, and those activities undertaken by locals for recreational purposes. This section assesses activities that generate economic income via tourist activities in the Swan zone such as:

- Whale and dolphin watching;
- Scuba diving and snorkelling;
- Beach activities such as surfing;
- Sailing; and
- Hotel revenue.

Tourism Research Australia publishes data annually on the income from tourism (TRA, 2016). In August 2016, Tourism Research Australia released an update for 2014-15 on the Tourism Satellite Account (TSA).

A TSA is a set of statistical tables based on data from the Australian Bureau of Statistics, which measure the contribution of tourism to the Australian economy. The TSA reports the contribution of tourism to the economy in relation to total output, value added and employment. TSAs need to be developed because there is no tourism 'industry' identified in the current national accounting framework.

The TSA statistics are available per tourism region. One region covers the whole of the Swan zone: the Perth region. This shapefile was obtained from TRA (2016). For the Perth region, this extends from Gingin in the north to Busselton in the south, and includes the City of Perth, City of Swan, Rottnest Island, City of Rockingham, City of Fremantle and City of Mandurah.

## Distribution

The TSA statistics show that the demand from tourism from the Perth region was \$6.217 billion in 2015 (TRA, 2016). The total demand for the state from tourism was \$10.954 billion. Therefore the Perth region generated almost 60% of the State's tourism income in 2015.

As the income data provided by Tourism Research Australia is provided for the Perth region and includes the whole Swan zone, all shoreline cells in the Swan zone have been given a single ranking for their income from tourism.

## Discussion

To produce an opportunity cost for tourism to include in this assessment, the value of the tourism in millions of dollars per annum has been assigned to the shoreline cell where each of the major centres are located in the regions. Realistically, in an oil spill, the impact on tourism is expected to be locally restricted to the shoreline cell where the impact occurs. It is important to identify the shoreline cells which contribute to the economy via tourism and thus be aware that, when planning a response to an oil spill, secondary impacts to tourism may be the result.

The protection priority rankings are presented in Table 3-28. Based on these rankings, all shoreline cells in the Swan zone have been ranked Medium for protection from both floating oil and dissolved oil, as the Swan zone provides a large portion of the state's tourism.

**Table 3-28: Tourism protection priority ranking**

Tourism Area	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Tourism Region key population centre >10% of State income from tourism	3	3	Income from tourism as a proportion of the state-wide tourism revenue is greater than 10%, indicating a significant contribution by tourism in that shoreline cell.
Tourism Region key population centre 5-10% of State income from tourism	2	2	Income from tourism as a proportion of the state-wide tourism revenue is 5-10%, indicating a significant contribution by tourism in that shoreline cell.
Tourism Region key population centre <5% of State income from tourism	1	1	Income from tourism as a proportion of the state-wide tourism revenue is less than 5%, indicating a low contribution by tourism in that shoreline cell.

### Data List

- Tourism Research Australia (TRA) (2014)



## 3.5 Social, Amenity and Recreation

The social, amenity and recreational importance of an area has been assessed by considering:

- Town population;
- Recreational fishing/boating zones;
- Jetties, marinas and yacht clubs;
- Snorkelling sites; and
- Beaches.

The towns located in the Swan zone along with their population size are listed in Table 3-29.

**Table 3-29: Towns in the Swan zone and their approximate populations**

Town	Population	Town	Population
Lancelin	600	Perth	1,83 million
Ledge Point	200	Fremantle	7,600
Guilderton	141	Mandurah	80,000
Two Rocks	2,200	Rockingham	120,000
Yanchep	2,400	Secret Harbour	10,000
Jindalee	5,000	Preston Beach	200
Quinns Rocks	8,900		

### 3.5.1 Recreational Fishing/Boating Zones

#### Description

Fishing and boating are key recreational activities undertaken in WA. These activities are often associated with marine management areas and marine parks. The marine park data has been sourced from the DotE CAPAD Marine dataset and an updated DPaW CAPAD dataset. These two datasets include areas in the marine park category with designations including:

- Sanctuary Zones;
- Recreational Zones;
- Special Purpose Zones; and
- General Use Zones.

#### Distribution

In the Swan zone, there are three legislated marine parks that have these recreational designations. These are Marmion Marine Park, Swan Estuary Marine Park and Shoalwater Islands Marine Park. There are no marine conservation reserves, but there is one Commonwealth marine reserve: Two Rocks Commonwealth Marine Reserve.





Within the Swan zone, the Swan Estuary Marine Park areas are all contained in Shoreline Cell 203. Marmion Marine Park straddles two shoreline cells (Shoreline Cells 201 and 202) and so does Shoalwater Islands Marine Park (Shoreline Cells 203 and 204).

Since these zones are generally smaller subsets located in a marine park category which is used for the full range of recreational pursuits, the category level has been assigned a relatively low weighting.

## Discussion

The marine park and management areas are used for water-based recreational pursuits. The impact from an oil spill will be a tendency to avoid the area, with flow-on effects in local regional commercial benefit. Floating oil will visually detract from people pursuing fishing or water sports in these areas. Dissolved oil may impact on species and decrease the catch for an area. The significance of an oil spill is largely related to the amount of oil which comes ashore and is present in the fishing and recreational zones, and its impact on visual amenity.

The rankings for recreational fishing/boating zones are presented in Table 3-30. Based on these rankings, Shoreline Cells 201, 202, 203 and 204 have been ranked Low for protection from both floating oil and dissolved oil.

**Table 3-30: Recreational Fishing/Boating Zones protection priority ranking**

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Multi-Use Zones (for boating and fishing)			
Marine Management Areas	2	2	<b>Importance:</b> Floating oil will visually detract from people pursuing fishing in these areas. Dissolved oil may impact on species and decrease the fishing for an area.
Marine Parks	2	2	<b>Importance:</b> Floating oil will visually detract from people pursuing fishing in these areas. Dissolved oil may impact on species and decrease the fishing for an area.
Marine Nature Reserve	2	2	<b>Importance:</b> Floating oil will visually detract from people pursuing marine recreation in these areas. Dissolved oil may impact on species and decrease the fishing/species to observe, and the visual amenity of an area.

### Data List

- Multi-User Zones in Marine Management Areas or Marine Parks, CAPAD dataset (DotE) (June 2014)
- Marine Parks, CAPAD dataset (DotE) (June 2014)
- DPaW CAPAD (June 2016)



## 3.5.2 Beaches

### Description

WA has some of the most iconic beaches in Australia. From the unique Shell Beach at Monkey Mia in the north to the pure white sandy beaches near Esperance in the south, many people who live in WA choose to do so to be near the beach. Beaches are used for recreation, amenity and social events and may be significant to local residents as well as tourists. The dataset for patrolled beaches in WA was obtained from Surf Life Saving WA, who provided annual visitor statistics of their patrolled beaches.

Many of the Surf Life Saving WA patrolled beaches fall in the Swan zone, including the beach with the highest recorded attendance (Cottesloe beach). The beaches in the Swan zone include 19 ranked beaches. Of these, Cottesloe and City Beach saw more than a million visitors recorded in 2014-15, which are the two most visited beaches in the State and the only two beaches with more than one million visitors.

Beaches with more than one hundred thousand visitors are Fremantle, Scarborough, Sorrento and Mullaloo.

The protection priority of beaches associated with tourism has been captured indirectly in Section 3.4.7. The tourism detailed in this section is where the experience associated with a major centre includes beach-based activities (e.g. fishing from shore).

### Distribution

City Beach is located in Shoreline Cell 202 and Cottesloe Beach is located in Shoreline Cell 203.

Fremantle beach is in Shoreline Cell 203, Scarborough and Sorrento beaches are in Shoreline Cell 202, and Mullaloo beach is in Shoreline Cell 201.

The 13 other beaches have less than one hundred thousand visitors recorded for 2014-15, and are found in Shoreline Cells 200 to 205 and 337 (Rottnest Island).

### Discussion

Beaches in the context of social aspects are mainly used for recreation, and may be significant to local residents as well as tourists. The dataset regarding number of visitors for patrolled beaches was obtained from Surf Life Saving WA, which included several beaches in the Swan zone.

Priority has been ranked based on the number of people that visit the various beaches each year. These are presented in Table 3-31. Using these rankings, Shoreline Cells 202 and 203 have been ranked Medium for protection from floating oil and Low for protection from dissolved oil.

Shoreline Cell 201 has been ranked Low for protection from floating oil and Very Low for protection from dissolved oil. Shoreline Cells 200, 204, 205 and 337 have been ranked Very Low for protection from both floating oil and dissolved oil as they contain beaches with less than 100,000 visitors annually.



**Table 3-31: Beaches protection priority ranking**

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Beaches			
Beaches with >1 million visitors a year	3	2	
Beaches with >100,000 visitors a year	2	1	
Beaches with <100,000 visitors a year	1	1	

**Data List**

- Top Ten Beaches, Western Australia ([www.westernaustralia.com](http://www.westernaustralia.com), 2016)
- Surf Life Saving WA Patrolled Beaches (2016)
- DMP Coastal Landforms dataset (May 2016)



**Advisian**

WorleyParsons Group

**DOT307215 Provision of Western  
Australian Marine Oil Pollution Risk  
Assessment - Protection Priorities**  
Protection Priority Assessment for  
Zone 4: Swan - Final Report



Department of **Transport**

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## 4 Summary of Protection Priority Rankings

The following tables summarise the value indicators (e.g. threatened mammals, marine protection areas, commercial fishing areas, etc.) used for each of the five categories for floating hydrocarbons (Table 4-1) and dissolved hydrocarbons (Table 4-2). They illustrate the comparative protection priorities between the five categories for the shoreline cells.

**Table 4-1: Summary of value indicators and their protection priority for floating hydrocarbons**

	Very Low	Low	Medium	High	Very High
<b>Protected Fauna</b>	<ul style="list-style-type: none"> <li>CR species if extinct (birds, mammals, invertebrates, reptiles)</li> <li>Normal range for EN species (fish)</li> <li>Normal range for VU, Migratory or Marine species (mammals and fish)</li> <li>All areas Known for VU species (invertebrates)</li> <li>All other conservation codes (birds)</li> <li>Terrestrial species which do not use the marine or intertidal zone for any instance of their lifecycle, and do not use the marine or intertidal zone as any component of their habitat</li> </ul>	<ul style="list-style-type: none"> <li>Known/migration area for CR species which are Very Certain or Moderately Certain (birds, mammals)</li> <li>Normal range for EN species (birds, mammals and terrestrial invertebrates) which are Moderately Certain</li> <li>Normal range for VU, Migratory or Marine species (birds, furry marine mammals) which is Certain or Moderately Certain</li> <li>Southern right whale: all calving areas</li> <li>Breeding/aggregation area for VU, CD and P1-P4 Migratory OR marine species and normal range for CR species (fish) Certain</li> <li>Foraging and inter-nesting for VU species (Certain) and all Migratory and Marine species and all CD, P1-P4 species (invertebrates, reptiles) Certain and Moderately Certain</li> </ul>	<ul style="list-style-type: none"> <li>Likely/Moderately Certain habitat for CR species. Breeding areas for EN species (birds) if Moderately Certain</li> <li>Breeding/aggregation for VU species if sighting Very Certain (birds)</li> <li>Breeding/aggregation area for VU, normal range for CR species (mammals, furry marine mammals and terrestrial invertebrates) Certain and Moderately Certain</li> <li>Normal range for EN species (furry marine mammals)</li> <li>Breeding/aggregation area for CR species (fish) Moderately Certain and EN species Very Certain or Certain</li> <li>Foraging and inter-nesting for EN species and nesting/breeding area for VU species (reptiles) Certain or Very Certain</li> </ul>	<ul style="list-style-type: none"> <li>Known habitat for CR species breeding area/migration route for EN species (birds) and sighting is Certain</li> <li>Breeding/aggregation area for EN species (birds, mammals, furry marine mammals and terrestrial invertebrates) is caught/trapped or sighting Very Certain or Certain</li> <li>Normal range for CR species (furry marine mammals) and Certain or Very Certain</li> <li>Breeding/aggregation area for CR species (fish) and caught, trapped or sighted and Certain/Very Certain</li> <li>Foraging and inter-nesting for CR species and nesting/breeding area for EN species (reptiles) Certain or Moderately Certain</li> </ul>	<ul style="list-style-type: none"> <li>Breeding area for CR species (birds and terrestrial invertebrates) which are caught/trapped and sighting is Very Certain/WAM Vouchered/Certain</li> <li>Breeding/calving/congregation aggregation area for CR species (mammals and furry marine mammals) Certain and Very Certain</li> <li>Nesting/breeding area for CR species (reptiles) where sighting is Very Certain</li> </ul>
<b>Protection Areas</b>	<ul style="list-style-type: none"> <li>ESI 1 and 2: 1A Exposed rocky shore; 1B Exposed, solid man-made structures; 1C Exposed rocky cliffs with boulder talus base; 2A Exposed wave-cut platforms in bedrock, mud or clay; 2B Exposed scarps and steep slopes in clay; 9A Sheltered tidal flats with &lt;1,000 ha per shoreline cell</li> <li>All terrestrial and marine conservation areas and proposed conservation areas ranked IUCN VI: 5(1)(g) reserves; 5(1)(h) reserves; Miscellaneous Reserves which do not include the intertidal zone</li> <li>Shoreline types: Exposed rocky shore; Exposed, solid man-made structures; Exposed rocky cliffs with boulder talus base; Exposed wave-cut platforms in bedrock, mud or clay; Exposed scarps and steep slopes in clay</li> </ul>	<ul style="list-style-type: none"> <li>ESI 3, 4, 5 and 6: 3A Fine- to medium-grained sand beaches; 3B Scarps and steep slopes in sand; 4 Coarse-grained sand beaches; 5 Mixed sand and gravel beaches; 6A Gravel beaches (granules and pebbles); 6B Riprap structures and gravel beaches (cobbles and boulders)</li> <li>CAMRIS marc, calcareous clay, gravel, sand silt, mud pelagic clay and volcanic grit; 10D Mangroves &lt;1,000 ha per shoreline cell; 9A Sheltered tidal flats with between 1,000 ha and 3,000 ha per shoreline cell</li> <li>All terrestrial and marine conservation areas and proposed conservation areas ranked IUCN II, III, IV, V which do not include the intertidal zone</li> <li>All terrestrial and marine conservation areas and proposed conservation areas ranked IUCN VI: 5(1)(g) reserves; 5(1)(h) reserves; Miscellaneous Reserves which include the intertidal zone</li> <li>Seagrass</li> <li>Fish habitat protection areas</li> </ul>	<ul style="list-style-type: none"> <li>ESI 7, 8 and 9: 7 Exposed tidal flats; 8A Sheltered scarps in bedrock, mud or clay and sheltered rocky shore; 8B Sheltered, solid man-made structures; 8C Sheltered riprap; 8D Sheltered rocky rubble shores; 8E Peat shorelines; 9A Sheltered tidal flats &gt;3,000 ha per shoreline cell; 9B Vegetated low banks; 9C Hypersaline tidal flats; 10D Mangroves with between 1,000 and 3,000 ha per shoreline cell</li> <li>All terrestrial and marine conservation areas and proposed conservation areas IUCN IA, IB which do not include the intertidal zone</li> <li>All terrestrial and marine conservation areas and proposed conservation areas ranked IUCN II, III, IV, V which include the intertidal zone</li> <li>Coral</li> </ul>	<ul style="list-style-type: none"> <li>ESI 10: 10A Salt and brackish water marshes; 10B Freshwater marshes; 10C Swamps; 10D Mangroves with &gt;3,000 ha per shoreline cell</li> <li>All terrestrial and marine conservation areas and proposed conservation areas IUCN IA, IB which include the intertidal zone</li> <li>Nationally Important wetlands</li> <li>Areas closed under the <i>Fish Resource Management Act 1994</i></li> </ul>	<ul style="list-style-type: none"> <li>World Heritage areas</li> <li>Ramsar wetlands</li> <li>Shoreline types: Sheltered tidal flats; Vegetated low banks; Hypersaline tidal flats; Salt and brackish water marshes; Freshwater marshes; Swamps; Mangroves</li> </ul>

	Very Low	Low	Medium	High	Very High
<b>Cultural Heritage</b>		<ul style="list-style-type: none"> <li>State protected shipwrecks</li> </ul>	<ul style="list-style-type: none"> <li>National Indigenous and historic heritage places and Natural heritage places</li> <li>Commonwealth Maritime Cultural Heritage</li> </ul>	<ul style="list-style-type: none"> <li>Commonwealth National and Indigenous and historic heritage places and Natural heritage places</li> </ul>	<ul style="list-style-type: none"> <li>World Heritage areas</li> </ul>
<b>Economic</b>	<ul style="list-style-type: none"> <li>Ports throughput &lt;1 million tonnes annually</li> <li>&lt;\$20M (&lt;0.01% State GDP) and recovery of species is &lt;10 years</li> <li>Commonwealth managed fisheries</li> <li>Majority of State managed commercial fishing locations</li> <li>Tourism Region key population centre &lt;5% of State income from tourism</li> </ul>	<ul style="list-style-type: none"> <li>Ports throughput 1.1-10 million tonnes annually</li> <li>\$21M-\$100M (0.01-0.05% State GDP) and recovery of species is &lt;10 years OR &lt;\$20M (&lt;0.01% State GDP) and recovery of species is &gt;11 years</li> <li>Aquaculture licence areas</li> <li>Water intake locations for aquaculture seawater intakes</li> <li>Tourism Region key population centre 5-10% of State income from tourism</li> </ul>	<ul style="list-style-type: none"> <li>Ports throughput 11-100 million tonnes annually</li> <li>\$101M-\$500M (0.05-0.25% of State GDP) and recovery of species is &lt;10 years OR \$21M-\$100M (0.01-0.05% State GDP) and recovery of species is &gt;11 years</li> <li>Cooling water intakes for power stations</li> <li>Tourism Region key population centre &gt;10% of State income from tourism</li> </ul>	<ul style="list-style-type: none"> <li>Ports throughput 101-400 million tonnes annually</li> <li>\$501M-\$1B (0.25-0.5% of State GDP) and recovery of species is &lt;10 years OR \$101M-\$500M (0.05-0.25% of State GDP) and recovery of species is &gt;11 years</li> </ul>	<ul style="list-style-type: none"> <li>Reverse osmosis potable water plant seawater intakes</li> <li>Ports throughput &gt;401 million tonnes annually</li> <li>&gt;\$1B (&gt;0.5% of State GDP) OR \$501M-\$1B (0.25-0.5% of State GDP) and recovery of species is &gt;11 years</li> </ul>
<b>Social, Amenity and Recreation</b>	<ul style="list-style-type: none"> <li>Beaches with &lt;100,000 visitors a year</li> </ul>	<ul style="list-style-type: none"> <li>Marine Parks, Marine Management Areas &amp; Marine Nature Reserve</li> <li>Coastal Landforms' 'fine- to medium-grained sand beaches</li> <li>Beaches with &gt;100,000 visitors a year</li> </ul>	<ul style="list-style-type: none"> <li>Beaches with &gt;1 million visitors a year</li> </ul>		

**Table 4-2: Summary of value indicators and their protection priority for dissolved hydrocarbons**

	Very Low	Low	Medium	High	Very High
<b>Protected Fauna</b>	<ul style="list-style-type: none"> <li>Other Known areas for VU, CR, EN species (birds) if Moderately Certain</li> <li>CR species if extinct (birds, mammals, invertebrates, reptiles, fish)</li> <li>Normal range for EN species and Normal range for VU, Migratory or Marine species (mammals and fish)</li> <li>Normal range for VU (furry marine mammals)</li> <li>All areas for terrestrial invertebrates</li> <li>Foraging and inter-nesting for VU species and all Migratory and Marine species (reptiles)</li> <li>Terrestrial species which do not use the marine or intertidal zone for any instance of their lifecycle, and do not use the marine or intertidal zone as any component of their habitat</li> </ul>	<ul style="list-style-type: none"> <li>ESI 3, 4, 5 and 6: 3A Fine- to medium-grained sand beaches; 3B Scarps and steep slopes in sand; 4 Coarse-grained sand beaches; 5 Mixed sand and gravel beaches; 6A Gravel beaches (granules and pebbles); 6B Riprap structures and gravel beaches (cobbles and boulders)</li> <li>Known habitat for CR species Moderately Certain. Breeding area for VU, EN species Very Certain (birds)</li> <li>Normal range for CR species. Breeding area for VU species (mammals and fish) Certain or Moderately Certain</li> <li>Normal range for EN species. Breeding/aggregation areas for VU (furry marine mammals, fish) Certain or Moderately Certain</li> <li>Nesting/breeding area for VU species (reptiles, fish) Certain, Moderately Certain</li> </ul>	<ul style="list-style-type: none"> <li>Known habitat for CR species. Breeding areas for EN species (birds)</li> <li>Breeding/aggregation area for EN species (mammals, furry marine mammals and fish) Very Certain or Certain</li> <li>Known habitat for CR species migration or foraging Moderately Certain to occur (Fish)</li> <li>Normal range for CR species (furry marine mammals) Known or Very Certain</li> <li>Foraging and inter-nesting for CR species and nesting/breeding area for EN species (reptiles) Certain or Very Certain</li> </ul>	<ul style="list-style-type: none"> <li>Breeding and nesting area for CR species (birds, mammals, furry marine mammals and fish) which are Certain</li> <li>Breeding and Very Certain EN species (fish)</li> <li>Nesting/breeding area for CR species (reptiles) Certain or Very Certain</li> </ul>	<ul style="list-style-type: none"> <li>Known habitat for CR species breeding, congregation caught or Certain (fish)</li> </ul>
<b>Protection Areas</b>	<ul style="list-style-type: none"> <li>ESI 1 and 2: 1A Exposed rocky shore; 1B Exposed, solid man-made structures; 1C Exposed rocky cliffs with boulder talus base; 2A Exposed wave-cut platforms in bedrock, mud or clay; 2B Exposed scarps and steep slopes in clay; 9A Sheltered tidal flats with &lt;1,000 ha per shoreline cell</li> <li>All conservation areas and proposed conservation areas as defined under the <i>WA Conservation and Land Management Act 1984</i> ranked IUCN VI (Managed Resource Protected Area) and all other types: 5(1)(g) reserves; 5(1)(h) reserves; Indigenous Protected Areas; Miscellaneous Reserves</li> <li>Shoreline types: Exposed rocky shore; Exposed, solid man-made structures; Exposed rocky cliffs with boulder talus base; Exposed wave-cut platforms in bedrock, mud or clay; Exposed scarps and steep slopes in clay</li> </ul>	<ul style="list-style-type: none"> <li>All conservation areas and proposed conservation areas ranked IUCN II (National Park), III (National Monument), IV (Habitat/Species Management Area), V (Protected Landscape/Seascape)</li> <li>All conservation areas and proposed conservation areas as defined under the <i>WA Conservation and Land Management Act 1984</i> ranked IUCN VI (Managed Resource Protected Area) and all other types (existing and proposed): 5(1)(g) reserves; 5(1)(h) reserves; Indigenous Protected Areas; Miscellaneous Reserves</li> <li>Algae</li> </ul>	<ul style="list-style-type: none"> <li>ESI 7, 8 and 9: 7 Exposed tidal flats; 8A Sheltered scarps in bedrock, mud or clay and sheltered rocky shore; 8B Sheltered, solid man-made structures; 8C Sheltered riprap; 8D Sheltered rocky rubble shores; 8E Peat shorelines; 9A Sheltered tidal flats &gt;3,000 ha per shoreline cell; 9B Vegetated low banks; 9C Hypersaline tidal flats; 10D Mangroves with between 1,000 and 3,000 ha per shoreline cell</li> <li>All marine and terrestrial conservation areas and proposed conservation areas (conservation park, national park, nature reserve) ranked IUCN IA (Strict Nature Reserve) and IB (Wilderness Area) which include the intertidal zone</li> <li>All conservation areas and proposed conservation areas as defined under the <i>WA Conservation and Land Management Act 1984</i> ranked IUCN II (National Park), III (National Monument), IV (Habitat/Species Management Area) or V (Protected Landscape/Seascape)</li> <li>Fish habitat protection areas</li> <li>Seagrass</li> </ul>	<ul style="list-style-type: none"> <li>ESI 10: 10A Salt and brackish water marshes; 10B Freshwater marshes; 10C Swamps; 10D Mangroves with &gt;3,000 ha per shoreline cell</li> <li>All marine conservation areas and proposed conservation areas (marine nature reserve, marine park or marine management area) ranked IUCN IA (Strict Nature Reserve) and IB (Wilderness Area) which include the intertidal zone</li> <li>Nationally Important Wetlands</li> <li>Shoreline types: Sheltered scarps in bedrock, mud or clay and sheltered rocky shore; Sheltered, solid man-made structures; Sheltered riprap; Sheltered rocky rubble shores; Peat shorelines</li> <li>Coral</li> <li>Areas closed under the <i>Fish Resource Management Act 1994</i></li> </ul>	<ul style="list-style-type: none"> <li>World Heritage areas</li> <li>Ramsar wetlands</li> <li>Shoreline types: Sheltered tidal flats; Vegetated low banks; Hypersaline tidal flats; Salt and brackish water marshes; Freshwater marshes; Swamps; Mangroves</li> </ul>

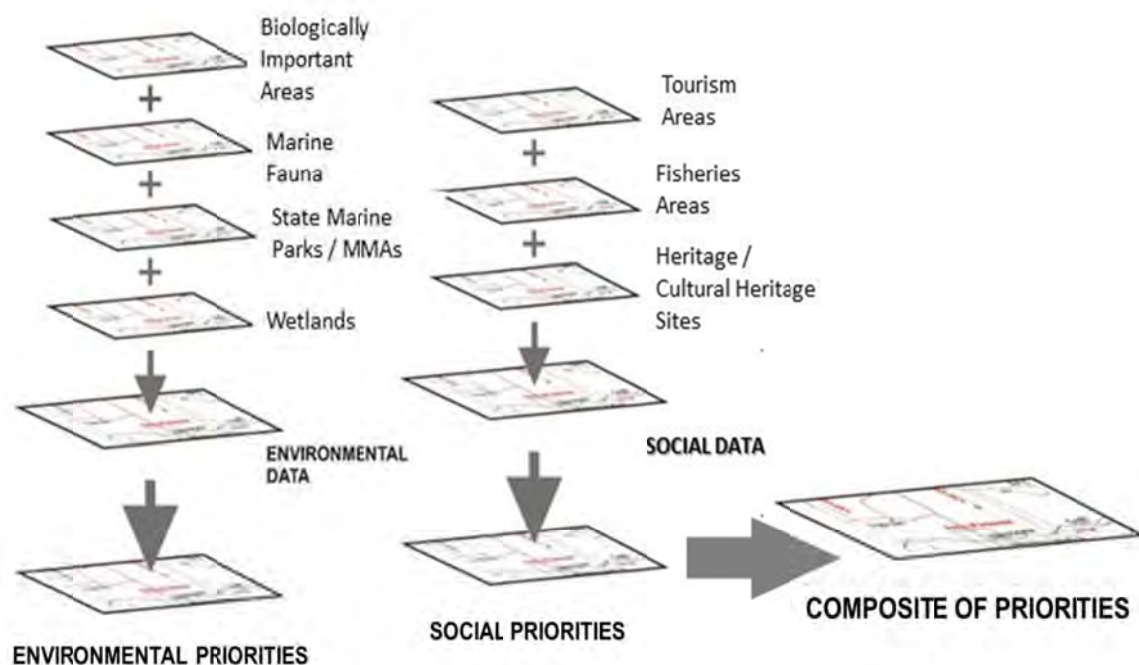


	Very Low	Low	Medium	High	Very High
<b>Cultural Heritage</b>		<ul style="list-style-type: none"> <li>State protected maritime archaeology</li> </ul>	<ul style="list-style-type: none"> <li>National Heritage properties, Indigenous and historic heritage places</li> <li>Commonwealth heritage places, Indigenous and historic heritage places</li> <li>Commonwealth Maritime Cultural Heritage</li> </ul>	<ul style="list-style-type: none"> <li>National Heritage Properties, natural heritage places</li> <li>Commonwealth heritage places, natural heritage</li> </ul>	<ul style="list-style-type: none"> <li>World Heritage areas</li> </ul>
<b>Economic</b>	<ul style="list-style-type: none"> <li>Ports throughput &lt;1 million tonnes annually</li> <li>&lt;\$20M (&lt;0.01% State GDP) and recovery of species is &lt;10 years</li> <li>Commonwealth managed fisheries</li> <li>Majority of State managed commercial fishing locations</li> <li>Many State and all Commonwealth managed fisheries locations</li> <li>Tourism Region key population centre &lt;5% of State income from tourism</li> </ul>	<ul style="list-style-type: none"> <li>Ports throughput 1.1-10 million tonnes annually</li> <li>\$21M-\$100M (0.01-0.05% State GDP) and recovery of species is &lt;10 years OR &lt;\$20M (&lt;0.01% State GDP) and recovery of species is &gt;11 years</li> <li>Aquaculture licence areas</li> <li>Water intake locations for aquaculture seawater intakes</li> <li>Tourism Region key population centre 5-10% of State income from tourism</li> </ul>	<ul style="list-style-type: none"> <li>Ports throughput 11-100 million tonnes annually</li> <li>\$101M-\$500M (0.05-0.25% of State GDP) and recovery of species is &lt;10 years OR \$21M-\$100M (0.01-0.05% State GDP) and recovery of species is &gt;11 years</li> <li>Cooling water intakes for power stations</li> <li>Tourism Region key population centre &gt;10% of State income from tourism</li> </ul>	<ul style="list-style-type: none"> <li>Ports throughput 101-400 million tonnes annually</li> <li>\$501M-\$1B (0.25-0.5% of State GDP) and recovery of species is &lt;10 years OR \$101M-\$500M (0.05-0.25% of State GDP) and recovery of species is &gt;11 years</li> <li>Reverse osmosis potable water plant seawater intakes</li> </ul>	<ul style="list-style-type: none"> <li>Ports throughput &gt;401 million tonnes annually</li> <li>&gt;\$1B (&gt;0.5% of State GDP) OR \$501M-\$1B (0.25-0.5% of State GDP) and recovery of species is &gt;11 years</li> </ul>
<b>Social, Amenity and Recreation</b>	<ul style="list-style-type: none"> <li>All town sites</li> <li>Beaches with up to 100,000 visitors a year</li> </ul>	<ul style="list-style-type: none"> <li>Recreational fishing/boating zones</li> <li>Marine Parks, Marine Management Areas and Marine Nature Reserve</li> <li>Beaches with &gt;1 million visitors a year</li> </ul>			

## 5 Analysis Method

### 5.1 Overview of Multi-Criteria Analysis

Using a multi-criteria analysis approach, the data layers identified for inclusion have been assigned a ranking from one (Very Low priority) to five (Very High priority) for protection from the effects of both floating and dissolved hydrocarbons, as outlined in Section 3. These rankings have then been used to produce a map showing Very Low (dark green) to Very High (red) priorities of the shoreline cells for each category, for protection from the impacts of both floating and dissolved hydrocarbons. Figure 5-1 illustrates the process. Each layer has been ranked, then combined to give an overall shoreline cell map showing the highest priority areas for protection.



**Figure 5-1: Example illustration of composite of ranked geospatial data**

The map has been derived from the ranking information developed when weighting the criteria; and confirmation of the weightings in the Steering Committee Workshop held on 17 November 2016. The weighted importance of all criteria has been ranked from Very Low to Very High and the shoreline cell layer has been overlain and "clipped" or "cookie cut" to each shoreline cell, with the information extracted from the overall weighted layer and put into an attribute table (see Section 5.2).

The reasons this method was selected for this project were:

- Known and standard method previously used with success;
- Produces a single output for each overall highest priority ranking of 'floating oil', 'dissolved oil' and 'overall';



- Produces data identifying the shoreline cells with the highest protection priority and the identity of the aspect which caused the highest ranking; and
- No scripting in the geoprocessing is required to achieve this output.

The geoprocessing which occurred to collate the multiple shapefile attributes and assign the weightings identified were as follows:

1. For each of the shapefiles in a sub-category (e.g. all the shapefiles comprising 'Protected Fauna'), the weighting has been assigned in a new column and appended to each of the shapefiles.
2. The data in each of the sub-categories has been clipped to the shoreline cells' outlines, and processed per category (i.e. Protected Fauna, Protection Areas, etc.).
3. All the sub-categories contained in Protected Fauna have been combined into a newly created single Protected Fauna category shapefile, which is the same shape as the shoreline cell, and assigned the weighting equal to the highest weighting.
4. The categories have all been treated this way until six new shapefiles were created in each shoreline cell representing Protected Fauna, Protection Areas, etc., all being categorised from Very Low to Very High.
5. This process has been repeated for floating and dissolved oil rankings for each category.
6. The overall ranking for each shoreline cell is the highest ranking value of any of the categories in each shoreline cell, identified for protection from 'floating oil' and 'dissolved oil'.

This has been used to create the map outputs as contained in Appendix A, as well as the attribute table containing the data pertaining to the highest ranked aspect from each category in each shoreline cell.

Three rankings for each category, for each cell, will be provided in the form of an attribute table to the Risk Consultant for inclusion in a WebMap Application. An extract from the first two shoreline cells in the attribute table is presented in Section 5.2.

## **5.2 Analysis Output: Attribute Table**

The attribute table will be provided in Microsoft Excel format with nine columns containing the following headings and information:

1. Shoreline Cell ID – Each shoreline cell has a unique identification number. This has been provided by Navigatus as an attribute in the 'WAMOPRA Coast Cells' shapefile dataset.
2. Category ID – There are six category rankings that will be provided for each shoreline cell. These are: Protected Fauna; Protection Areas; Cultural Heritage; Economic; Social, Amenity and Recreation; and Overall. These have been given a number from one to six.
3. Category Name – There are six categories: Protected Fauna; Protection Areas; Cultural Heritage; Economic; Social, Amenity and Recreation; and Overall.
4. Floating Ranking – This is the overall ranking from one to five of the single highest ranked protection priority at risk from being impacted by floating hydrocarbons in each shoreline cell. This ranking has been assessed and a ranking assigned for each category.



5. Dissolved Ranking – This is the overall ranking from one to five of the single highest ranked protection priority at risk from being impacted by dissolved hydrocarbons in each shoreline cell. This ranking has been assessed and a ranking assigned for each category.
6. Overall Ranking – This is the overall highest ranking for each category between the 'Floating Ranking' and the 'Dissolved Ranking'.
7. Brief Description Floating Oil – This is a brief description of the priority(ies) identified that have given the category its highest priority ranking for protection from floating hydrocarbons.
8. Brief Description Dissolved Oil – This is a brief description of the priority(ies) identified that have given the category its highest priority ranking for protection from dissolved hydrocarbons.
9. Data Source – This is the source of the data that has given the cell its ranking, either for floating or dissolved hydrocarbons.

An extract from the attribute table is provided in Table 5-1.

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**Table 5-1: Attribute table format (Extract, Shoreline Cell number 198)**

Shoreline Cell ID	Category ID	Category Name	Floating Ranking	Dissolved Ranking	Overall Ranking	Brief Description Floating Oil	Brief Description Dissolved Oil	Data Sources
198	1	Protected Fauna	3	2	3	Reptiles: EN loggerhead turtle ( <i>Caretta caretta</i> ) breeding Likely to occur in the area. EN leatherback turtle ( <i>Dermochelys coriacea</i> ) breeding likely to occur in the area. Mammals: EN southern right whale ( <i>Eubalaena australis</i> ) breeding known to occur in the area	Reptiles: <i>Caretta caretta</i> loggerhead turtle) (EN) Breeding likely to occur in the area, <i>Dermochelys coriacea</i> (leatherback turtle) (EN) Breeding likely to occur in the area. Mammals: <i>Eubalaena australis</i> (southern right whale) (EN) Breeding known to occur in the area, Fish: <i>Carcharias taurus</i> (grey nurse shark) (VU) Species habitat known to occur in the area, <i>Carcharodon carcharias</i> (white shark) (VU) known to occur in the area	DotE SNES (22 February 2017), DPaW Protected Fauna (2 March 2017), DotE BIA (26 April 2016)
198	2	Protection Areas	4	3	4	IUCN IA Nature Reserve (Lancelin and Edwards Islands)	IUCN IA Nature Reserve (Lancelin and Edwards Islands); Seagrass	DotE CAPAD – Terrestrial and Marine (30 June 2014) with DPaW update (30 June 2016), DPaW Marine Habitats dataset (May 2015)
198	3	Cultural Heritage	3	3	3	Cmlth Protected Shipwrecks and Maritime Archaeology (J.P. Webb, Juliann 2, Palermo, Perseverance, Stirling, Torrens, Venus, Vergulde Draak (Draeck) (Gilt Dragon), Yandranica)	Cmlth Protected Shipwrecks and Maritime Archaeology (J.P. Webb, Juliann 2, Palermo, Perseverance, Stirling, Torrens, Venus, Vergulde Draak (Draeck) (Gilt Dragon), Yandranica)	DotE Australian National Shipwrecks Database (3 February 2016)

Shoreline Cell ID	Category ID	Category Name	Floating Ranking	Dissolved Ranking	Overall Ranking	Brief Description Floating Oil	Brief Description Dissolved Oil	Data Sources
198	4	Economic	3	4	4	West Coast Rock Lobster Managed Fishery	West Coast Rock Lobster Managed Fishery	DoF State Managed Commercial Fisheries (7 April 2017)
198	5	Social, Amenity and Recreation	NA	NA	NA	NA	NA	NA
198	6	Overall	4	4	4	IUCN IA Nature Reserve (Lancelin and Edwards Islands); Seagrass	West Coast Rock Lobster Managed Fishery	DotE CAPAD - Terrestrial and Marine (30 June 2014) with DPaW update (30 June 2016), DPaW Marine Habitats dataset (May 2015), DoF State Managed Commercial Fisheries (7 April 2017)

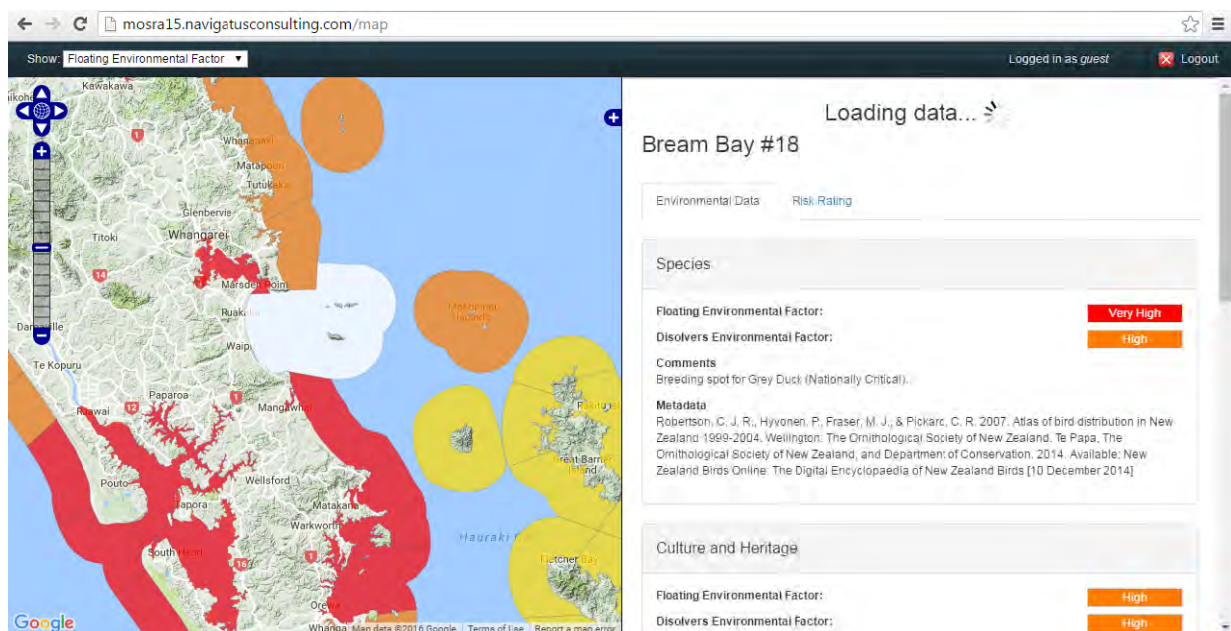


## 6 Oil Spill Risk Assessment

The attribute table containing the protection priorities information for each shoreline cell will be input into the Oil Spill Risk assessment by Navigatus for the Department of Transport. This step will occur once an Oil Spill Risk ranking has been produced for floating oil and dissolved oil for each shoreline cell. The combination of the 'likelihood' (the oil spill risk) and the 'consequence' (the protection priority) for each of the protection categories (Protected Fauna, Protection Areas, Cultural Heritage, etc.) will be displayed in a WebMap Application.

A sample of this WebMap output of the combined efforts of this project and that of the oil spill risk modelling, as presented on the New Zealand Marine Oil Spill Risk Assessment website accessed via <http://mosra15.navigatusconsulting.com/login>, is presented in Figure 6-1.

The data created by this project will be used to populate the entries against each of the shoreline cells under each category (Protected Fauna, Protection Areas, etc.), and the corresponding colour of the cell according to its ranking in each category, from Very High to Very Low.



**Figure 6-1: Marine Oil Spill Risk Assessment WebMap sample by Navigatus for New Zealand (accessed 31 July 2016)**

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## 7 Results

Shoreline cell maps which display the cumulative effect of all the protection priorities are included in Figure 7-1 to Figure 7-3. These maps summarise the protection priorities that have been identified as a result of this project.

Included in Appendix A are a series of maps that provide additional granularity which underpins the results of the assessment. The maps are presented for each category (i.e. Protected Fauna; Protection Areas; Cultural Heritage; Economic; and Social, Amenity and Recreation). Summary maps depict the shoreline cells in the Swan zone, ranked (and coloured) based on the highest ranking of any aspect present in that shoreline cell, irrespective of its spatial coverage in that shoreline cell. Two summary maps are included for each category, one each for floating oil and dissolved oil protection priority rankings.

When the protection priorities are reviewed for the cumulative rankings of floating oil, dissolved oil and overall oil impacts for each of the categories, the following is apparent:

- For protection from floating oil impacts, the cumulative rankings across all five categories resulted in six shoreline cells being ranked Very High priority (Figure 7-1). These are for the protection of Critically Endangered fauna (Shoreline Cells 203, 204, 205 and 337) as well as Ramsar wetlands (Shoreline Cells 204, 205 and 206), and an economically important port (Shoreline Cells 202 and 203).
- Three shoreline cells are ranked High priority for protection from floating oil (Figure 7-1) for the presence of Strict Nature Reserves (both marine and terrestrial) in Shoreline Cells 198 and 201, as well as environmentally vulnerable marsh, swamp and saltmarsh in Shoreline Cell 199.
- One shoreline cell is overall ranked Medium for protection from floating oil (Figure 7-1) for the likely presence of breeding locations for the Endangered loggerhead and leatherback turtle, breeding and calving for the Endangered southern right whale, vulnerable coastal environments such as the clay and sheltered rocky shore, State protected heritage, and economic tourism income (Shoreline Cell 200).
- For protection from dissolved oil impacts, the cumulative rankings across all five categories resulted in five shoreline cells being ranked Very High priority (Figure 7-2). These are for the presence of Ramsar wetlands (Shoreline Cells 204, 205 and 206), an economically important port (Shoreline Cells 202 and 203), and seawater intakes for a reverse osmosis seawater desalination plant (Shoreline Cell 203).
- The remaining five shoreline cells are ranked a High priority (Figure 7-2) for protection from dissolved oil due to the known presence of breeding Critically Endangered fauna (Shoreline Cell 337), the economically important West Coast Rock Lobster Managed Fishery (Shoreline Cells 198, 199, 200, 201 and 337), the presence of both marine and terrestrial Strict Nature Reserves (Shoreline Cell 201), as well as environmentally vulnerable marsh, swamp and saltmarsh (Shoreline Cell 199).



## Protected Fauna

The **Protected Fauna** category had the most comprehensive dataset coverage of all the categories. The datasets incorporated in this category included the DotE SNES and BIA polygons, and the discrete points in the DPaW fauna dataset.

Four of the Swan zone shoreline cells have been ranked Very High for protection from the impacts of floating oil on protected fauna (Appendix A: Figure A1). These cells (Shoreline Cells 203, 204, 205 and 337) contain known roosting sites for two Critically Endangered birds: the curlew sandpiper (*Calidris ferruginea*); and the eastern curlew (*Numenius madagascariensis*). The other six shoreline cells in the Swan zone have been ranked Medium for protection from floating oil, due to the likely presence of breeding areas for the Endangered leatherback turtle (*Dermochelys coriacea*) and Endangered loggerhead turtle (*Caretta caretta*), and a known breeding and calf resting area for the Endangered southern right whale (*Eubalaena australis*).

For protection from the impacts of dissolved oil on protected fauna, four shoreline cells have been ranked High priority (Shoreline Cells 203, 204, 205 and 337) and the remaining six have been ranked Low priority (Appendix A: Figure A2). These rankings are for the protection of the same fauna, but ranked lower due to the lesser expected impacts on these fauna because the oil is in a dissolved form. In addition, the six Low priority cells have also been given this ranking to protect two Vulnerable fish species from the effects of dissolved oil. These are the grey nurse shark (*Carcharias taurus*) and the great white shark (*Carcharodon carcharias*), which are both known to occur in the area.

Some threatened terrestrial fauna species have also been recorded in the Swan zone. These species were investigated and reported to be only terrestrial; they do not use or have habitat in the marine or intertidal zone. As a result, these species have been ranked Very Low for protection from both floating and dissolved oil to ensure the correct level of risk is being assigned for marine oil pollution. These species include terrestrial birds such as the Endangered Carnaby's black cockatoo (*Calyptorhynchus latirostris*) and Baudin's cockatoo (*Calyptorhynchus baudinii*); terrestrial mammals such as the Critically Endangered western ringtail possum (*Pseudocheirus occidentalis*) and woylie (*Bettongia penicillata*); terrestrial invertebrates (bees, spiders, a moth and a snail); and terrestrial reptiles such as the Vulnerable Lancelin Island skink (*Ctenotus Lancelini*), VU Rottnest Island bobtail (*Scincidae Tiliqua rugosa konowi*), VU Rottnest Island dugite (*Elapidae Pseudonaja affinis exilis*) and the P4 black striped snake (*Neelaps calonotos*).

Many other protected marine fauna species are found across the Swan zone, including aggregation areas for protected bird species, such as the EN northern royal albatross which is likely to have habitat across the zone.

## Protection Areas

There were 13 datasets used to identify **Protection Areas** across all zones in WA, including the Swan zone. The most comprehensive of these are the DotE compiled CAPAD datasets for marine and terrestrial areas, and the updated dataset by the WA DPaW. Other key datasets were for internationally and nationally important wetlands (Ramsar Wetlands and Nationally Important Wetlands datasets). These are Commonwealth provided datasets and identify key areas for protection in the event of an oil spill. The key dataset identified for future improvement was the OSRA ESI dataset. This is a state-wide dataset but it has a portion of areas 'unclassified' and others classified as 'island'. The DPaW Marine Habitats dataset was extremely useful as it is highly detailed



and well classified, however it is only for marine and coastal areas under DPaW management. Whilst this covers a significant portion of state waters, it was still recognised as a limited dataset.

These state-wide datasets have been supplemented by localised studies providing valuable benthic and coastal habitat information. For the Swan zone, these were obtained for Rottnest Island and Cockburn Sound.

Using the above datasets, three of ten shoreline cells have been ranked Very High priority for the protection of Protection Areas from floating oil, a further six have been ranked High priority, and one has been ranked Medium priority. For protection from dissolved oil, three have been ranked Very High priority, five have been ranked High priority, and two have been ranked Medium priority.

The Very High priority rankings for protection from both floating oil and dissolved oil are due to two Ramsar wetlands (Peel-Yalgorup System and the Becher Point Wetlands). The Peel-Yalgorup System spans Shoreline Cells 204, 205 and 206, while the Becher Point Wetlands is smaller and falls in Shoreline Cell 204.

The High priority rankings for protection from both floating oil and dissolved oil are due to the presence of Nationally Important Wetlands including the Swan-Canning Estuary in Shoreline Cell 203 and Rottnest Island Lakes in Shoreline Cell 337. Fish Habitat Protection Areas have also been given High priority and are found in Shoreline Cells 202 and 203 (Cottesloe Reef) and 337 (Rottnest Island). Strict Nature Reserves (both marine and terrestrial) fall in Shoreline Cell 198 (IUCN IA Nature Reserve (Lancelin and Edwards Islands)) and Shoreline Cells 201 and 202 (IUCN IA Marmion Marine Park), as well as environmentally vulnerable marsh, swamp and saltmarsh in Shoreline Cell 199. One shoreline cell has been ranked Medium priority for protection from floating oil due to the presence of environmentally vulnerable sheltered scarps in bedrock, mud or clay (Shoreline Cell 200). Two shoreline cells have been ranked Medium priority for protection from dissolved oil due to the presence of a multi-user section of the Two Rocks Commonwealth Marine Reserve, and the presence of environmentally vulnerable seagrass beds (Shoreline Cells 198 and 200).

## Cultural Heritage

The key state-wide datasets used in the **Cultural Heritage** category were the DotE provided World Heritage Areas dataset, National Heritage List dataset, Commonwealth Heritage Places and the Australian National Shipwrecks Database, and the State provided cultural heritage datasets for the same heritage. These are comprehensive and cover the Commonwealth and State protected cultural heritage values of WA.

The impact on Cultural Heritage including maritime shipwrecks is the same for dissolved oil and floating oil for all shoreline cells in the Swan zone. All shoreline cells have been ranked Medium for protection of Commonwealth protected shipwrecks (Appendix A: Figure A5 and Figure A6).

The number of shipwrecks in the other cells varies from cell to cell with the highest number (54) found in Shoreline Cell 203. Shoreline Cell 202 only contains one (the Centaur), and Shoreline Cell 201 contains two (the Burns Beach Rowing Boat and the Vergulde Draeck Inscription).

There are more than 120 Commonwealth and State protected historic shipwrecks found along the Swan coastline, and the presence of these has given most of the Swan zone a ranking of Medium priority in an oil spill event, indicating the rich history of the Swan area.



## Economic

The key datasets used to identify the key **Economic** priorities for protection were State Managed Fishery license areas and the Ports and Shipping datasets and, for the Swan zone in particular, the seawater intake locations. These datasets are comprehensive and state-wide. Individual geospatial shapefiles for the fisheries took a long time to incorporate into the rankings due to the different management of species under each fishery. It made this process quite complicated.

The Economic impacts in the Swan zone has seen two shoreline cells being ranked Very High for protection from floating and dissolved oil (Shoreline Cells 202 and 203) (Appendix A: Figure A7 and Figure A8). These are due to the port of Fremantle and other port private activities based out of Kwinana. Shoreline Cell 203 has also been given a Very High priority for protection from dissolved oil, due to the presence of a seawater intake for a major reverse osmosis plant which supplies much of Perth's drinking water. The other economic protection priorities are for the West Coast Rock Lobster Managed Fishery, which has been ranked High priority for protection from dissolved oil in the other eight shoreline cells (Appendix A: Figure A7 and Figure A8). There is also an aquaculture site in Shoreline Cell 203, which has also been ranked High priority for protection from dissolved oil impacts. For floating oil, there are eight shoreline cells that have been ranked Medium priority for protection of economically important tourism income in the area (Appendix A: Figure A7 and Figure A8).

## Social, Amenity and Recreation

Three state-wide datasets were key to identifying **Social, Amenity and Recreation** values in the Swan zone. These were the multi-use zones of the marine parks and reserves in the DotE CAPAD Marine and DPaW updated CAPAD datasets (2016). The other key data was popularity information for WA beaches, sourced from Surf Life Saving WA. These datasets have been supplemented with Swan-specific information such as yacht clubs, jetties and marinas in the Swan River from DPaW.

The results for the assessment of protection priority for Social, Amenity and Recreation aspects have indicated that the Swan zone has the highest areas of use for these activities. Shoreline Cells 202 and 203 have been ranked Medium for protection from floating oil due to the presence of the state's two most popular beaches: City Beach and Cottesloe Beach. Shoreline Cells 201 and 204 have been ranked Low for protection of multi-use marine parks used for snorkelling, fishing and boating, as well as the presence of other less popular beaches. Shoreline Cell 337 (Rottnest Island) has only been ranked Very Low for protection from floating oil and dissolved oil, which does not match with expectations and perhaps has some data missing for this particular aspect.





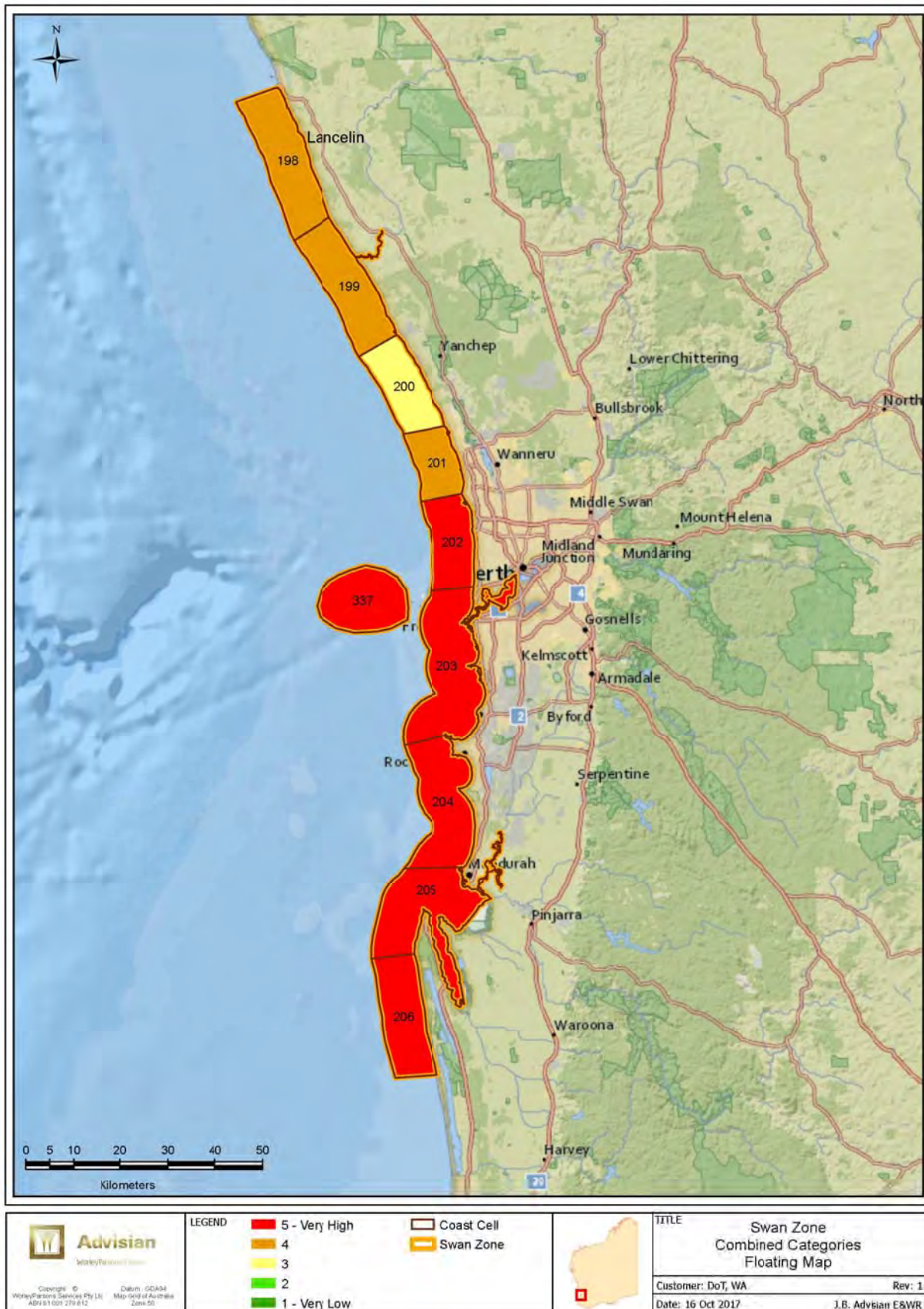
**Advisian**

WorleyParsons Group

**DOT307215 Provision of Western  
Australian Marine Oil Pollution Risk  
Assessment - Protection Priorities**  
Protection Priority Assessment for  
Zone 4: Swan - Final Report

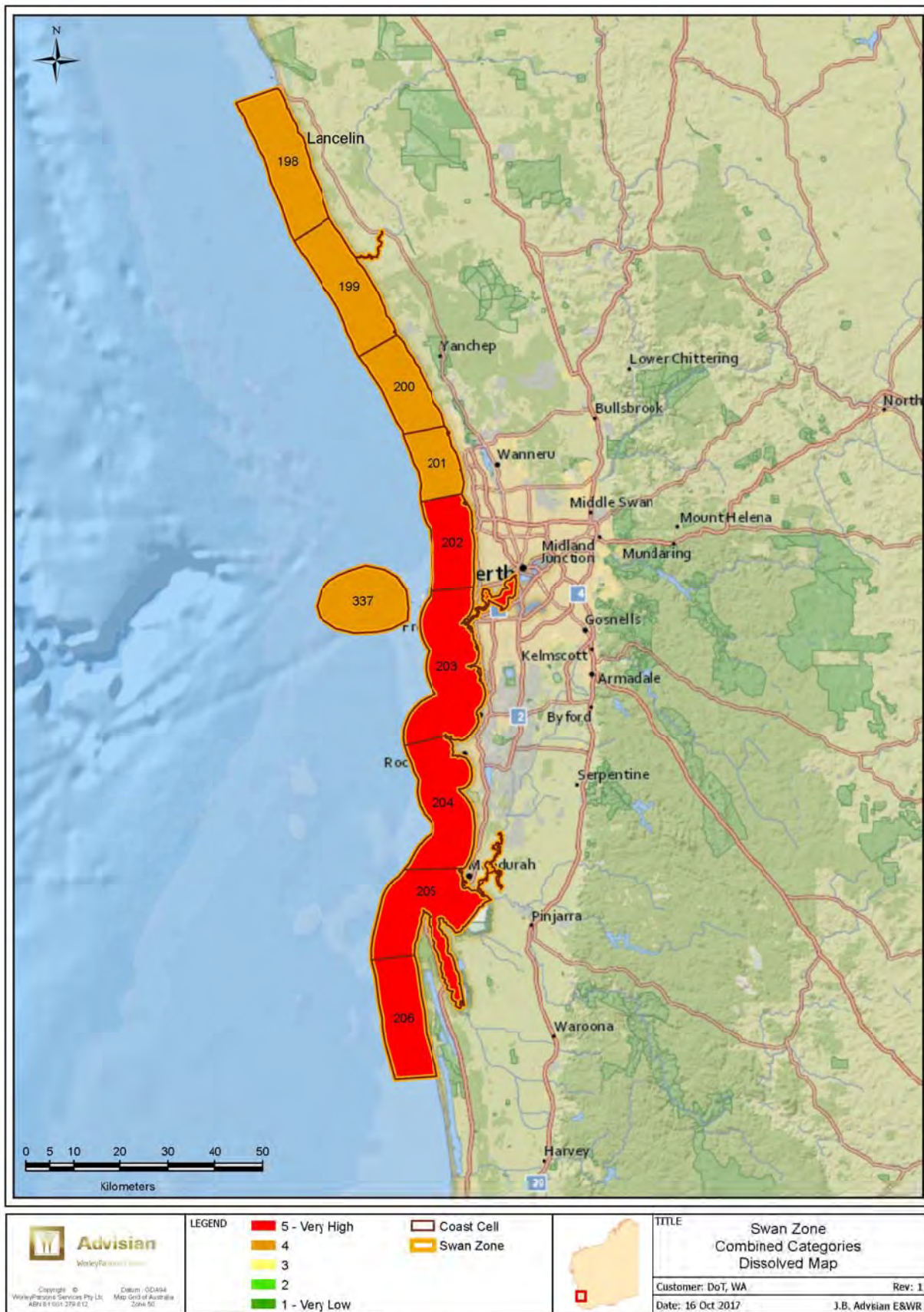


Department of **Transport**



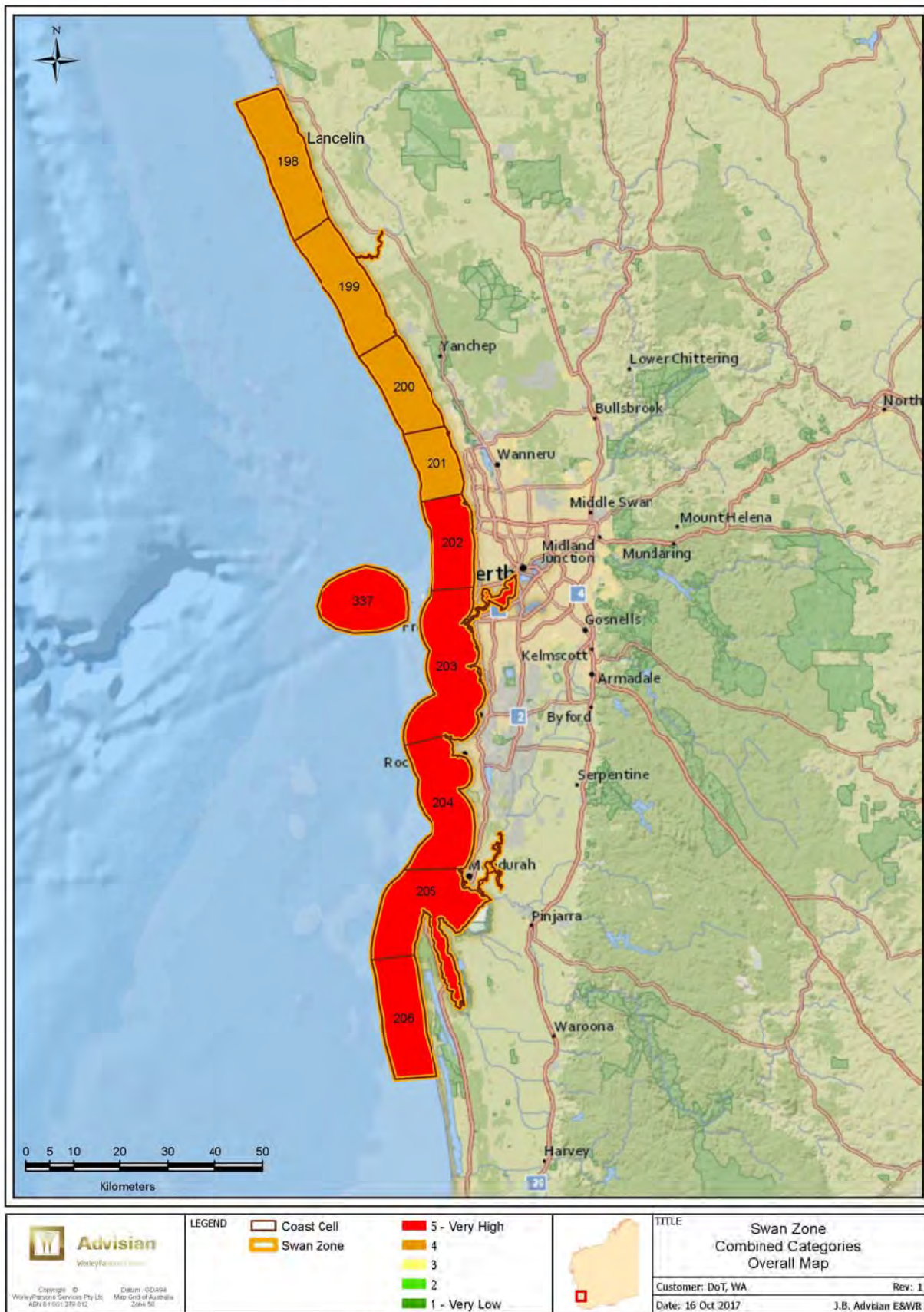
**Figure 7-1: Cumulative (including all category rankings) shoreline cell protection priority ranking for floating hydrocarbons effects**





**Figure 7-2: Cumulative (including all category rankings) shoreline cell protection priority ranking for dissolved hydrocarbons effects**





**Figure 7-3: Cumulative (including all category rankings) shoreline cell protection priority ranking, for both floating and dissolved effects**

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## 8 Discussion

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The key discussion points from the Swan zone are grouped into four key areas:

1. Dataset Comparison;
2. Data from Tertiary Institutions and Research Centres;
3. Currency of Data;
4. Data Saturation;
5. Relevant Discussions from Previous Zones; and
6. Terrestrial Fauna Data Treatment.

### 8.1 Dataset Comparison

More than 60 datasets have been incorporated for use in the Swan zone. These have been sourced from various government departments, tertiary institutes and private organisations, and adapted for use for the project. Through the project's intimate exploration of the data on a large regional scale, a question has been raised about including too much data, such as how applicable some datasets are for driving high rankings based on small scale protection priorities.

Some questions have also been raised about how applicable the DPaW fauna dataset is, because it includes some sightings of wildlife protected under the State *Wildlife Conservation Act 1950*, recorded from as far back as the 1890s. Some of these sightings are not verified, and do put some species well outside their now better understood locations. Compared with the DoE SNES dataset, the DPaW fauna dataset appears to be less reliable for species protection areas.

The DoT ESI dataset for regional coastal and intertidal areas covers the WA coastline. Though there have been some gaps with the ESI dataset (some areas being 'unclassified'), in general the predominant coastal characteristics have been identified (e.g. exposed sea cliffs). Therefore when compared to other datasets, this one has been quite useful, though the areas listed as 'unclassified' should be reviewed by DoT at some stage and classified where possible.

The coastal marine habitats are best defined in the marine parks and coastal marine protection areas provided by DPaW and the DoF, where they have been extensively studied. The Swan has a marine network that generally well represents and protects the zone's key habitats. These are based on many of the areas identified in the Wilson *et al.* (1994) report, which recommended a 'representative' marine system for WA. The additional areas identified in the report which have not become formally protected as part of this marine reserve system have also been incorporated into this assessment, to ensure all areas for protection have been included.

There have been plans to undertake broad-scale mapping of the WA coastline to map marine habitats, coastal habitats and bathymetry. While the raw LiDAR data has been captured, this has yet to be processed. A review of the general classifications in the many habitat datasets identified through this project could be useful in creating a broad set of general classification criteria. This could be used to create a dataset that is compatible with the existing information for future refinement of this project's outcomes.



## 8.2 Data from Tertiary Institutions and Research Centres

Each year there the government provides significant funding for collaborative research projects to be undertaken as joint ventures between government agencies, tertiary institutions and research centres such as CSIRO and AIMS. This includes the \$20 million Strategic Research Fund for the Marine Environment between the Government of WA and CSIRO, and the WA Marine Futures Biodiversity project undertaken with the University of Western Australia (UWA).

Through the West Australian Marine Sciences Institution (WAMSI) and connections with DPaW, DoT and DoF, benthic habitat data has been collected from UWA for use by the project. It has been recognised that many tertiary institutions may not be fully aware of the extent of this project. At times, it has been difficult to gain traction with individual researchers, due to their time constraints, availability between fieldwork assignments, and other conflicting priorities. However, as the project continues, it is anticipated that a presentation to the Operations Group meeting of WAMSI, where all the tertiary institutions are represented, will be able to be arranged for better visibility and engagement for future zones.

## 8.3 Currency of Data

The DPaW fauna dataset, which is a key driver for many of the High and Very High protection priority rankings across the zone, may not be the most accurate representation of current protected fauna locations. This was also raised in Dataset Comparison (Section 8.1) above. The dataset is a continuous record since the 1890s of wildlife sightings and surveys of wildlife protected under the *State Wildlife Conservation Act 1950*.

Chris Surman from Halfmoon Biosciences raised the concern that some of the DPaW fauna dataset sightings are not verified, and do put some species well outside their now better understood locations. This is in addition to the data being collected over more than 100 years. He has been collecting data for the past 26 years, monitoring seabird distribution along the WA coast, and has compared the DPaW data with his findings. The surveys have been between the Montebello Islands and Cape Leeuwin, and collected through at-sea observations and island visits which include the Houtman Abrolhos Islands. More recently he has been tracing seabird migratory patterns and breeding/foraging distributions using tracking devices. Unfortunately, as most of this research is self-funded and the data unpublished, it data was not available for this project.

It has been highlighted that, while the data may be available, societal drivers such as research funding for private collection will need to be investigated to incorporate these and other datasets in the future. This includes engaging with private industries that must continuously monitor environmental health and assess benthic habitat, but whose data is not publically available.

Other data, such as the marine heat wave in 2011, showed a significant decline in seagrass, coral and fish distributions in Shark Bay, which has not been incorporated. This is because data is not available on the extent of the damage. This is a reminder that the project is working on capturing a dynamic environmental system, and it is always going to be a challenge to gain a representative reflection of the current environmental sensitivities.



## 8.4 Data Saturation

This project aims to gain the best information available to cover all oil spill priorities for protection along the WA coastline. However, through process and experience, it has been recognised that there is a limit reached, where the effort to collect and incorporate additional data would not significantly change the outcome of the process.

Some datasets, particularly from university institutions involved in government funded research, were difficult to obtain, either due to their large size, because they are still being finalised, or for various other reasons. In some cases, the data was unable to be obtained, and various solutions have been discussed, including extending the data collection period for future zones, or using different engagement methods. However, when compared to the data available and already acquired, either during the first zone assessed (Pilbara) or during the data collection for this Swan zone, the opinion is that there is sufficient data coverage for the Swan zone.

Future zones, such as the extensive South Coast zone or the Kimberley zone, may require a different approach, but more data would not necessarily equal a 'better' output for the Swan zone. Other considerations have been the back-end of data use, with too many different datasets detracting from the ability to use and interpret the data; the key information and datasets are lost in the volume of data collected. Future considerations include creating a system that allows datasets to be grouped and compared, such as that provided in this project in Section 3.2.6, (Coastal and Intertidal Habitats).

It is also possible that some datasets could be completely excluded. For example, terrestrial invertebrates were included in the assessment of the Swan zone, however many of these species are Priority listed under the WC Act, which means their extent has often not been extensively studied. However, as this project is to identify protection priority for marine oil pollution, this inclusion, or the rankings used for inclusion, may be skewing the data toward a higher ranking. For example, based on the rankings for terrestrial invertebrates, Shoreline Cells 199 and 205 have been ranked Very High for protection from floating oil as the P1 sun-moth has known habitat in these cells. Shoreline Cell 199 also contains the P1 land snail. Shoreline Cell 203 has also been ranked Very High for protection priority due to the presence of a P1 spider in Kings Park.

## 8.5 Relevant Discussions from Previous Zones

It was discussed in the Steering Committee Workshop for the first zone assessed (Pilbara zone) whether, in an oil spill, an environmental priority with a lower rating than an economic one, would result in the environment not being protected in favour of the economic priority. While the project has included economic factors, in a spill, the decisions made regarding the appropriate response will be based on situational best judgement and likely environmental impacts, not economic ones. Economics has been included as the Incident Controller will want to know what the potential economic impacts may be, as well as other impacts, so they are considered holistically.





## 8.6 Terrestrial Fauna Data Treatment

Terrestrial fauna rankings have been reviewed where coastal species are shown as geospatially present in a shoreline cell, but are not known to use the marine or intertidal environment. These species are therefore not expected to be affected by marine oil in the event of a spill. In this context, the marine and intertidal environment is defined as the area of the sea, including the water up to the high water mark which includes the intertidal zone and the debris beach habitat (e.g. dried seagrass).

This issue has likely occurred where the geospatial boundary of the fauna data overlaps with the landward boundary of the shoreline cells. The landward boundary of the shoreline cells is an estimation of the high water mark, and theoretically only captures the fauna that has habitat in the intertidal zone. However, the accuracy of the boundaries of the shoreline cells and terrestrial fauna is limited.

In all zones, the shoreline cells have been reviewed to determine how the terrestrial fauna that is geospatially present use the coastal zone across their lifecycle, as defined above. The information from two credible sources was evaluated to determine if each species spends any part of their lifecycle in the marine or intertidal environment. The sources evaluated included the Species Profile and Threats (SPRAT) database (<http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl>), Commonwealth and State Recovery Plans (<http://www.environment.gov.au/biodiversity/threatened/recovery-plans>, <https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-animals>) and published EPA reports and records (<http://www.epa.wa.gov.au/>).

This review resulted in the following amendments to the treatment of data records for terrestrial birds, mammals, invertebrates, reptiles and freshwater fish:

- Any fauna which was found to use the marine or intertidal environment retained its ranking in accordance with the ranking system in Section 3; and
- Any terrestrial fauna which was found to not use the marine or intertidal environment was given a ranking of Very Low for protection from both floating oil and dissolved oil. This ranking was assigned because the fauna is highly unlikely to be impacted by an oil spill, as it does not use the marine or intertidal zone.

This has resulted in the re-ranking of some shoreline cell protection priorities, but has been done to ensure the correct level of risk is being assigned for marine oil pollution.





## 9 Conclusions

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The following are key conclusions of this study:

- The Swan zone contains key areas that are quite vulnerable to marine oil pollution, both from floating and dissolved hydrocarbons across the spectrum of all five categories (Protected Fauna, Protection Areas, Cultural Heritage, Economic, and Social, Amenity and Recreation);
- The top drivers of the Very High priority rankings were due to the presence of threatened marine fauna including two Critically Endangered birds that are known to roost in the area, being the curlew sandpiper and the eastern curlew, as well as economic values (Port of Fremantle) and Ramsar wetlands (Becher Point Wetlands, Peel-Yalgorup System);
- High priority rankings were driven by economically important West Coast Rock Lobster Managed Fishery, Strict Nature Reserves (both marine and terrestrial which include the intertidal zone), and vulnerable environmental habitats such as seagrass, marsh, swamp and saltmarsh areas;
- Datasets were suitably comparable between the initial zone assessed (the Pilbara zone) and the Swan zone, as well as other zones which have been reassessed (the Midwest, the South West and the South Coast zones);
- Half of the Swan zone is ranked Very High overall, due to a range of factors. This is a positive outcome of the State Wide Overview assessment, where rankings were rationalised and some priority rankings reduced because Protected Fauna was reassessed to reflect the confidence and reliability of the data;
- The areas for protection priority were further refined by the additional investigation and reduction of priority rankings for protected terrestrial fauna. This supports the conclusion that the correct level of risk has been assigned, as only those fauna that may be affected in a marine pollution event have been ranked;
- The Steering Committee is vital for providing input and advice regarding dataset suitability and ranking of criteria, while also addressing the desire to be robust and transparent in the identification of protection priorities;
- This is a static assessment and further data, information, locations and priority rankings can change in the future;
- This assessment will not replace the role of the Environmental Scientific Coordinators (ESCs) in an oil spill. The ESCs will still be called upon in an oil spill, with full information required to be sought by the Incident Commander in the spill; and
- This report and assessments are intended as a guide only and are intended to enhance the process and reduce the response time in the event of an oil spill off the Swan coast.

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## 10 Recommendations

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A number of recommendations have been identified when assessing the Swan zone. These are:

- Chris Surman highlighted that the DPaW fauna dataset may be misleading, as all records of fauna sightings over the last century are retained in the dataset; it may not accurately reflect the species' key locations. It is recommended that this be investigated and the dataset revised, if required, with engagement from Chris Surman to incorporate the 26 years of seabird research he and other fauna specialists have collected, as identified through the investigation;
- When the final zone has been assessed in two to four years' time, a gap analysis review should be conducted of the earliest zones completed, to identify any key datasets that either become available later in the project process, or were not identified in these earlier zones. Upon review, it may be prudent to revisit some of these earlier zones; and
- A presentation to the Operations Group meeting of WAMSI, where all the tertiary institutions are represented, should be arranged before starting the next zones. This is to gain recognition and engagement for increased efficiency, and access to data for future zones.



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WorleyParsons Group

**DOT307215 Provision of Western  
Australian Marine Oil Pollution Risk  
Assessment - Protection Priorities**  
Protection Priority Assessment for  
Zone 4: Swan - Final Report



Department of **Transport**

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## **Appendix A    Shoreline Cell Maps**

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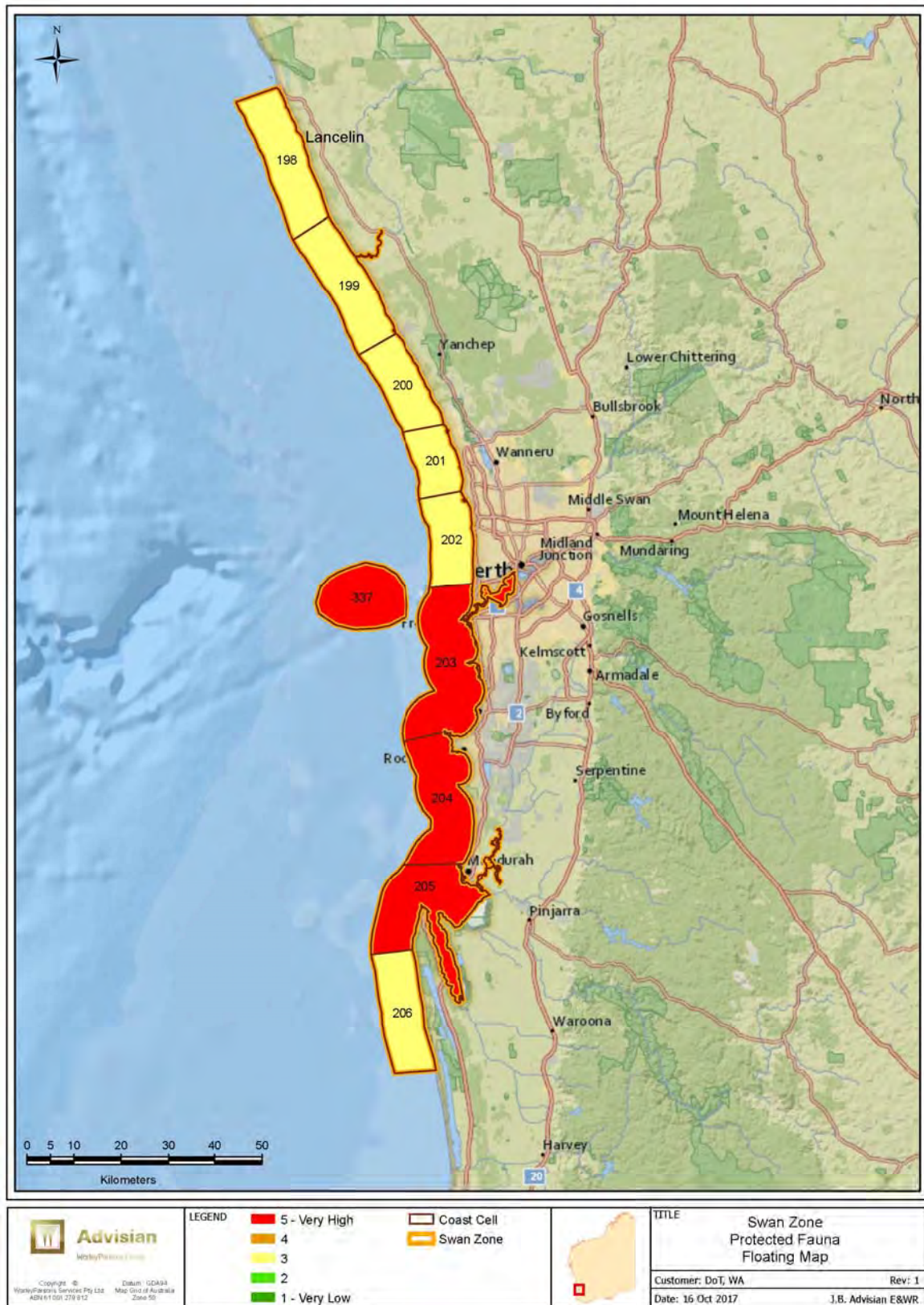
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## Protected Fauna

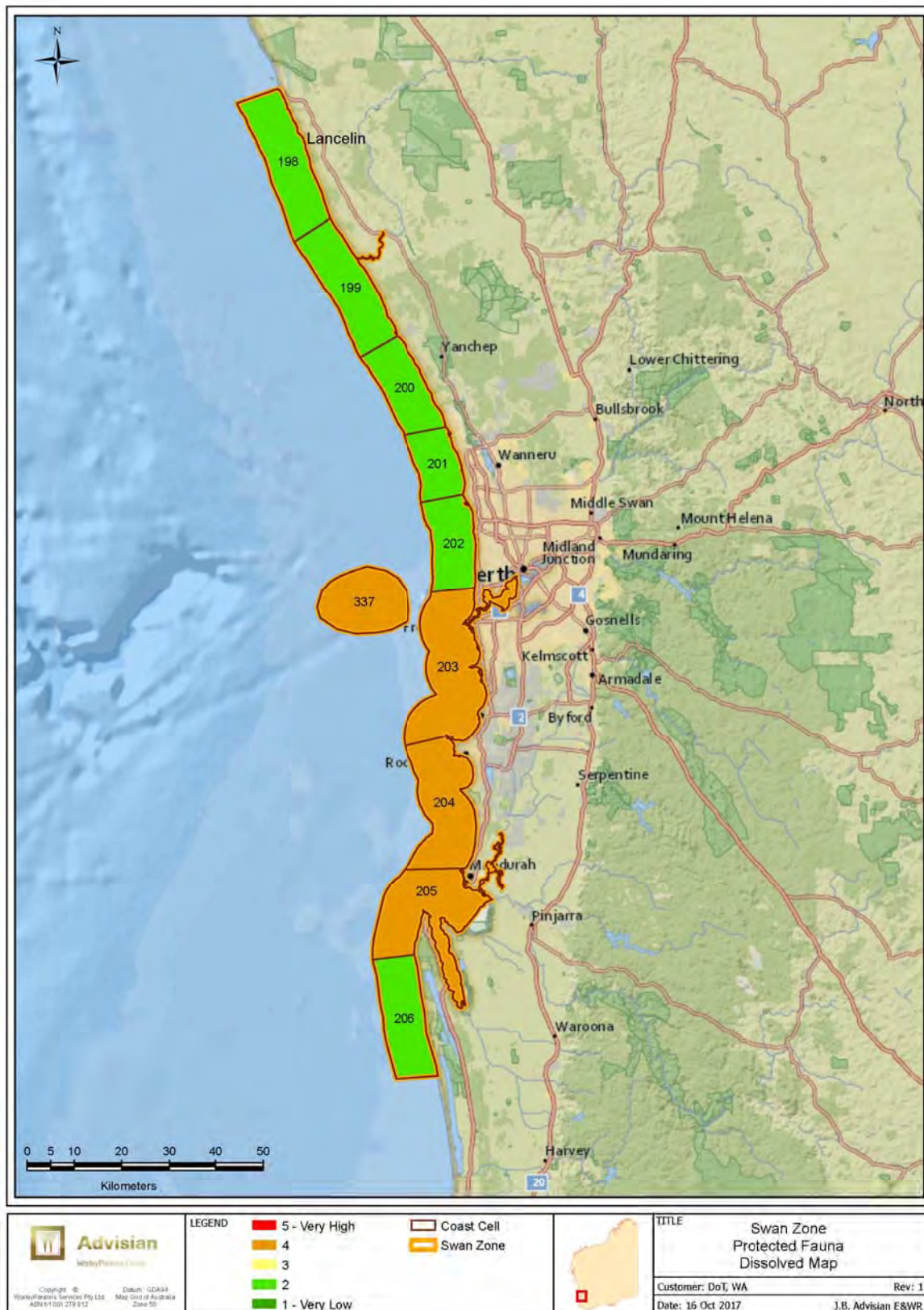


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**Figure A1: Protected Fauna shoreline cell protection priority ranking for floating hydrocarbons effects**



**Figure A2: Protected Fauna shoreline cell protection priority ranking for dissolved hydrocarbons effects**



## Protection Areas



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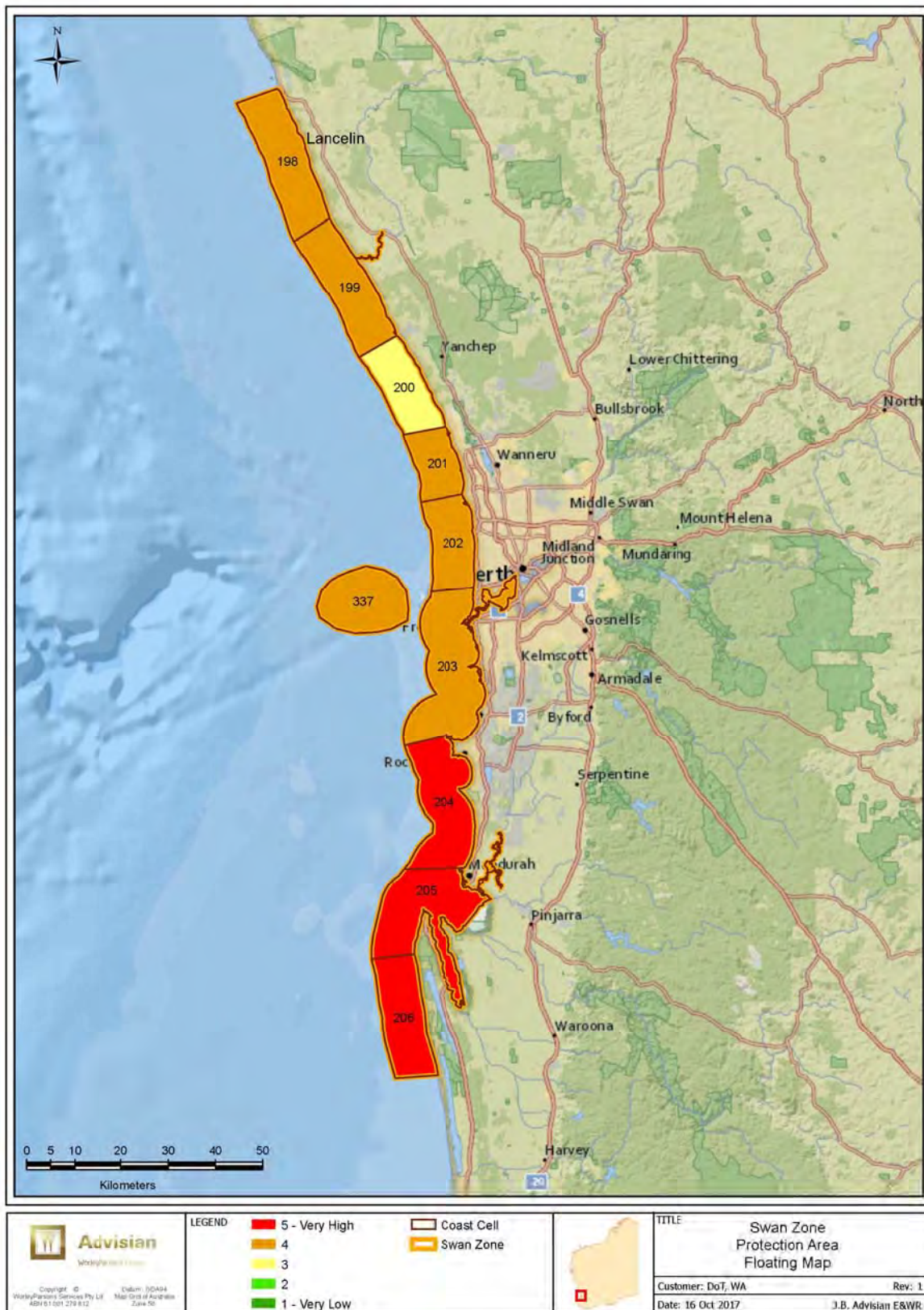
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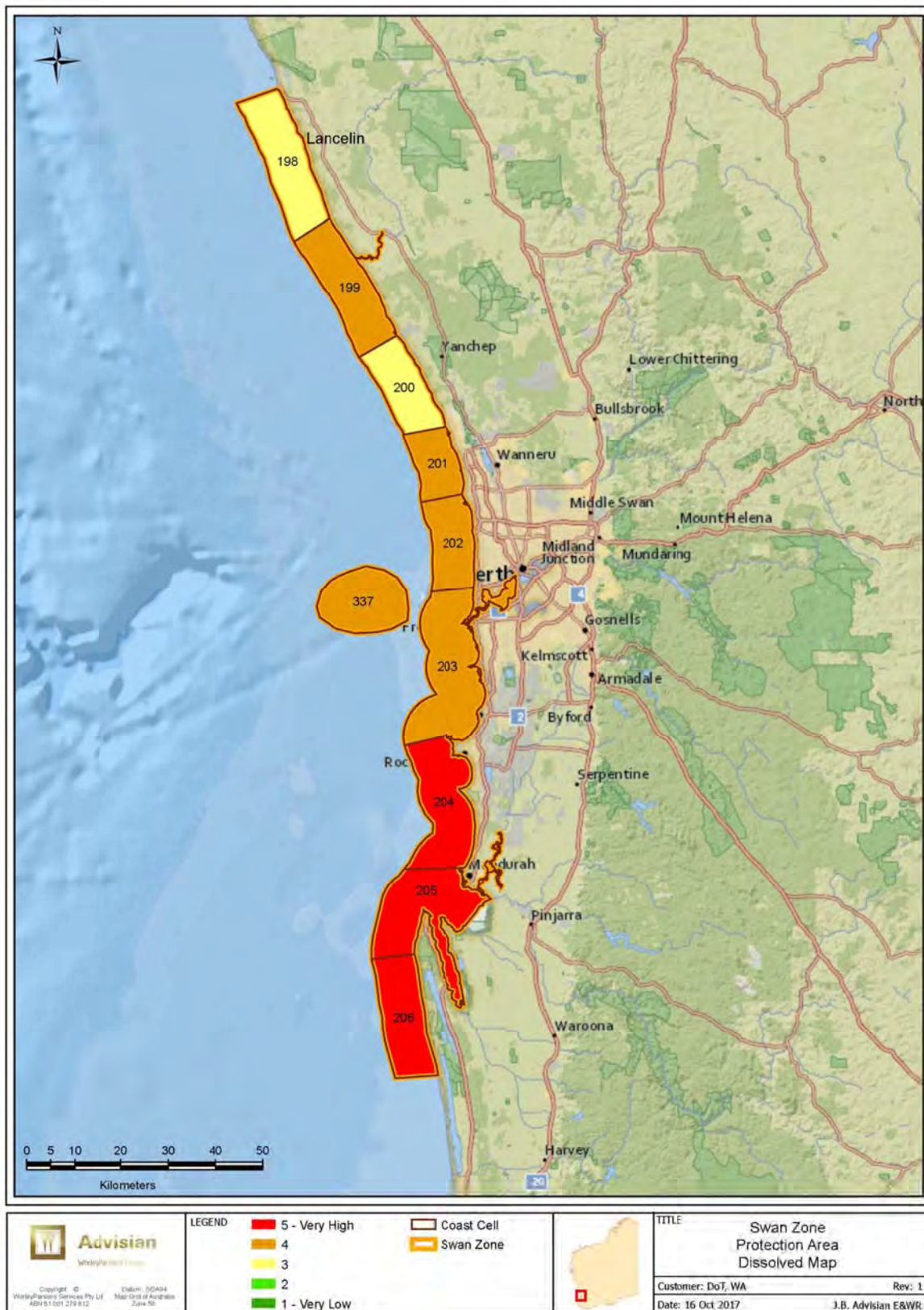
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**Figure A3: Protection Areas shoreline cell protection priority ranking for floating hydrocarbons effects**



**Figure A4: Protection Areas shoreline cell protection priority ranking for dissolved hydrocarbons effect**



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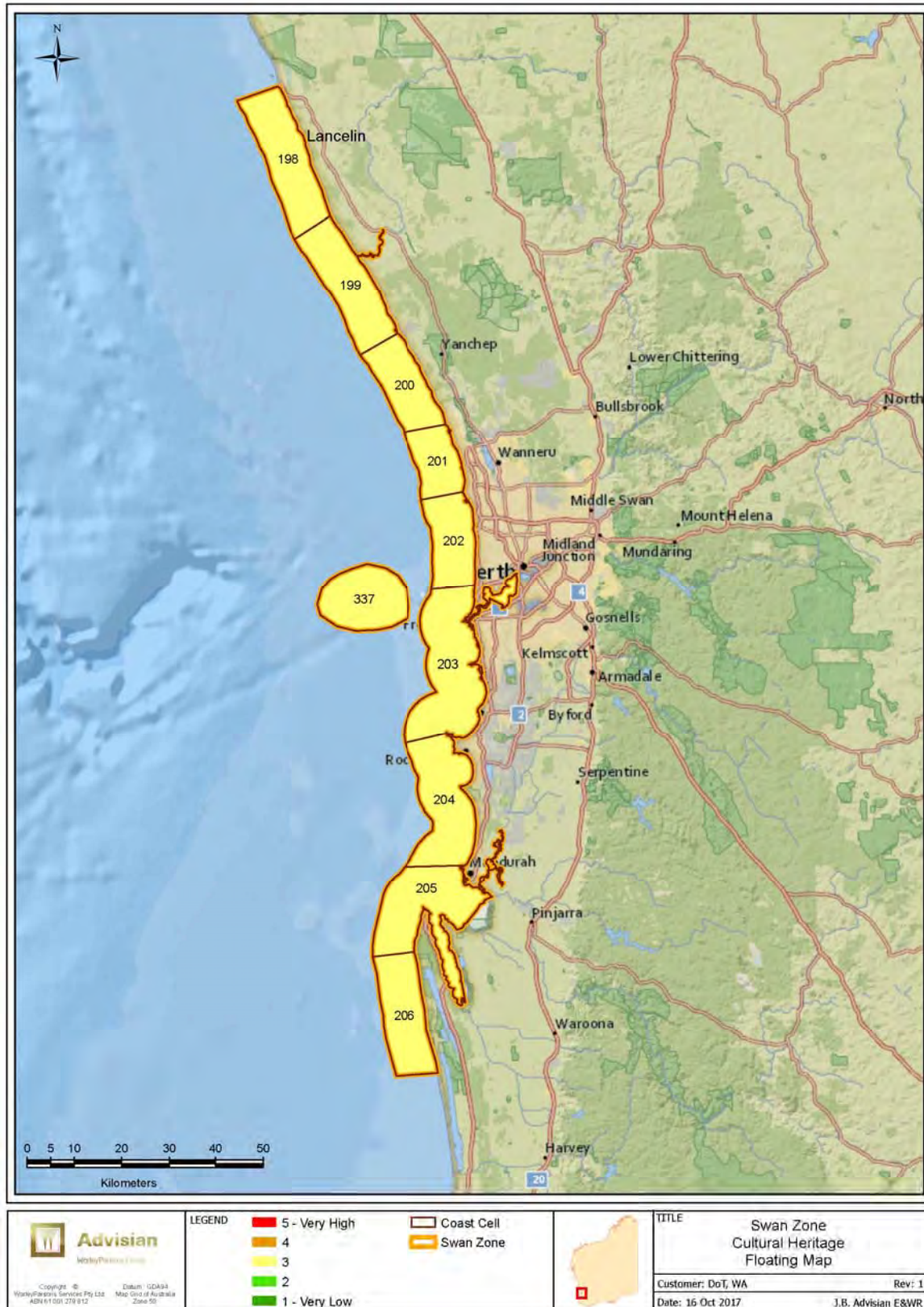
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## Cultural Heritage

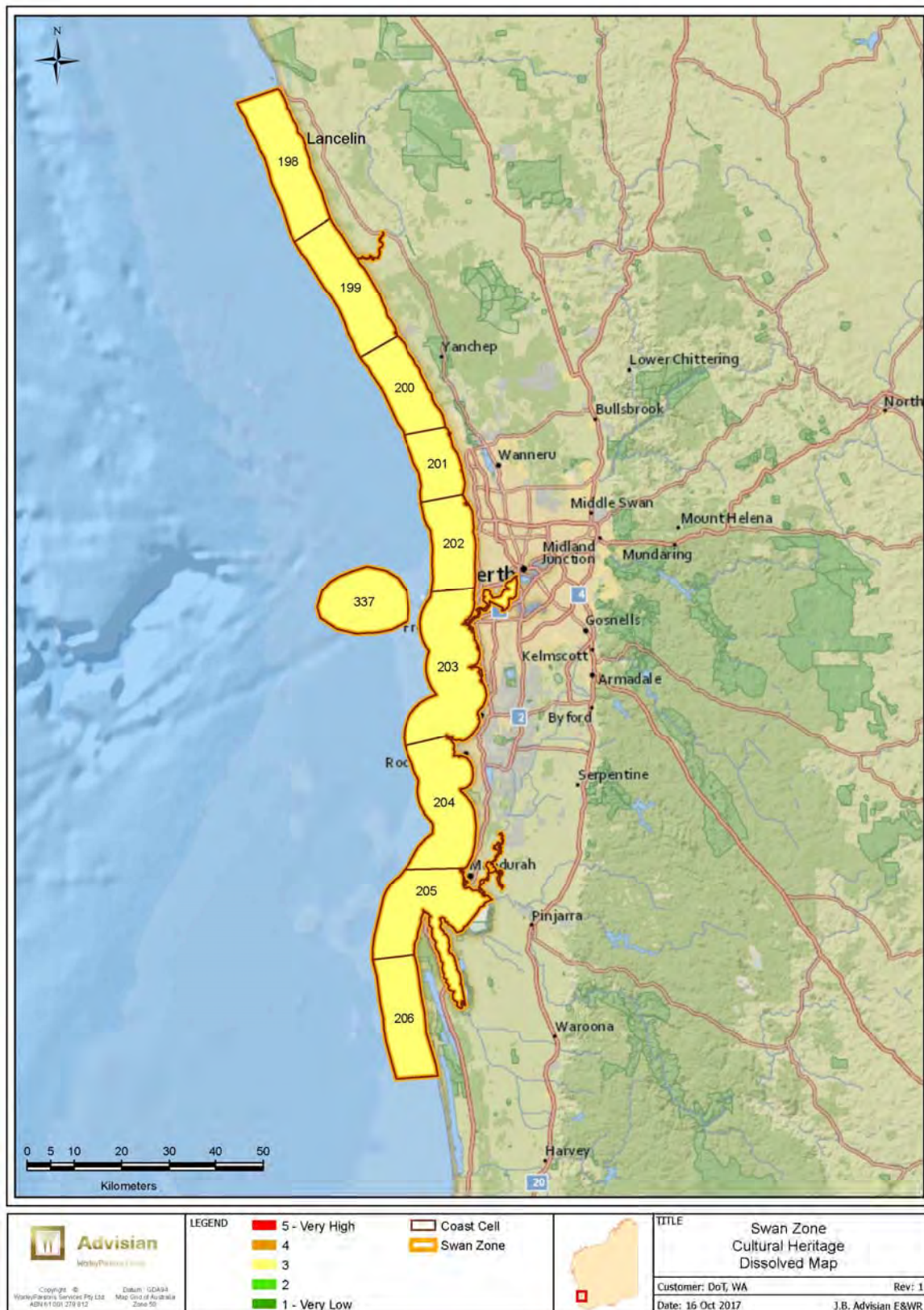




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**Figure A5: Cultural Heritage shoreline cell protection priority ranking for floating hydrocarbons effects**



**Figure A6: Cultural Heritage shoreline cell protection priority ranking for dissolved hydrocarbons effects**



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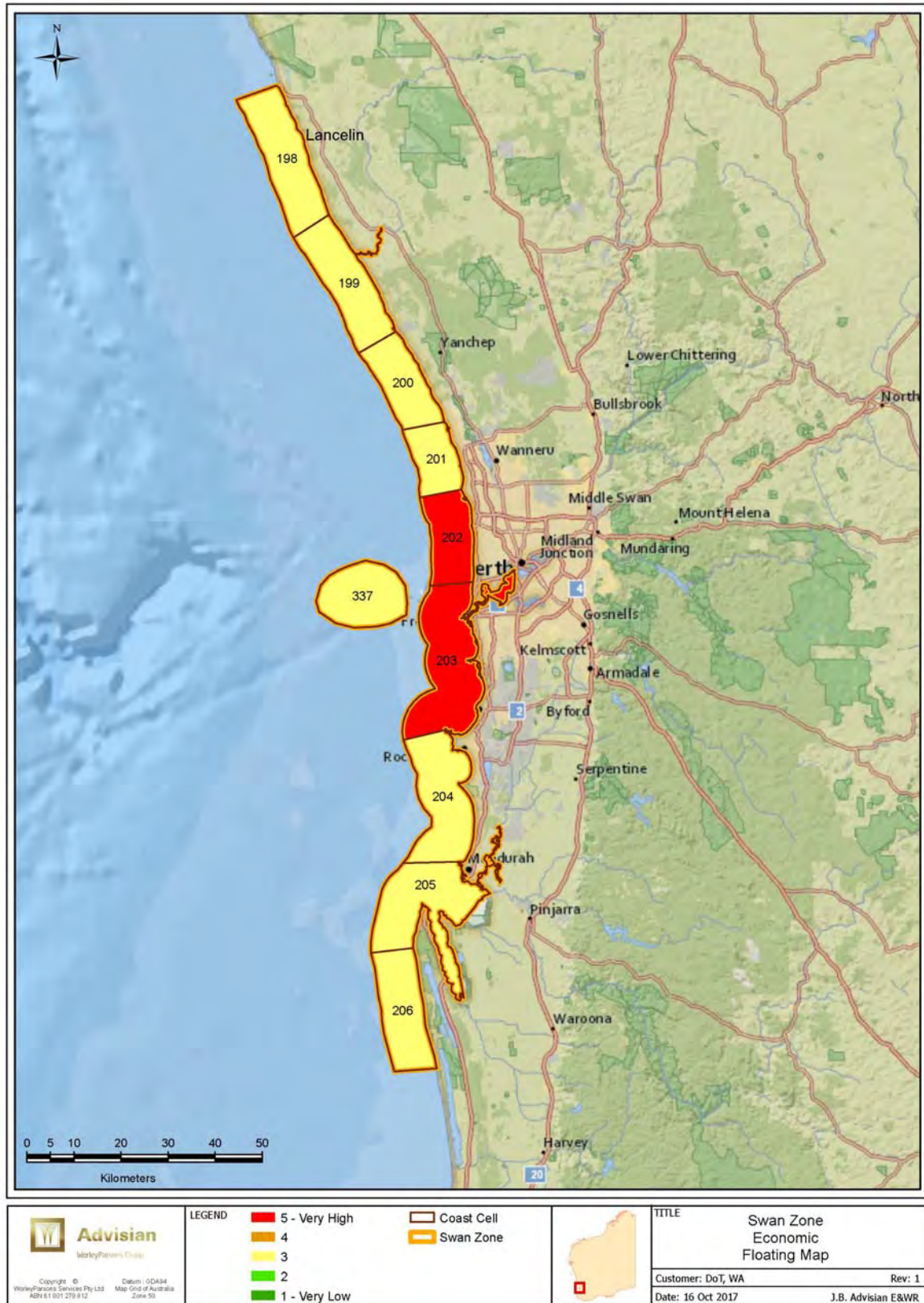
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## Economic





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**Figure A7: Economic shoreline cell protection priority ranking for floating hydrocarbons effects**

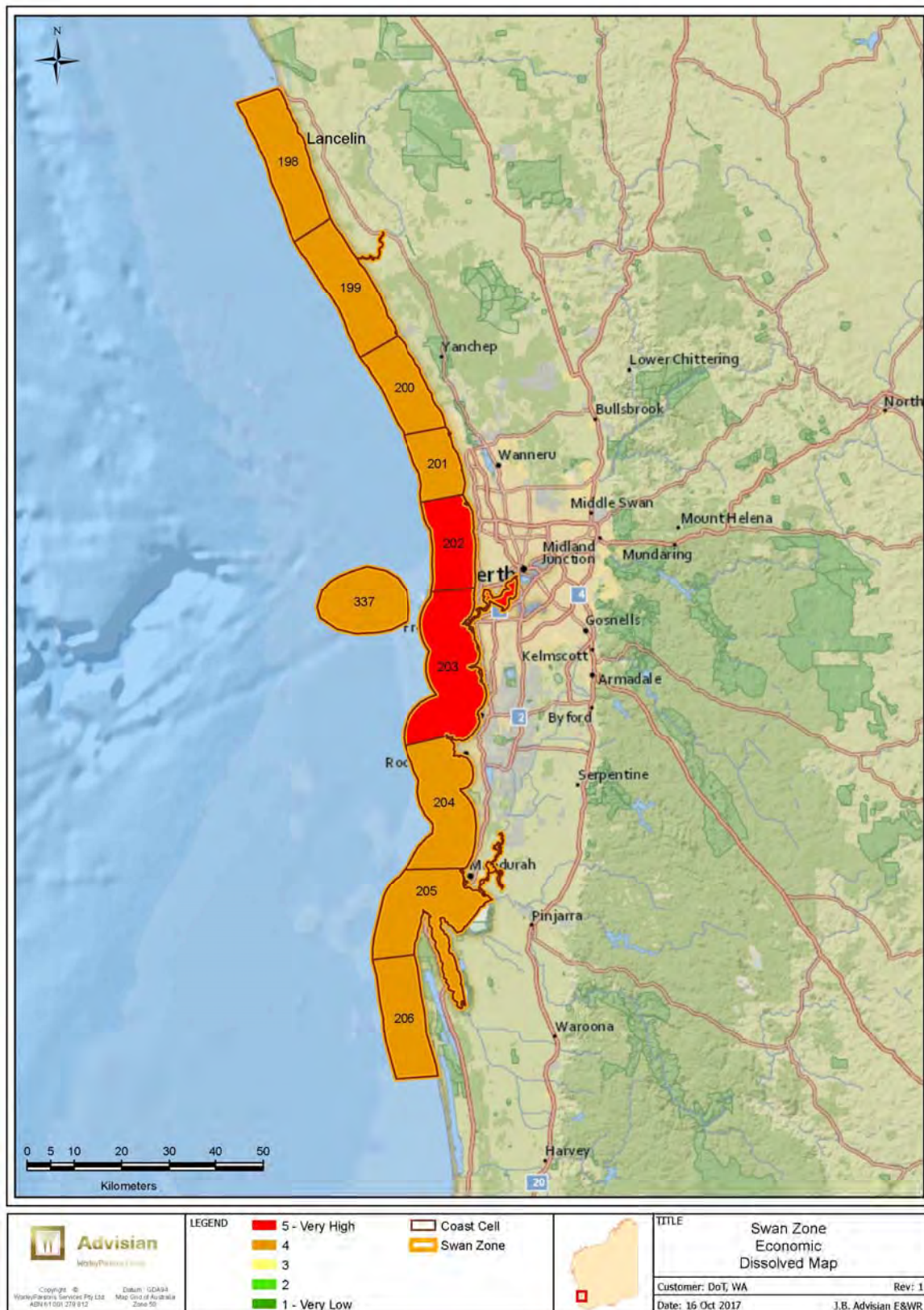


Figure A8: Economic shoreline cell protection priority ranking for dissolved hydrocarbons effect





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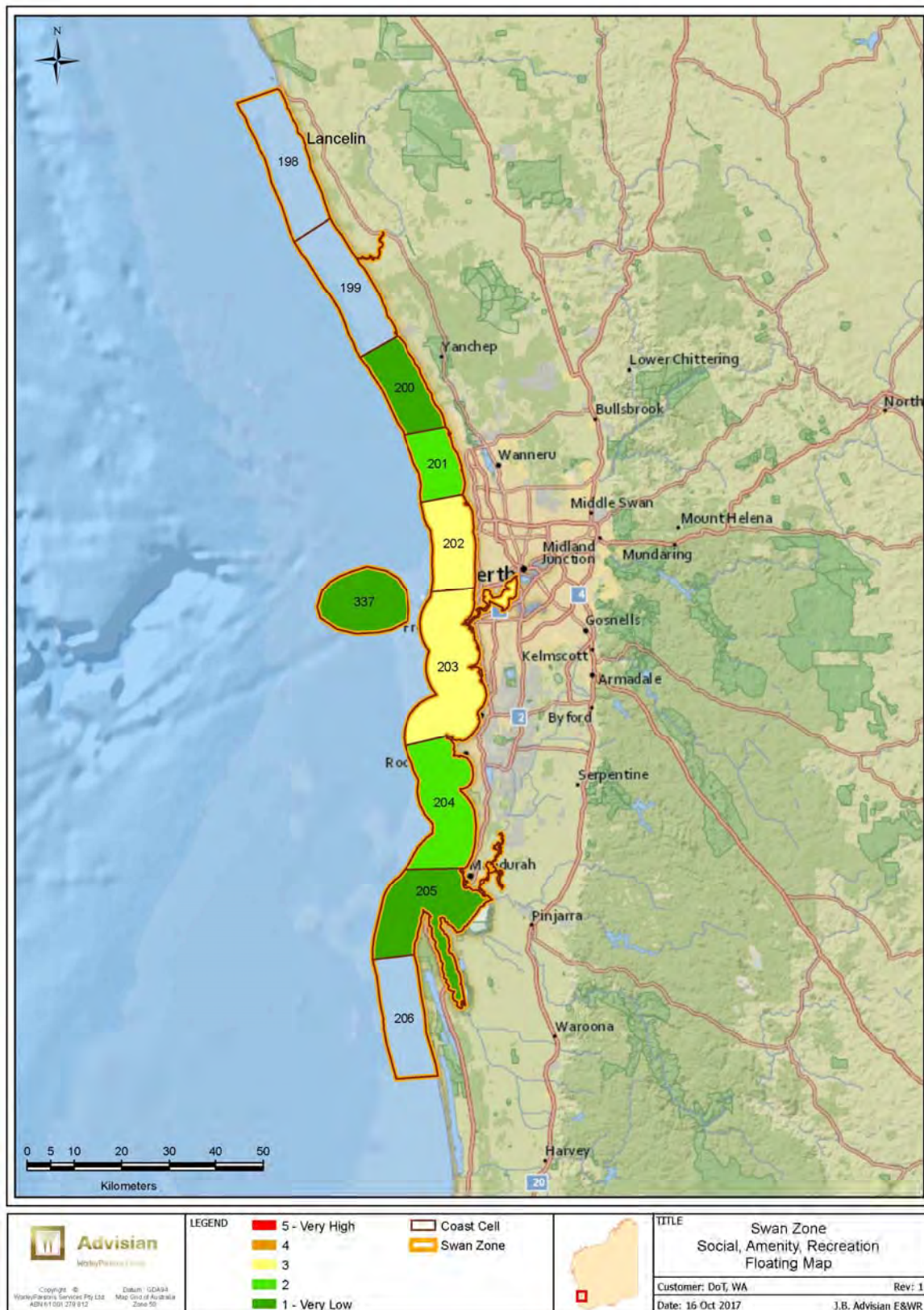


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## **Social, Amenity and Recreation**

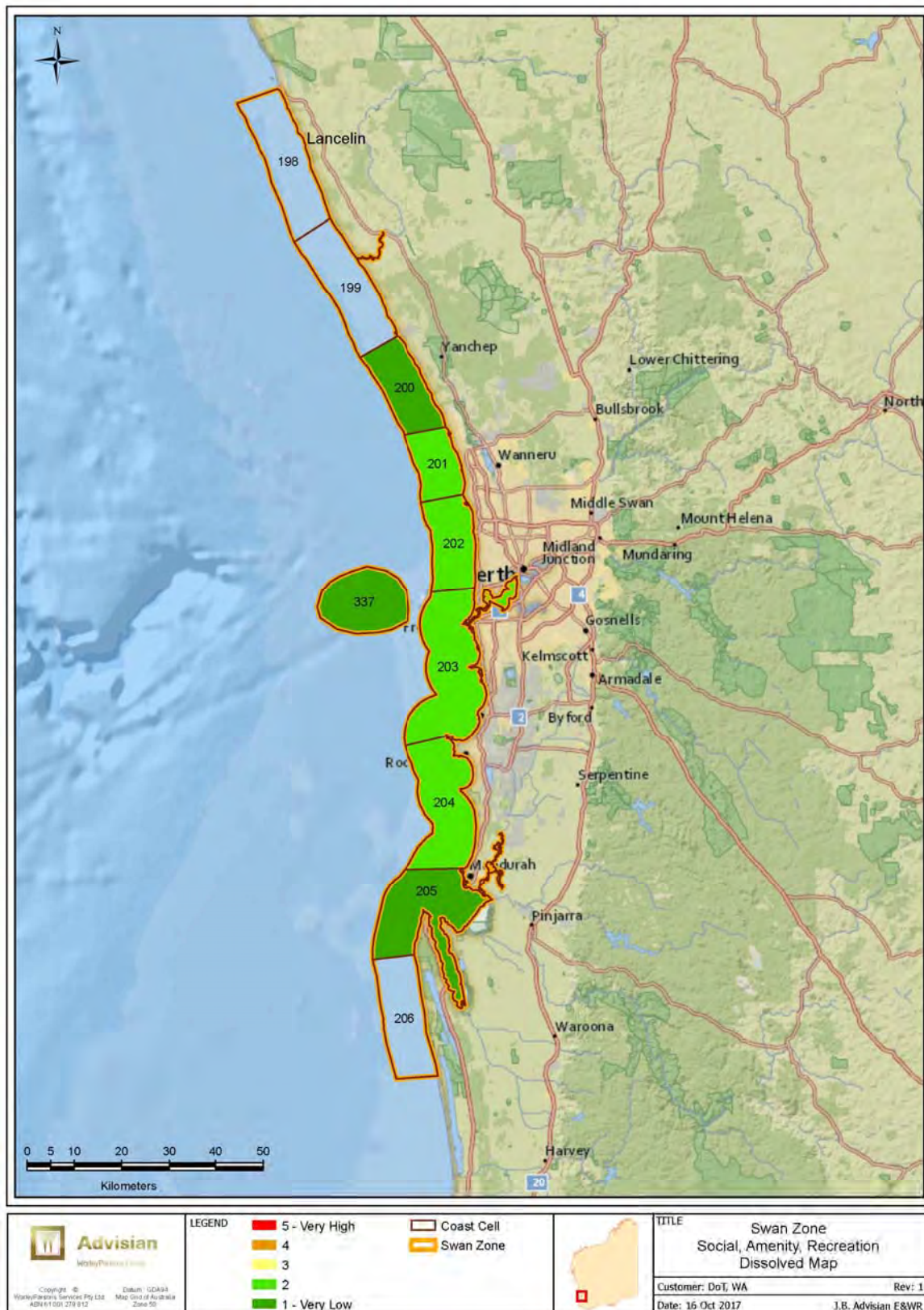


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**Figure A9: Social, Amenity and Recreation shoreline cell protection priority ranking for floating hydrocarbons effects**





**Figure A10: Social, Amenity and Recreation shoreline cell protection priority ranking for dissolved hydrocarbons effects**