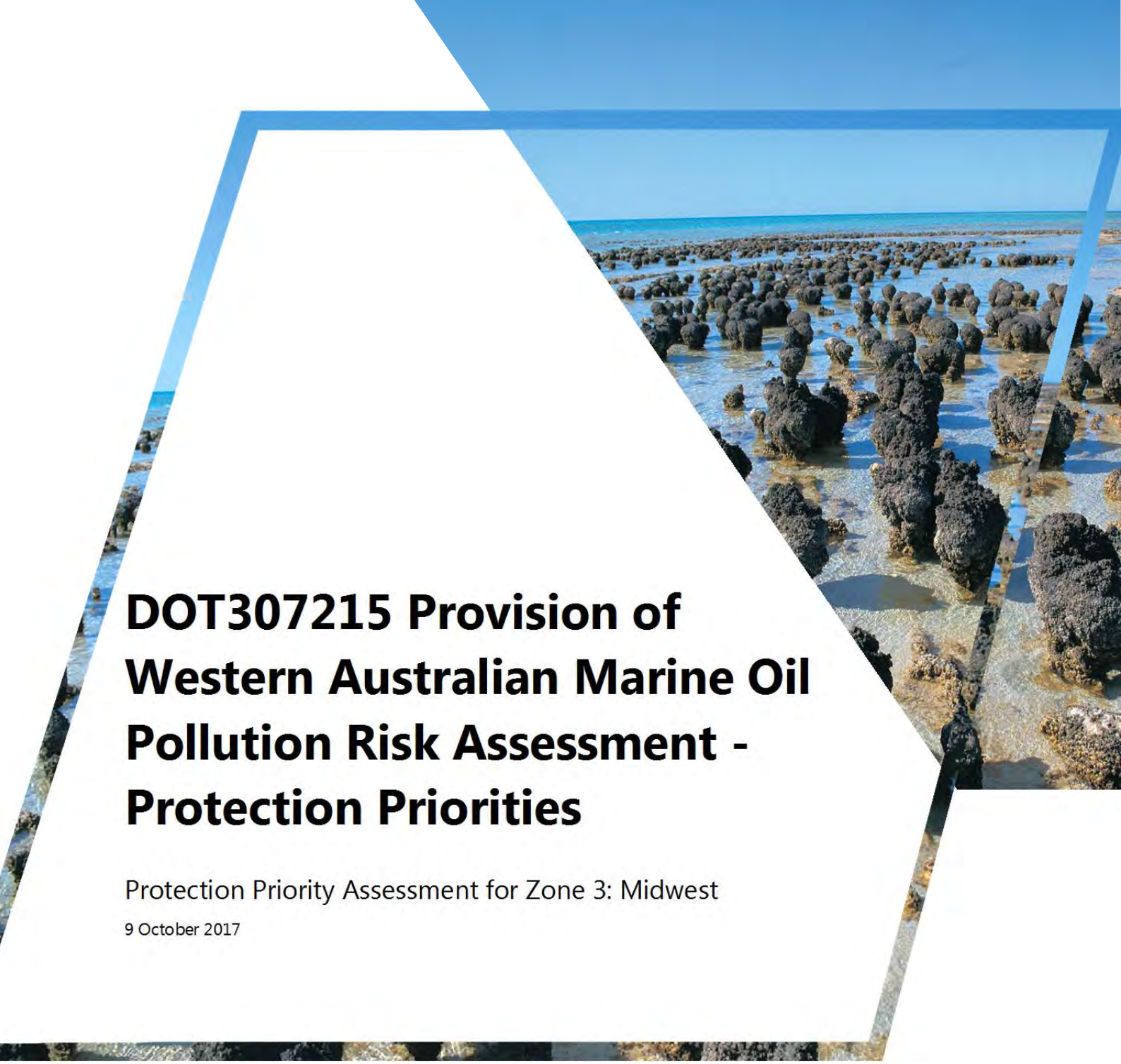

DOT307215 Provision of Western Australian Marine Oil Pollution Risk Assessment - Protection Priorities

Protection Priority Assessment for Zone 3: Midwest

9 October 2017

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301320-09591-EN-REP-0008

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Report No: 301320-09591-EN-REP-0008 – DOT307215 Provision of Western Australian Marine Oil Pollution Risk Assessment - Protection Priorities: Protection Priority Assessment for Zone 3: Midwest

Rev	Description	Author	Review	Advisian Approval	Date
A	Issued for Internal Review	K Swain	A Jacobs	N/A	20-Dec-16
B	Issued for Client Review	K Swain	A Jacobs	D Hunter	23-Dec-16
0	Approved for Use	K Swain	L Laver	A Jacobs	26-Jun-17
1	Approved for Use	A Jacobs Advisian	L Laver Advisian	E Gifford Department of Transport	13-Oct-17

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 will identify the key environmentally, socially, economically and culturally 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 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) 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 State Wide Overview went on to propose solutions to achieve the overall objective of this project process.

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 categories data. These revised rankings were incorporated in the Pilbara zone assessment and have now also been incorporated into this assessment of the Midwest zone. This report presents the revised results of the Midwest assessment 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 five categories of 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 of these five categories in order to identify the key areas of protection priority. It also recommends areas for improvement.

The protection priorities assessment for the Midwest 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 ranking for all five categories, for both floating oil and dissolved oil impacts, shows two clusters of shoreline cells in the Midwest zone being ranked Very High: one covering three consecutive shoreline cells; and one covering 43 consecutive shoreline cells. The largest area protects the Shark Bay World Heritage Area, while the smaller area covers the southern extent of the Ningaloo World Heritage Area. Both are given the highest protection priority due to their recognition as important habitat protection zones which represent 'the best examples of the world's natural heritage and is considered to be of outstanding value to humanity' (UNESCO, 2008). The presence of these two world heritage areas results in 63% of the Midwest zone identified for the highest protection priority.

Protected fauna in the Midwest zone results in many shoreline cells ranked High for protection from floating oil and Medium for protection from dissolved oil. This is due to the majority of the coastline being habitat for Endangered species, including many birds and reptiles. The key species which are driving this High classification are the Endangered loggerhead and leatherback turtles, which congregate and nest along the majority of this section of WA coastline. The areas these protected fauna are found are the southern end of Ningaloo, Shark Bay, Abrolhos Islands, and scattered shoreline cells along the mainland coastline between Kalbarri and Lancelin.

The Midwest zone is ranked High for protection of cultural heritage from both floating and dissolved oil in the area of the Shark Bay Marine Park, which is a National Heritage Area. The other cultural heritage in the zone is the National Heritage listed Batavia Shipwreck site and survivor camps area from 1629, located on the Houtman Abrolhos islands. More than 100 other historic shipwrecks are found along the Midwest coastline, and the presence of these gives the majority of the zone a ranking of Medium, indicating the rich history of the Midwest area.

From an economic perspective, the majority of the Midwest zone is ranked Low for protection from floating oil, except for the Port of Geraldton, which affects three shoreline cells and is ranked Medium. The entire Midwest zone is ranked Medium for protection from dissolved oil due to the prevalence of the Western Rock Lobster Managed Fishery (Appendix A: Figure A7 and A8).

For the Social, Amenity and Recreational category, the recreational fishing in the Marine Parks of Shark Bay and Jurien Bay and the beaches in these zones are ranked Low. This is due to the low number of local visitors to the area, as tourism is included in the Economic category. These areas are however ranked higher for protection in the Cultural Heritage and Protection Areas categories.

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Acknowledgements

Advisian would like to thank the following people who had valuable input into this project:

The Steering Committee:

- Department of Transport:
  - Emily Gifford – Team Leader Planning and Public Information | Marine Safety; and
  - 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; and
  - Steve Rowlands – Parks and Wildlife Data Manager.
- Australian Maritime Safety Authority (AMSA): Paul Irving – Senior Scientific Coordinator | Marine Environment Pollution Response;
- Roc Oil: Amelia Badri – Perth Basin Environmental Advisor;
- Department of Fisheries:
  - Carli Telfer – Senior Management Officer | Biodiversity Branch; and
  - Natalie Moore – Senior Management Officer | Biodiversity Branch.
- Environmental Protection Authority (EPA): Gordon Motherwell – Senior Environmental Officer | Infrastructure Assessments Branch.

Department of Transport personnel:

- Emily Gifford – Team Leader Planning and Public Information | Marine Safety;
- Matt Verney – Manager Maritime Environmental Emergency Response | Marine Safety;
- Sharon Hu – Senior Geospatial Information Analyst | Coastal Infrastructure;
- Steven James – Manager Geographic Information | Coastal Infrastructure; and
- Rodney Hoath – Director Coastal Information | Coastal Infrastructure.

Navigatus Consulting personnel:

- Kevin Oldham – Service Director | Project Delivery; and
- Matt Bilderbeck – Service Manager and Modelling Development.

Advisian team members and other Advisian personnel:

- Annette Jacobs – Project Manager and Multi-Criteria Analysis (MCA) Specialist;
- Lorie Jones – Project Sponsor;
- Kate Swain – Senior Environmental Specialist and Report Author;
- Mark Peel – Geospatial Information Systems (GIS) Specialist;
- Paul Nichols – Oil Spill Advisor;
- Nadene Claydon – Marine Specialist; and
- Dan Hunter – Environment and Society Team Manager.

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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 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
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
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAA	WA State Department of Aboriginal Affairs
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
EN	Endangered
EPA	Environmental Protection Authority
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
ESI	Environmental Sensitivity Index
FHPA	Fish Habitat Protection Area
GDP	Gross Domestic Product
GIS	Geospatial Information System
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
MSC	Marine Stewardship Council
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
SNES	Species of National Environmental Significance
TSA	Tourism Satellite Account
UNESCO	United Nations Educational, Scientific and Cultural Organization
VU	Vulnerable
WA	Western Australia
WAMSI	West Australian Marine Sciences Institution
WAM	Western Australian Museum
WC Act	WA State *Wildlife Conservation Act 1950*

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.
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 *et al.,* 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.
Coastal zone	The coastal zone 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).
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.
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 73 shoreline cells in Zone 3 *Midwest* (Figure 1-3).
Zones	The WA State waters have been divided into seven (7) zones: Zone 1 *Kimberley*; Zone 2 *Pilbara*; Zone 3 *Midwest*; Zone 4 *Swan*; Zone 5 *South West;* Zone 6 *South Coast*; Zone 7 *Federal Offshore Features* (Figure 1-1).

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1 Introduction

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 is comprised of 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. Navigatus Consulting is undertaking the second component, and 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 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 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 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 which had been developed during the initial Pilbara zone assessment were resulting in much 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, the drivers for these High and Very High rankings were investigated. The State Wide Overview identified that a few key state-wide datasets were driving the majority of the rankings. These were datasets in 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 Midwest zone, and this report presents the results of the assessment.

This report also describes 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 summarises these priorities and also recommends areas for improvement.

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.

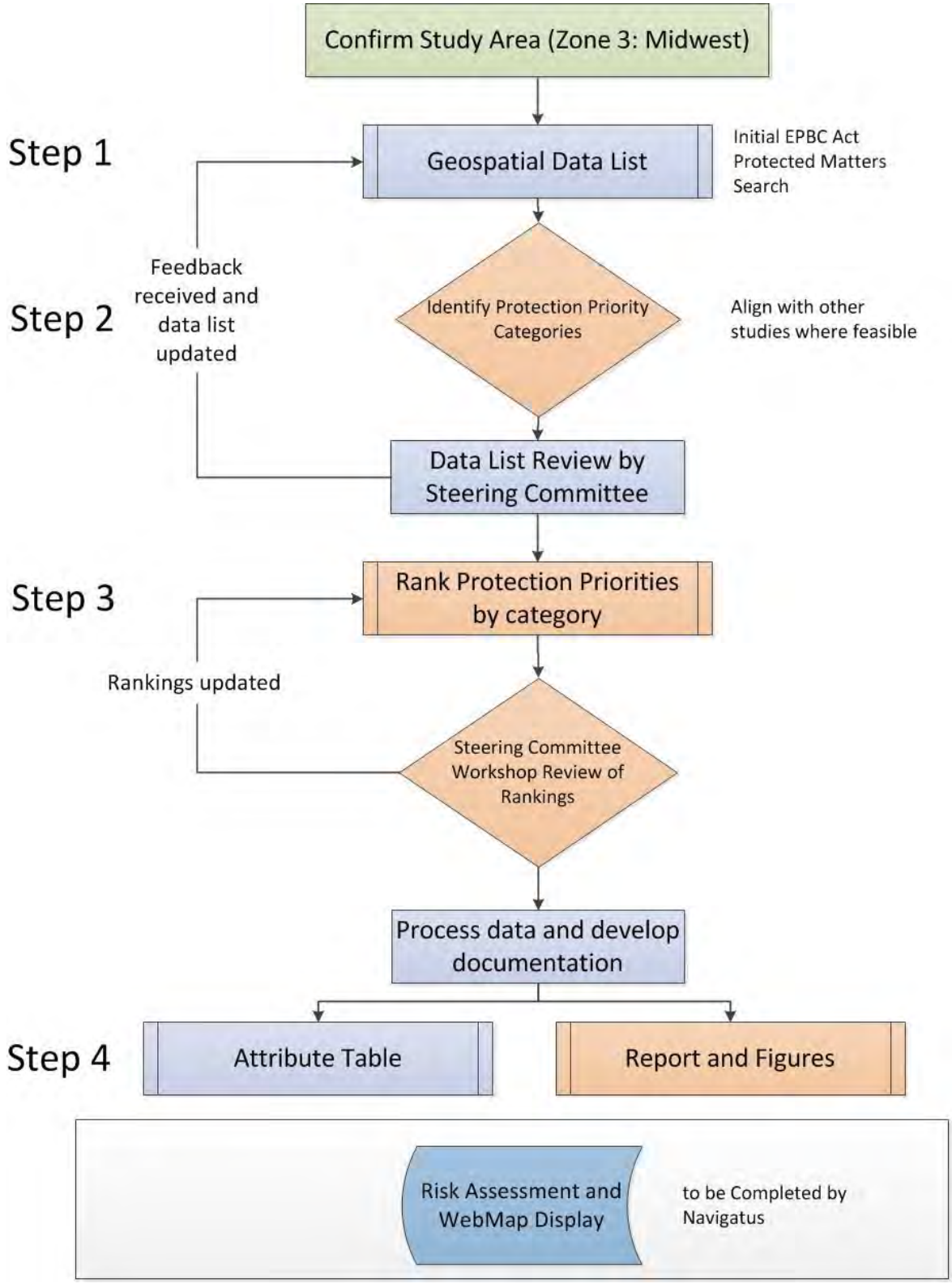

Figure 1-2: Protection priorities project component flowchart

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 Midwest zone are illustrated in Figure 1-3. There are 73 shoreline cells in the Midwest zone.

The shoreline cells used in this assessment were provided to Advisian by Navigatus.

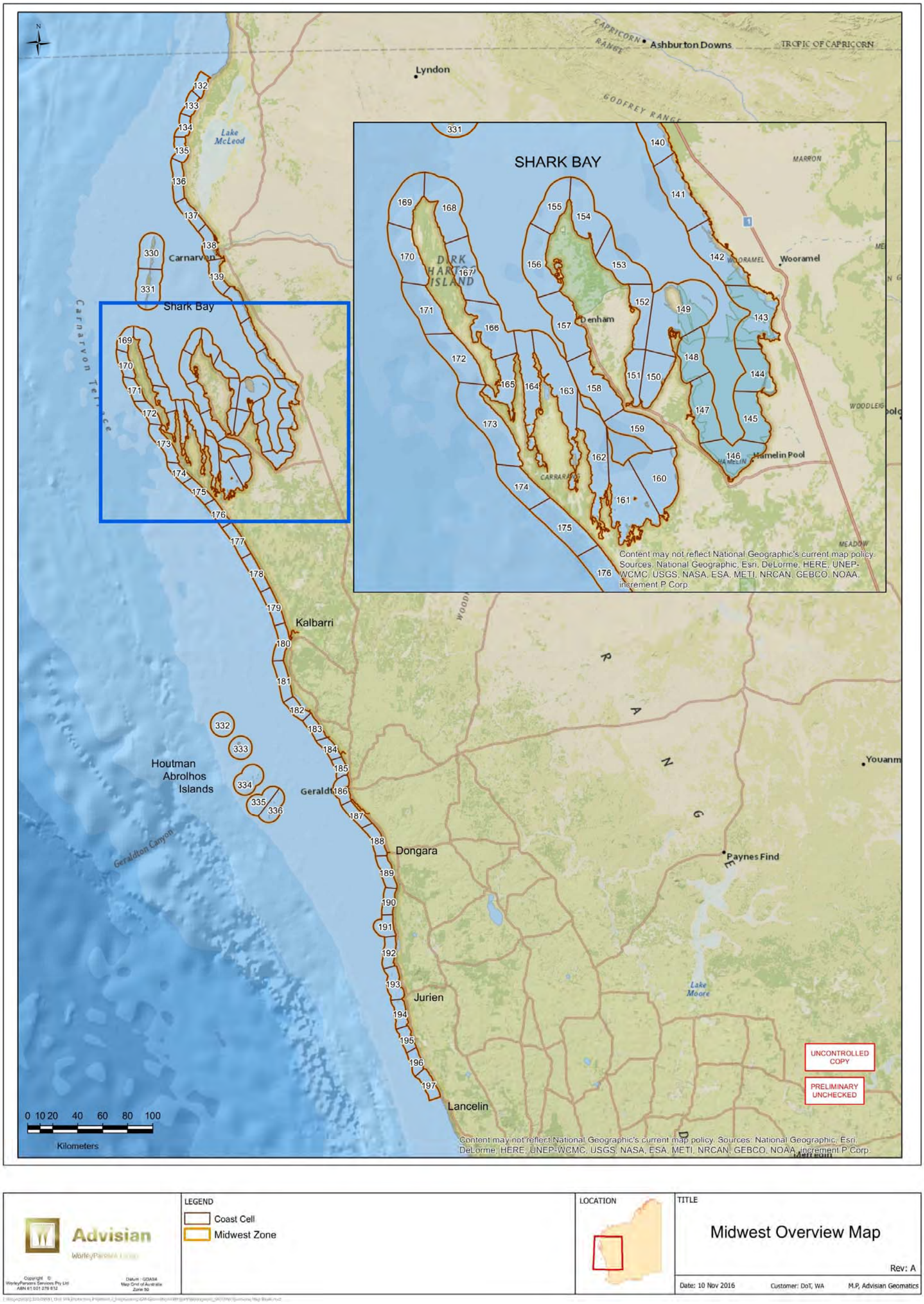

Figure 1-3: Midwest (Zone 3) shoreline cells

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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 1-4). 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 physical 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.

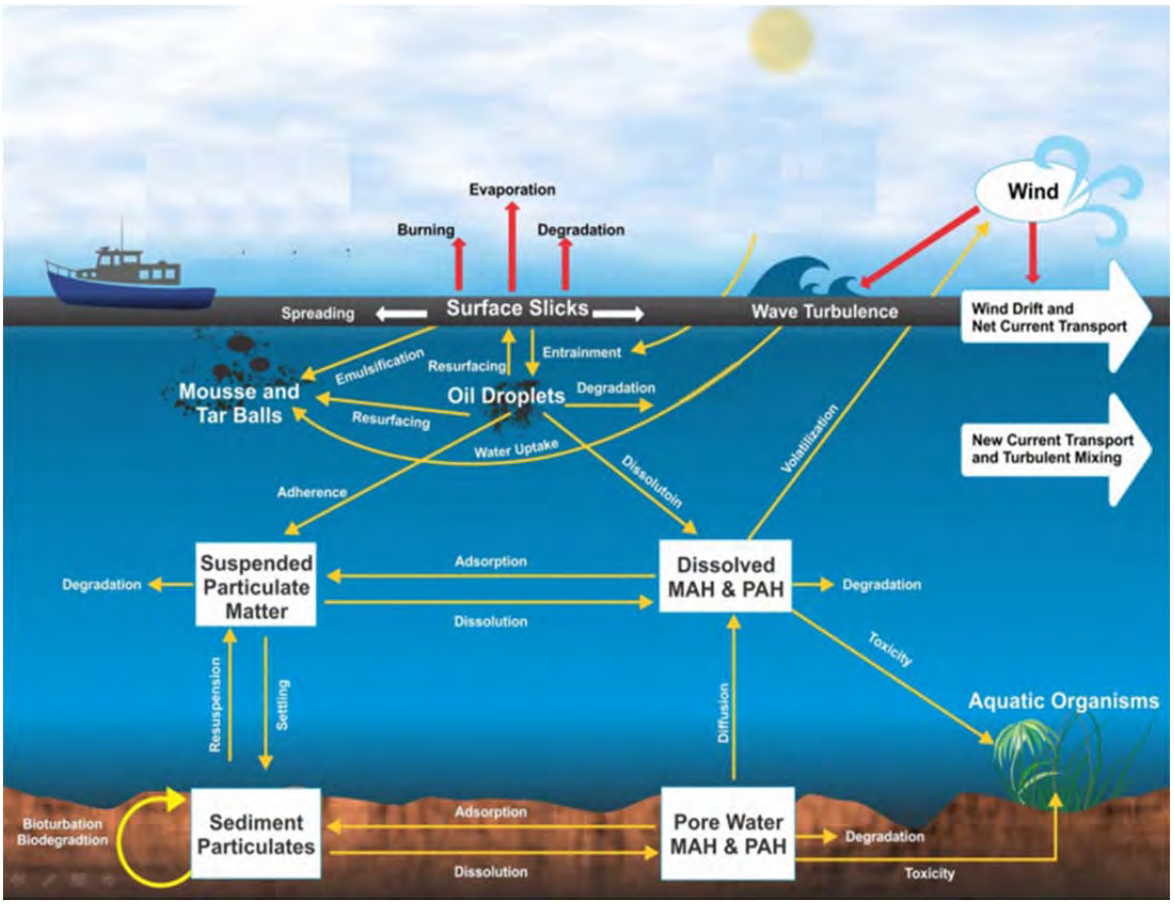

Figure 1-4: Hydrocarbon weathering and biodegradation processes

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 duration of exposure. In general, these effects and impacts are summarised below for each of the five categories.

For this assessment, entrained oil has been considered as included in the physical effects of oil, which is captured in the 'floating' component of this assessment. Therefore only two 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 reduction of 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 ensure appropriate rankings and processing. This developed through DoT's presentation of the project to the Environment Liaison Group of which DoT is a member. Feedback from the Environment Liaison Group 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
- Independent representatives as required.

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

Table 1-1: Steering Committee members for the Midwest 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 | Office of the Director General
	Steve Rowlands	Parks and Wildlife Data Manager
AMSA	Paul Irving	Senior Scientific Coordinator | Marine Environment Pollution Response
Roc Oil	Amelia Badri	Perth Basin Environment Advisor
Department of Fisheries	Carli Telfer	Senior Management Officer | Aquatic Environment Branch
	Natalie Moore	Senior Management Officer | Biodiversity Branch
EPA	Gordon Motherwell	Senior Environmental Officer | Infrastructure Assessments Branch

Emily, Ralph, Stuart, Paul, Carli and Gordon were engaged for the previous Pilbara zone 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 3: Midwest (301012-09591-EN-REP-0004) (sent 11 October 2016) for review and identification of additional data; and
- Workshop Discussion Paper (301012-09591-EN-EN-REP-0006) (sent 11 November 2016).

A workshop was held with the Steering Committee on 16 November 2016 to review the priority ranking process. The priority rankings were reviewed using the rankings assigned for priorities in the initial Pilbara zone, and rankings introduced for new sensitivities found in the Midwest. 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 Steering Committee members involved in all three zones assessed to date (Pilbara, Midwest and Swan) were also engaged to review and assess the revised protection priority rankings following the State Wide Overview assessment.

The agreed rankings that have been used for the Midwest 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 initial Pilbara zone assessment, which has been hugely beneficial. It is recommended that as the project moves across the remaining zones, the committee composition remains largely constant, with local subject matter experts added as appropriate.

In the Workshop on 16 November 2016, the following issues were also discussed:

- Houtman Abrolhos Islands – The islands were discussed at length, as there is an A-Class Reserve (A20253) over the islands, vested in the Minister of Fisheries, for conserving flora and fauna, tourism, and purposes associated with the fishing industry. This reserve is managed by the WA Department of Fisheries (DoF) through the *Fish Resources Management Act 1994*. The vested land was described to cover a vast majority of marine waters as well as the islands, and DoF raised the issue that the islands that are inhabited

will be reclassified and become a multi-use National Park to be managed in the near future by DPaW. The remaining uninhabited islands will remain A-Class Reserve. This is the only terrestrial location in WA that is protected under the *Fish Resources Management Act* and therefore vested with the WA DoF. In addition, the reserve boundary is being revised to better reflect the high and low water mark out at the islands, which is being done by Landgate. These changes have been reflected in this assessment;

- 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 Midwest 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 has been agreed to adopt a higher ranking for furry marine mammals;
- 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 was not an issue in the Pilbara zone nor has it been an issue in the Midwest, as there is a lot of data available. It may become a requirement in other zones where the equivalent amount of data does not yet exist, for example the Kimberley zone;
- Incorporation of seasonality – Periods of higher vulnerability were incorporated 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. For the Midwest it was particularly noted for seabird distribution taken from the DPaW fauna dataset, but also more widely targeted at the DPaW fauna dataset in general. Chris Surman from Halfmoon Biosciences, a well-regarded seabird expert in WA, raised the concern that some of the DPaW dataset consists of wildlife protected under the State *Wildlife Conservation Act 1950* (sightings recorded since 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 as well as island visits, which include the Houtman Abrolhos Islands which are "a stronghold of seabird breeding in Australia". 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 10; 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. Effort was concentrated into obtaining engagement early, and adhering to the data cut-off date.

During the previous Pilbara zone assessment, it was also noted that there are some more 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).

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

The ranking approach was revised in mid-2017. The Steering Committee was provided with an opportunity to comment on this revised approach during the Steering Committee workshop held for the Midwest in November 2017. This revision incorporated the records' certainty into the ranking. Using the supporting information supplied with the DPaW Fauna datasets, rankings were updated to incorporate how the species uses the area, i.e. breeding, foraging, inter-nesting, etc., and the certainty of the record, i.e. scats, tracks, observed, certain or likely to use the area. No further comments were received on the revision of the rankings specific to the Midwest zone.

2 Geospatial Data

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 Midwest zone built on the data that was identified and collected during the initial Pilbara zone assessment (see Advisian, 2016a).

The datasets collected during the Pilbara zone, and which are continuing to be collected or updated 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 Midwest zone for use. However, if the datasets are updated in the future, the updated datasets will be collected and used for the new zones. Efficiencies in this system are therefore expected to occur in future zones, as has been the case with this zone, following on from the initial Pilbara zone assessment.

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. This is an online interactive map maintained by the 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 covered approximately the whole of the Midwest 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. This data was downloaded and incorporated into this assessment.

2.2 Other Data Sources

It was identified that some data sources may not be publically available. This has occurred in the Pilbara zone, with some data identified to be available but not in geospatial format. One example of this was information and ratings of beaches from Surf Life Saving WA. In this example, beach popularity information was identified and a geospatial shapefile created for the beaches from a Google Maps location file. The same process has been followed for the Midwest zone data.

2.3 Steering Committee Review of Data List

The geospatial layers outlined in Table 2-1 have been included in the assessment for Zone 3 Midwest. These data layers were provided to the Steering Committee for review on 11 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 Midwest 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.

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	▪ Commonwealth DotE Biologically Important Areas (BIA) for marine species	▪ 4 Jan 2016
Mammals	3.1.2	▪ DotE Species of National Environmental Significance (SNES)	▪ 5 Oct 2016
Invertebrates	3.1.3	▪ WA Department of Parks and Wildlife (DPaW) for fauna	▪ 2 Mar 2017
Fish	3.1.4	▪ Dugong aggregation area – Henri Freycinet Harbour, Shark Bay (Holley *et al.,* 2006)	▪ Mar 2005
Reptiles	3.1.5	▪ Gnaraloo Station turtle nesting area	▪ Oct 2016
Protection Areas			
World Heritage Areas	3.2.1	▪ DotE World Heritage Areas	▪ 14 Oct 2015
Terrestrial Protection Areas	3.2.2	▪ DotE Collaborative Australian Protected Areas Database (CAPAD) 2014 – terrestrial	▪ 30 Jun 2016
Marine Protection Areas	3.2.3	▪ DotE CAPAD – marine ▪ DPaW – Proposed Houtman Abrolhos Islands National Park	▪ 30 Jun 2016 ▪ Dec 2016
Ramsar and Nationally Important Wetlands	3.2.4	▪ DotE Ramsar Wetlands of Australia ▪ DotE Directory of Important Wetlands in Australia	▪ 16 Feb 2015 ▪ 15 Oct 2008
Key Ecological Features	3.2.5	▪ DotE Marine Key Ecological Features	▪ 16 Sep 2015
Coastal Habitats	3.2.6	▪ DoT Oil Spill Response Atlas (OSRA) WA shorelines Environmental Sensitivities Index (ESI) ▪ DPaW Habitats ▪ DPaW Shark Bay Mangroves	▪ Apr 2011 ▪ May 2015 ▪ 8 Feb 2013
Benthic Habitats	3.2.7	▪ OSRA ESI (coral, algae) ▪ Coastal and Marine Resources Information System (CAMRIS) Seagrass ▪ Marine Futures Benthic Habitat Mapping	▪ Apr 2011 ▪ 10 Mar 2015 ▪ Aug 2008
Fish Habitat Protection Areas (FHPAs) and Fisheries Prohibited Areas	3.2.8	Department of Fisheries (DoF) Fish Habitat Protection Areas: ▪ Point Quobba FHPA ▪ Maboolya Beach FHPA ▪ Kalbarri Blue Holes FHPA ▪ Abrolhos Islands FHPA ▪ Lancelin Island Lagoon FHPA	▪ 2 Mar 2016

Layer	Section	Data Source	Last Updated
		DoF Areas closed to fishing under S43 of *Fish Resources Management Act 1994:*	
		▪ Houtman Abrolhos Islands	▪ 1994
		▪ Jurien Bay Marine Park	▪ 2 Dec 2005
		▪ Ningaloo Marine Park	▪ 9 Sep 2005
		▪ Shark Bay Marine Park	▪ 1 Mar 2013
		▪ South Tomi Wreck Site	▪ 30 Aug 2005
Protected Areas for Aquaculture and Pearling	3.2.9	▪ No protection areas identified	
Cultural Heritage			
World Heritage Properties	3.3.1	▪ DotE World Heritage Areas	▪ 15 Oct 2015
National Heritage	3.3.1	▪ DotE National Heritage List	▪ 11 Feb 2016
Commonwealth Heritage Places	3.3.1	▪ DotE Commonwealth Heritage – public	▪ 23 Feb 2016
State Protected Heritage	3.3.2	▪ State Register	▪ 10 Oct 2016
		▪ Conservation Orders	▪ 10 Oct 2016
		▪ Heritage Agreements	▪ 10 Oct 2016
		▪ Town Planning Scheme ('Heritage List')	▪ 10 Oct 2016
		▪ Municipal Inventory	▪ 10 Oct 2016
Shipwrecks and Maritime Archaeology	3.3.3	▪ DotE Australian National Shipwrecks	▪ 3 Feb 2016
		▪ WA Museum Recorded Shipwrecks	▪ 28 Jan 2016
Economic			
Aquaculture	3.4.1	▪ DoF Aquaculture Licences	▪ 9 Mar 2015
State Managed Commercial Fisheries	3.4.2	DoF individual shapefiles for each fishery:	
		▪ Western Rock Lobster	▪ 3 Jun 2015
		▪ Abrolhos Islands and Mid-West Trawl	▪ 11 Sep 2015
		▪ Shark Bay Prawn	▪ 11 Sep 2015
		▪ Abalone	▪ 20 Apr 2015
		▪ Gascoyne Demersal Scalefish	▪ 11 Sep 2015
		▪ Shark Bay Beach Seine and Mesh Net	▪ 11 Sep 2015
		▪ Shark Bay Crab	▪ 11 Sep 2015
		▪ Shark Bay Scallop	▪ 3 Jan 2013
		▪ Mackerel	▪ 11 Sep 2015
		▪ Marine Aquarium Fish	▪ 3 Jan 2013
		▪ Octopus Interim	▪ 8 Nov 2012
		▪ Specimen Shell	▪ 24 Mar 2015
		▪ West Coast Deep Sea Crustacean	▪ 11 Sep 2015
		▪ West Coast Demersal Gillnet and Demersal Longline Interim	▪ 11 Sep 2015
		▪ West Coast Demersal Scalefish	▪ 11 Sep 2015

Layer	Section	Data Source	Last Updated
Commonwealth Managed Fisheries	3.4.3	Australian Fishing Management Authority (AFMA): ▪ Western Tuna and Billfish ▪ Western Skipjack ▪ Southern Bluefin Tuna	 ▪ Mar 2016 ▪ Mar 2016 ▪ Mar 2016
Other Commercial Operations	3.4.4	▪ None identified	▪ N/A
Tourism	3.4.5	▪ Tourism WA	▪ Aug 2016
Ports and Shipping	3.4.6	▪ Department of Planning and Infrastructure Shipping and Pilotage Ports ▪ Landgate Port Authorities	▪ 25 Oct 2010 ▪ 23 Nov 2016
Water Intake Locations	3.4.7	▪ DoT Water Intake Location ▪ DoF Water Intake Locations	▪ 17 Dec 2012 ▪ 12 Dec 2016
Social, Amenity and Recreation			
Recreational Fishing/Boating Zones	3.5.1	▪ DotE CAPAD – marine	▪ 30 Jun 2016
Beaches	3.5.2	▪ Surf Life Saving WA beach popularity information ▪ Department of Planning – Town location and population size ▪ Beaches listed on Tourism's 'Australia's Best Beaches' list	▪ May 2016 ▪ Nov 2016 ▪ Feb 2016

2.4 Data Cut-Off and Summary of Inclusion

The Steering Committee's initial review of the data list for the Midwest 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 16 November 2016, and a final data cut-off date of 12 December 2016 was applied to produce this final report. No additional key datasets have been excluded from the Midwest, except for the updated DPaW Fauna data which was updated in March 2017.

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 Midwest 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 Midwest zone.

2.5 Data Excluded From Midwest Zone

During assessment of the first zone (the Pilbara), 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^2) 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.

The Coastal Landforms dataset was however used to identify and include potential recreation beaches in the Social, Amenity and Recreation category. This is because there was no other beach data available for the Pilbara.

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 included in this assessment 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 3.4.6 and Section 3.4.7.

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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 fauna behaviour and different states of vulnerability have been reflected in the occasional differences between the rankings for floating and dissolved priorities.

Additionally, the information provided in the datasets themselves has been incorporated when allocating protection priority rankings. For example, data confidence, reliability, accuracy and geospatial extent have been included in some instances where this information is available, in order to correctly reflect the key areas that require priority.

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 0) 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 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 2007.
- Western Australian *Wildlife Conservation Act 1950* (WC Act) which includes fauna of regional and local significance to the state.

The protection priority ranking considers the rankings adopted in the previous Pilbara zone assessment and the threatened status of a species listed under the EPBC Act[1] or the WC Act[2], and takes whichever is highest. The ranking 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 for species were taken into consideration, 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 inter-nesting travel is also lower than when it is active in its breeding and aggregation areas.

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 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

[1] 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 data was located for these species.

[2] Under the WC Act 11 conservation categories exist. In addition to those listed in the EPBC Act, there are six more used, including Conservation Dependent. 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

highest confidence, while 'secondary signs' and 'fossil' were the lowest along with 'not sure' and 'not defined'.

The process does not exclude responding to species if they are not formally protected; 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 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.

3.1.1 Birds

Description

WA is home to almost 550 species of birds; 387 of these have been recorded breeding (Birdlife WA, 2016). Seventeen (17) of these species are endemic to Western Australia. The Midwest zone is home to at least 70 legislatively protected bird species, and plays an important role in providing habitat for both endemic species and travelling migratory birds, which are protected under JAMBA and CAMBA agreements.

Bird 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.

The protected endemic and migratory birds known to occur in the Midwest region include the Critically Endangered (CR) curlew sandpiper (*Calidris ferruginea*) and eastern curlew (*Numenius madagascariensis*), the Endangered (EN) Abrolhos painted button-quail (*Turnix varia scintillans*), Australian lesser noddy (*Anous tenuirostris melanops*) and the Carnaby's cockatoo (*Calyptorhynchus latirostris*), and numerous Vulnerable (VU), migratory (IA) and Priority 4 (P4) species. It is predicted that several other species are likely to r may transit or inhabit the area, including the EN Australian painted snipe (*Rostratula australis*), and the VU white-capped albatross (*Thalassarche cauta steadi*) and wandering albatross (*Diomedea exulans (sensu lato)*) to name a few.

Distribution

The CR curlew sandpiper (*Calidris ferruginea*) and eastern curlew (*Numenius madagascariensis*) are found in the inner part of Shark Bay in Shoreline Cells 167 to 169 and 173, and south of Kalbarri in Shoreline Cell 182 at Hutt Lagoon. These species are described as having habitat known to occur in the area. The presence of these CR bird species in these shoreline cells, with species habitat known to occur in the area, gives them a ranking of High for protection from floating oil and Medium for protection from dissolved oil.

The EN Australian lesser noddy, the EN Abrolhos painted button-quail and several species of migratory terns and shearwaters are known to occur on the Abrolhos Islands, located in Shoreline Cells 332 to 336. The presence of these EN bird species in these shoreline cells, with species habitat certain in the area, gives them a ranking of High for protection from floating oil and Medium for protection from dissolved oil.

There are other bird species present along the coastline between Kalbarri and Geraldton which result in a ranking one level lower for protection from floating oil (Medium) and protection from dissolved oil (Low). These include a known occurrence of the VU fairy tern (*Sterna nereis nereis*) and the lesser sand plover.

South of Geraldton between Dongara and Lancelin, the bar-tailed godwit (northern Siberian) (*Limosa lapponica menzbieri*) is known to occur, resulting in a ranking of Medium for protection from floating oil and Low for protection from dissolved oil in Shoreline Cells 189, 190, 192, 195 and 196.

Discussion

The bird protection priority ranking considers both 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.

The EN Carnaby's cockatoo is concentrated in the southern-most shoreline cell (Shoreline Cell 197) and known to occur, with the record described as 'certain'. The Carnaby's cockatoo however has no habitat in the marine zone based on a review of literature available in DoEE (2017d) and DPaW (2013a). Based on the information reviewed for the Baudin's cockatoo, the protection priority ranking for this species is Very Low for protection from both floating and dissolved oil.

The EN Abrolhos painted button-quail located in Shoreline Cells 332 to 334 is most common in open *Spinifex longifolius* grassland on low sand dunes, and in open shrubland, composed of *Atriplex cinerea* and *Halosarcia halocnemoides*. It also occurs in *Frankenia pauciflora* shrubland and dense thickets of *Nitraria*, and occasionally forages in the sub-littoral zone and around fishing camps (Storr 1965a). The diet of the painted button-quail (Houtman Abrolhos) is essentially unknown. It takes scraps from around fishing camps (Storr, 1965a) and, based on observations of the subspecies T. v. varia on mainland Australia, probably feeds on a combination of seeds, fruits and insects (Cleland *et al.,* 1918; Johnstone & Storr, 1998; McKeown, 1944; Rose, 1973). Based on its likely use of the coastal zone, a protection priority ranking of High for protection from floating oil and Medium for protection from dissolved oil is associated with Shoreline Cells 332 to 334.

EN Baudin's cockatoo (*Calyptorhynchus baudinii*) is found in Shoreline Cells 180 and 185, and has no habitat in the marine zone. It is a terrestrial species with habitat including coastal trees and vegetation. Based on the information reviewed for the Baudin's cockatoo, the priority ranking for this species for protection from floating and dissolved oil is Very Low (DoEE, 2017c; DEC, 2008a).

VU malleefowl (*Leipoa ocellata*) is known to occur in Shoreline Cells 189 and 190. The Malleefowl is found in semi-arid to arid shrublands and low woodlands, especially those dominated by mallee and/or acacia. A sandy substrate and abundance of leaf litter are required for breeding. The birds are generally denser in areas of higher rainfall and on more fertile soils where habitats tend to be thicker and there are abundant food plants. The malleefowl is generalist and opportunistic, feeding on seeds, flowers and fruits of shrubs (especially legumes), herbs, invertebrates, tubers and fungi

(Benshemesh, 2007; Garnett, 2010). Its diet is locality specific (Reichelt and Jones, 2008 in Garnett, 2010). The information reviewed indicates that the malleefowl does not use the coastal zone for foraging, nesting or breeding so the priority ranking is Very Low for protection from floating and dissolved oil.

The ranking also considers the biological importance of an area to a species, elevating the priority of an area that could contain high numbers for that species, and the 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 fauna, especially birds (French-McCay *et al.,* 2002; 2004; 2006). When oiled, birds' 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 through ingestion from preening or feeding on contaminated prey such as benthic invertebrates.

Table 3-2: Bird protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Birds			
Critically Endangered species, if: ▪ Breeding, nesting, aggregation or translocated population Known to occur in the area ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain	5	4	**Species considered:** All SNES listed birds, State protected species in the DPaW database, and DotE species listed as having BIAs in the area. **Importance:** 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 the areas during these times.
Critically Endangered species, if: ▪ Breeding, nesting, aggregation or translocated population Likely to occur ▪ Migration route, foraging, roosting, species or species habitat Known to occur ▪ Secondary signs Very Certain/WAM Vouchered/ Certain ▪ Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure Endangered species, if: ▪ Breeding, nesting, aggregation or translocated population Known to occur ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain	4	3	
Critically Endangered species, if: ▪ Migration route, foraging, roosting, species or species habitat Likely to occur in the area ▪ Hair/skin or unknown method Very Certain/WAM Vouchered/Certain ▪ Secondary signs Moderately Certain, Not Defined or Not Sure Endangered species, if: ▪ Breeding, nesting, aggregation or translocated population Likely to occur or low density in the area ▪ Migration route, foraging, roosting, species or species habitat Known to occur in the area ▪ Distribution, known core range and foraging Known to occur in DPaW database ▪ Secondary signs Very Certain/WAM Vouchered/ Certain ▪ Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure Vulnerable species, if: ▪ Breeding, nesting, aggregation or translocated population Known to occur in the area	3	2	

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain			
Critically Endangered species, if: ▪ Migration, connecting habitat and unknown, significant habitat Known to occur, high density ▪ Distribution, resting, nesting or foraging Likely to occur/low density ▪ Distribution, known core range or foraging May occur ▪ Breeding and aggregation Former Range ▪ Dead Very Certain/WAM Vouchered ▪ Hair/skin or unknown method Moderately Certain, Not Defined or Not Sure Endangered species, if: ▪ Distribution (low density), resting, nesting, foraging Likely, inter-nesting buffer, Known to occur ▪ Migration route, foraging, roosting, distribution, known core range, species or species habitat Likely to occur in the area ▪ Hair/skin or unknown method Very Certain/WAM Vouchered/Certain ▪ Secondary signs Moderately Certain, Not Defined or Not Sure Vulnerable species, if: ▪ Breeding, nesting, aggregation or translocated population Likely to occur or low density in the area ▪ Migration route, foraging, roosting, species or species habitat Known to occur in the area ▪ Distribution, known core range and foraging Known to occur in DPaW database ▪ Secondary signs Very Certain/WAM Vouchered/ Certain ▪ Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure Conservation Dependent, Other specially protected fauna and P1-P4 species, if: ▪ Breeding, nesting, aggregation or translocated population Known to occur in the area ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain	2	1	

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Critically Endangered species, if: ▪ Extinct in the area, dead, fossils, subfossil, historical record All Endangered, Vulnerable and Other species with a conservation code with all other information.	1	1	
Terrestrial birds which do not use the coastal zone for any instance of their lifecycle, and do not use the coastal zone as any component of their habitat.	1	1	This is researched through two sources which cite no use of the coastal/intertidal zone, one of which is SPRAT.

Data List

- DotE SNES (22 February 2017)
- *Wildlife Conservation Act 1950* protected fauna (2 March 2017)
- Biologically Important Areas (4 January 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 are found nowhere else in the world.

Mammal 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.

Terrestrial mammals include the CR woylie, also known as the brush-tailed bettong (*Bettongia penicillata ogilbyi*), EN western barred-bandicoot (*Perameles bougainville*), EN black-flanked rock wallaby (*Petrogale lateralis*), EN dibbler (*Parantechinus apicalis*) and VU Djoongari (Shark Bay mouse or *Pseudomys fieldi*), VU *Lagorchestes hirsutus bernieri* (Shark Bay rufous hare-wallaby, mala) and VU *Lagostrophus fasciatus fasciatus* (banded hare-wallaby).

Marine mammals in the Midwest zone include the EN pygmy blue whale (*Balaenoptera musculus brevicauda*), VU humpback whale (*Megaptera novaeangliae*) and OS dugong.

One additional dugong aggregation area was also identified from published literature not included in the BIA dataset. This was Henri Freycinet Harbour in the Shark Bay area.

Distribution

The Shark Bay coastal area (Shoreline Cells 167 to 169) is potentially inhabited by the critically endangered woylie, also known as the brush-tailed bettong (*Bettongia penicillata ogilbyi*), based on one dead specimen collected in 1997.

Shoreline Cells 167 to 169 and 330-331 houses the western barred-bandicoot, and Shoreline Cells 167 to 169 have the Djoongari and black-flanked rock wallaby. Jurien Bay (Shoreline Cell 193) houses the endangered dibbler (*Parantechinus apicalis*).

Marine mammals that may live in or visit the coastal waters of the Midwest zone include the VU humpback whale (*Megaptera novaeangliae*), the EN pygmy blue whale (*Balaenoptera musculus brevicauda*) and OS dugong. The whale habitats are described as habitat known to occur and are found in Shoreline Cells 135 and 136 (Lake MacLeod, north of Carnarvon), Shoreline Cells 177 to 180 (north of Kalbarri), Shoreline Cells 183, 186, 187 and 189 (Geraldton and Dongara), and Shoreline Cells 195 and 196 (south of Jurien Bay).

The EN dibbler (*Parantechinus apicalis*) is known to occur in Shoreline Cells 193 and 194 (Jurien Bay).

Furry marine mammals also visit the Midwest zone, including the VU Australian sea-lion, which is known to forage and visit the Abrolhos Islands (Shoreline Cells 332 to 336) and the mainland south of Jurien Bay (Shoreline Cell 194). However, they do not influence the ranking of the shoreline cells, which are ranked higher because other species are present in those shoreline cells.

Discussion

Whales, dolphins, furry marine mammals and dugongs could come in direct contact with floating oil, or potentially ingest hydrocarbons that are dissolved when feeding. Physical oiling can burn and irritate eyes. The effects of oil on marine mammals, such as cetaceans, have been shown to be minor following an oil spill (NOAA, 2016). Cetaceans are more likely to be affected when their bodies become 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.

One species was also identified as a unique case and re-ranked. The southern right whale is listed as Critically Endangered, with "Breeding, calving or aggregation Known to occur in area", across most of southern Western Australia. Because it is present in a large number of shoreline cells, 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 the case of an oil spill. This single species was re-ranked as lower than the prescribed value following the process described above.

The original ranking for the southern right whale in breeding and calving areas was Very High, which resulted in the majority of the shoreline cells being given a Very High protection priority ranking. Through the treatment of the southern right whale area in this manner, the ranking is dropped from Very High to Medium where breeding and congregation occurs. No other species were identified as requiring this additional step.

While the data for the CR brush-tailed bettong appears to support it being located in the shoreline cells, its habitat and use of the coastal zone was researched further. It rests during the day in a well-concealed nest, built over a shallow depression that is most commonly constructed with 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). As the seagrass is dried, it is unlikely to be in the intertidal area, so 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. For this reason it

has been ranked Very Low for protection from floating and dissolved oil, and does not influence the overall ranking of the shoreline cells, despite being a critically endangered species.

The EN western-barred bandicoot is found in Shoreline Cells 167 to 169. The western-barred bandicoot is particularly common in scrub associated with vegetated dunes behind beaches, but occurs in all vegetation types (Friend & Burbridge, 1995). It shelters during the day in well-concealed nests made from plant material and constructed in a hemispherical hollow scrape beneath a low or prostrate shrub. Near the coast, nests may be made from accumulated dead seagrass (Friend & Burbridge, 1995). The western barred bandicoot appeared to be omnivorous, eating insects, seeds, roots, herbs and small animals (Flannery, 1990)

The research and available information supports the conclusion that the western-barred bandicoot does not forage or live in the coastal zone. The ranking for Shoreline Cells 167 to 169 is therefore not influenced by the presence of the western-barred bandicoot which is ranked Very Low for protection from both floating and dissolved oil.

Shoreline Cells 167 to 169 contain the EN black-flanked rock wallaby. The black-flanked rock wallaby exists in scattered populations restricted to sites with suitable rocky habitat with caves and crevices. It grazes on grass and herbs. The available literature indicates that it does not use the coastal zone for foraging or shelter (DoEE, 2017b; DPaW, 2013b). Because the evidence suggests that the species does not use the coastal zone and is unlikely to be impacted by an oil spill, the ranking of Very Low for protection from floating and dissolved oil has been assigned to the records of the black-flanked rock wallaby, despite its endangered ranking.

The EN dibbler (*Parantechinus apicalis*) is 'known to occur' in Shoreline Cells 193 and 194 (Jurien Bay). The species is known to exist in WA in isolated locations that occupy a diverse range of habitats, including island and mainland populations (DoEE, 2017g; TSSC, 2015). Capture sites all seem to have a similar vegetation structure, and Baczocha and Start (1997) suggested that dibblers "...seem to prefer vegetation with a dense canopy >1 metre high which has been unburnt for at least 10 years". It is noted however, that Boullanger and Whitlock Islands are separated by about 300 m of shallow water and are periodically linked by a sandbar (DoEE, 2017g). As such, the dibbler is probably able to move between the islands during periods of very low tide (Friend, 2004; Wolfe *et al.,* 2004). Based on this information, it has been determined that dibblers are not known to use the marine or intertidal environment. As such, the species would not be impacted by a marine oil spill, and has been ranked Very Low priority for protection from both floating and dissolved oil (DoEE, 2017g; Baczocha *et al.,* 1996; Friend, 2004; Wolfe *et al.,* 2004; TSCC, 2015).

Shoreline Cells 167 to 169 house the VU Djoongari (Shark Bay mouse) (*Pseudomys fieldi*). On Bernier Island, Djoongari inhabits coastal dune vegetation dominated by beach spinifex (*Spinifex longifolius*) and coast daisy bush (*Olearia axillaris*). The Djoongari is vegetarian/omnivorous, feeding mainly on petals, flowers and insects (DPaW, 2000). It does not appear to use burrows as commonly as most other Pseudomys species. It is known to construct tunnels and runways in heaps of seagrass piled up on Bernier Island beaches during winter storms (Robinson, 1983 in DPaW, 2000) and use above ground nests as diurnal refuges. More use of burrows is made during the breeding season (Morris and Speldewinde, 1992 in DPaW, 2000). Animals translocate to Doole Island using hollows sited above high water level in mangrove (*Avicennia marina*) trees, as well as sites among rocks and under *Triodia* for daytime refuges. Based on this information, it has been determined that the Djoongari are not known to use the marine or intertidal environment and the species would not be impacted by a marine oil spill, and has been ranked as a Very Low priority species for protection from both floating and dissolved oil.

The VU *Lagorchestes hirsutus bernieri* (Shark Bay rufous hare-wallaby) and VU *Lagostrophus fasciatus fasciatus* (banded hare-wallaby) are both found in Shoreline Cells 330-331 which are the Bernier and Dorre Islands respectively. The rufous hare-wallaby occurs in all habitat types on Bernier Island, including dunes, heath, grassland and low scrub in proportion to their availability. The rufous hare-wallaby is a herbivore and eats forbs, perennial grasses, grass seed heads, seeds, bulbs of sedges and some dicotyledonous plants (DoEE, 2017h). Based on this information it has been determined that the rufous hare-wallaby does not use the coastal zone or intertidal environmental for any aspect of its life cycle and would not be impacted by a marine oil spill. It has been ranked a Very Low priority for protection from both floating and dissolved oil.

The banded hare-wallaby occurs in all types of habitat on the islands including dunes, grassland and heathland. However, higher densities occur in areas of thicker vegetation. Habitat features critical to the survival of the Banded Hare-wallaby include areas of dense heath and shrub thickets to avoid predators. Banded hare-wallabies are herbivorous, consuming grasses, malvaceous and leguminous shrubs and other dicotyledonous plants (DoEE, 2017i). Based on this information it has been determined that the banded hare-wallaby does not use the coastal zone or intertidal environmental for any aspect of its life cycle and would not be impacted by a marine oil spill. It has been ranked a Very Low priority for protection from both floating and dissolved oil.

Table 3-3: Mammal protection priority ranking

<table>
<tr><th rowspan="2">Value Measure</th><th colspan="2">Ranking</th><th rowspan="2">Main Factors Considered in Ranking</th></tr>
<tr><th>Floating</th><th>Dissolved</th></tr>
<tr><td colspan="4">Mammals</td></tr>
<tr><td>Critically Endangered species, if:
Breeding, calving, congregation, aggregation or translocated population Known to occur in the area (except for the southern right whale)
Caught, trapped or sighted Very Certain/WAM Vouchered/Certain</td><td>5</td><td>4</td><td rowspan="3">Species considered: All SNES listed mammals, State protected species in the DPaW database, and DotE species listed as having BIAs in the area.
Importance: 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</td></tr>
<tr><td>Critically Endangered species, if:
Breeding, calving, congregation, aggregation or translocated population Likely to occur (except for the southern right whale)
Migration route, foraging, species or species habitat Known to occur
Secondary signs Very Certain/WAM Vouchered/ Certain
Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure
Endangered species, if:
Breeding, calving, congregation, aggregation or translocated population Known to occur
Caught, trapped or sighted Very Certain/WAM Vouchered/Certain</td><td>4</td><td>3</td></tr>
<tr><td>Critically Endangered species, if:
Migration route, foraging, species or species</td><td>3</td><td>2</td></tr>
</table>

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
habitat Likely to occur in the area (including the southern right whale) ▪ Hair/skin or unknown method Very Certain/ WAM Vouchered/Certain ▪ Secondary signs Moderately Certain, Not Defined or Not Sure Endangered species, if: ▪ Breeding, calving, congregation, aggregation or translocated population Likely to occur or low density in the area ▪ Migration route, foraging, species or species habitat Known to occur in the area ▪ Distribution, calving buffer, known core range and foraging Known to occur in DPaW database ▪ Secondary signs Very Certain/WAM Vouchered/ Certain ▪ Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure Vulnerable species, if: ▪ Breeding, calving, congregation, aggregation or translocated population Known to occur in the area ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain			foraging and migration areas were ranked as 'known habitat' and given a lower importance.
Southern right whale: all calving information. Critically Endangered species, if: ▪ Migration, connecting habitat and unknown, significant habitat Known to occur or high density ▪ Distribution or foraging Likely to occur/low density ▪ Distribution, calving buffer, known core range or foraging May occur ▪ Breeding, calving and aggregation Former Range ▪ Dead Very Certain/WAM Vouchered ▪ Hair/skin or unknown method Moderately Certain, Not Defined or Not Sure Endangered species, if: ▪ Distribution (low density), resting, nesting or foraging Likely, Known to occur ▪ Migration route, foraging, distribution, calving buffer, known core range, species or species habitat Likely to occur in the area ▪ Hair/skin or unknown method Very Certain/WAM Vouchered/Certain ▪ Secondary signs Moderately Certain, Not Defined	2	1	

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
or Not Sure Vulnerable species, if: ▪ Breeding, calving, congregation, aggregation or translocated population Likely to occur or low density in the area ▪ Migration route, foraging, species or species habitat Known to occur in the area ▪ Distribution, calving buffer, known core range and foraging Known to occur in DPaW database ▪ Secondary signs Very Certain/WAM Vouchered/ Certain ▪ Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure Conservation Dependent, Other specially protected fauna and P1-P4 species, if: ▪ Breeding, calving, congregation, aggregation or translocated population Known to occur in the area ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain			
Critically Endangered species, if: ▪ Extinct in the area, dead, fossils, subfossil, historical record All Endangered, Vulnerable and Other species with a conservation code with all other information.	1	1	
Terrestrial mammals which do not use the coastal zone for any instance of their lifecycle, and do not use the coastal zone as any component of their habitat.	1	1	This is researched through two sources which cite no use of the coastal/intertidal zone, one of which is SPRAT.
Data List ▪ DotE SNES (22 February 2017) ▪ *Wildlife Conservation Act 1950* protected fauna (2 March 2017) ▪ Biologically Important Areas (4 January 2016) ▪ Dugong aggregation area – Henri Freycinet Harbour, Shark Bay (Holley *et al.,* 2006) (March 2005) ▪ Gnaraloo Station turtle nesting area (October 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. No marine invertebrates are legislatively protected. While coral is an invertebrate, it is included under Protection Areas as a 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.

One protected terrestrial invertebrate is found in the Midwest zone. This is the VU shield-backed trapdoor spider or black rugose trapdoor spider (*Idiosoma nigrum*). This record is very certain as it was caught or trapped.

Distribution

The shield-backed trapdoor spider is found in a single coastal strip near Geraldton.

The shield-backed trapdoor spider is an opportunistic feeder and feeds primarily on ants, but also on beetles, cockroaches, millipedes and moths (Clark & Spier-Ashcroft, 2003 in DoEE, 2017c). The species relies on the twigs and leaves it attaches to the rim of its burrow to detect prey in the vicinity. Because it relies on leaf litter, any loss of that leaf litter through inappropriate fire regimes and management may significantly impact the species' ability to feed. The species is very well adapted for life in semi-arid habitats and lives in burrows that are tubular and approximately 20-30 cm deep. The burrow is deep enough to ensure air in the lower burrow remains humid and relatively cool in summer. The shield-backed trapdoor spider is endemic to semi-arid south-west Western Australia. It occurs in a number of severely fragmented populations in the central and northern Wheatbelt, the Midwest and coastal areas of the Midwest (e.g. Zuytdorp Station north of the Murchison River and Nanga Station south of Shark Bay) (DoEE, 2017c)

Based on the information reviewed, it is apparent that the species requires deep, clayey-sand habitat to make its burrows, and does not feed on crustaceans or marine flora. It has therefore been deemed unlikely that the shield-backed trapdoor spider will be impacted by floating or dissolved oil. The presence of this VU species gives Shoreline Cell 186 a ranking of Very Low for protection from both floating and dissolved oil.

Discussion

As some protected terrestrial invertebrates have habitats along the coast, a protection priority ranking has been adopted for terrestrial invertebrates only. It is expected that the effect on terrestrial invertebrates such as spiders is expected to be fatal in the event of an oil spill washing up on shore and coating their habitat. Dissolved oil will have a very low effect.

In this case, the terrestrial invertebrate found in the Midwest zone does not use the coastal zone for its habitat, so the ranking assigned due to its presence in the Shoreline Cell 186 is Very Low.

Table 3-4: Invertebrate protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Terrestrial Invertebrates			
Critically Endangered species, if: ▪ Breeding, congregation, aggregation or translocated population Known to occur in the area ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain	5	1	**Species considered:** 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. **Importance:** Terrestrial invertebrates may be in the area and tend to be concentrated to highly localised areas. In an oil spill, their coastal habitats may become oiled and this is expected to be fatal. Dissolved oil is not expected to have an impact. 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. This is to reflect the higher vulnerability of an invertebrate during breeding, including the vulnerability of its young, and also the aggregation of the
Critically Endangered species, if: ▪ Breeding, congregation, aggregation or translocated population Likely to occur ▪ Migration route, foraging, species or species habitat Known to occur ▪ Secondary signs Very Certain/WAM Vouchered/ Certain ▪ Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure Endangered species, if: ▪ Breeding, congregation, aggregation or translocated population Known to occur ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain	4	1	
Critically Endangered species, if: ▪ Migration route, foraging, species or species habitat Likely to occur in the area ▪ Hair/skin or unknown method Very Certain/ WAM Vouchered/Certain ▪ Secondary signs Moderately Certain, Not Defined or Not Sure Endangered species, if: ▪ Breeding, congregation, aggregation or translocated population Likely to occur or low density in the area ▪ Migration route, foraging, species or species habitat Known to occur in the area ▪ Distribution, known core range and foraging Known to occur in DPaW database ▪ Secondary signs Very Certain/WAM Vouchered/ Certain ▪ Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure Vulnerable species, if: ▪ Breeding, congregation, aggregation or	3	1	

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
translocated population Known to occur in the area ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain			species in certain the areas during these times.
Critically Endangered species, if: ▪ Migration, connecting habitat and unknown, significant habitat Known to occur, high density ▪ Distribution, nesting or foraging Likely to occur/ low density ▪ Distribution, known core range or foraging May occur ▪ Breeding and aggregation Former Range ▪ Dead Very Certain/WAM Vouchered ▪ Hair/skin or unknown method Moderately Certain, Not Defined or Not Sure Endangered species, if: ▪ Distribution (low density), nesting or foraging Likely, Known to occur ▪ Migration route, foraging, distribution, known core range, species or species habitat Likely to occur in the area ▪ Hair/skin or unknown method Very Certain/ WAM Vouchered/Certain ▪ Secondary signs Moderately Certain, Not Defined or Not Sure Vulnerable species, if: ▪ Breeding, congregation, aggregation or translocated population Likely to occur or low density in the area ▪ Migration route, foraging, species or species habitat Known to occur in the area ▪ Distribution, known core range or foraging Known to occur in DPaW database ▪ Secondary signs Very Certain/WAM Vouchered/ Certain ▪ Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure Conservation Dependent, Other specially protected fauna and P1-P4 species, if: ▪ Breeding, congregation, aggregation or translocated population Known to occur in the area ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain	2	1	

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Critically Endangered species, if: ▪ Extinct in the area, dead, fossils, subfossil, historical record All Endangered, Vulnerable and Other species with a conservation code with all other information.	1	1	
Terrestrial invertebrates which do not use the coastal zone for any instance of their lifecycle, and do not use the coastal zone as any component of their habitat.	1	1	This is researched through two sources which cite no use of the coastal/intertidal zone, one of which is SPRAT.

Data List

- DotE SNES (22 February 2017)
- *Wildlife Conservation Act 1950* protected fauna (2 March 2017)
- Biologically Important Areas (4 January 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.

Fish species under the Protected Fauna category incorporates fish which are protected under conservation legislation. This includes the whale shark (*Rhincodon typus*), grey nurse shark (*Carcharias taurus*), great white shark (*Carcharodon carcharias*) and leafy seadragon (*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. These include whale shark, potato cod, humphead Maori wrasse, leafy and weedy seadragons, and sawfish.

Two protected fish species are found in the Midwest zone: the VU narrowsnout sawfish (*Pristis zijsron*) and great white shark (*Carcharodon carcharias*).

Fish habitat protection areas are included in the Protection Areas category, in Section 3.2. Fishing areas associated with economic and tourism enterprise are included in the Economic category in Section 3.4. The records of fish distribution included in this assessment came from the DPAW NatureMap records, DotE SNES polygons, and the BIA polygons for fish. 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.

Distribution

The VU narrowsnout sawfish (*Pristis zijsron*) and great white shark (*Carcharodon carcharias*) have been identified with breeding likely to occur in the area in Shoreline Cells 135 and 136, near Lake MacLeod north of Carnarvon, and in the islands off Shark Bay in Shoreline Cells 330 and 331. These cells are ranked Very Low for protection from floating oil and Low for protection from dissolved oil.

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 pipefish. 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 was used to determine its ranking in the first instance; where point data was available, the shoreline cell was ranked where the fish had been recorded.

Table 3-5: Fish protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Fish			
Critically Endangered species, if: ▪ Breeding, congregation, aggregation or translocated population Known to occur in the area ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain	4	5	**Species considered:** All SNES listed fish, State protected species in the DPaW database, and DotE species listed as having BIAs in the area. **Importance:** 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
Critically Endangered species, if: ▪ Breeding, congregation, aggregation or translocated population Likely to occur ▪ Migration route, foraging, species or species habitat Known to occur ▪ Secondary signs Very Certain/WAM Vouchered/ Certain ▪ Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure Endangered species, if: ▪ Breeding, congregation, aggregation or translocated population Known to occur ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain	3	4	

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Critically Endangered species, if: ▪ Migration route, foraging, species or species habitat Likely to occur in the area ▪ Hair/skin or unknown method Very Certain/WAM Vouchered/Certain ▪ Secondary signs Moderately Certain, Not Defined or Not Sure Endangered species, if: ▪ Breeding, congregation, aggregation or translocated population Likely to occur or low density in the area ▪ Migration route, foraging, species or species habitat Known to occur in the area ▪ Distribution, known core range and foraging Known to occur in DPaW database ▪ Secondary signs Very Certain/WAM Vouchered/ Certain ▪ Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure Vulnerable species, if: ▪ Breeding, congregation, aggregation or translocated population Known to occur in the area ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain	2	3	range areas were ranked as 'known habitat' and given a lower importance.
Critically Endangered species, if: ▪ Migration, connecting habitat and unknown, significant habitat Known to occur, high density ▪ Distribution or foraging Likely to occur/low density ▪ Distribution, known core range or foraging May occur ▪ Breeding and aggregation Former Range ▪ Dead Very Certain/WAM Vouchered ▪ Hair/skin or unknown method Moderately Certain, Not Defined or Not Sure Endangered species, if: ▪ Distribution (low density), foraging Likely, Known to occur ▪ Migration route, foraging, Distribution, known core range, species or species habitat Likely to occur in the area ▪ Hair/skin or unknown method Very Certain/WAM Vouchered/Certain	1	2	

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
▪ Secondary signs Moderately Certain, Not Defined or Not Sure Vulnerable species, if: ▪ Breeding, congregation, aggregation or translocated population Likely to occur or low density in the area ▪ Migration route, foraging, species or species habitat Known to occur in the area ▪ Distribution, known core range and foraging Known to occur in DPaW database ▪ Secondary signs Very Certain/WAM Vouchered/ Certain ▪ Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure Conservation Dependent, Other specially protected fauna and P1-P4 species, if: ▪ Breeding, congregation, aggregation or translocated population Known to occur in the area ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain			
Critically Endangered species, if: ▪ Extinct in the area, dead, fossils, subfossil, historical record All Endangered, Vulnerable and Other species with a conservation code with all other information.	1	1	
Freshwater fish species which do not use the intertidal zone for any instance of their lifecycle, and do not use the coastal/intertidal zone as any component of their habitat.	1	1	This is researched through two sources which cite no use of the coastal/intertidal zone, one of which is SPRAT.
Data List ▪ DotE SNES (22 February 2017) ▪ *Wildlife Conservation Act 1950* protected fauna (2 March 2017) ▪ Biologically Important Areas (4 January 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. Reptile distribution, species and legislated protection classification data was obtained as 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 obtained from the Biologically Important Areas (BIA) database.

Reptiles found in the Midwest zone include five species of marine turtles: the EN loggerhead (*Caretta caretta*) and leatherback (*Dermochelys coriacea*) turtles, and VU green (*Chelonia mydas*), flatback (*Natator depressus*) and hawksbill (*Eretmochelys imbricata*) turtles. There are numerous land snakes, skinks and lizards that are also protected, such as the VU Abrolhos dwarf bearded dragon.

Distribution

Reptiles including the EN loggerhead turtle and the VU green and flatback turtles are found along the entire Midwest coastline. There are key turtle nesting beaches located in Shoreline Cells 132 to 134 adjacent to Lake MacLeod, and in Shark Bay nearest to Denham (Shoreline Cells 152 to 157). These shoreline cells are ranked High for protection from floating oil and Medium for protection from dissolved oil.

The Abrolhos Islands (Shoreline Cells 332 to 336) are home to several protected terrestrial reptile species including the VU Abrolhos dwarf bearded dragon.

Additional EN loggerhead turtle nesting areas were identified through records of Gnaraloo Station (Shoreline Cells 132 to 134) which are currently outside the formally protected marine reserve network. Shoreline Cells 132 to 134 are ranked High for protection from floating oil and Medium for protection from dissolved oil due to the confirmed presence of these turtle nesting beaches.

Discussion

The assessment of impacts on reptiles considered that physical oiling by floating oil causes irritation to 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 directly ingest dissolved oil.

In the protection priority ranking for reptiles (Table 3-6), the conservation category as well as the above considerations were taken into account. The species' key uses such as nesting and breeding were also considered. 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 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. The priority rankings consider data confidence, reliability, survey method type, accuracy and geospatial extent.

The Abrolhos Islands (Shoreline Cells 332 to 336) are home to several protected terrestrial reptile species including the VU Abrolhos dwarf bearded dragon. It occurs in sandy habitats or outcrops of limestone. The range is restricted to three islands of the Wallabi Group: North Island; East Wallabi Island; and West Wallabi Island. The distribution range of this subspecies is around 80 km from the mainland and its near relations (Revolvy, 2017). Based on this information, it is apparent that the Abrolhos dwarf bearded dragon does not use the intertidal or coastal zone, so the species is ranked Very Low for protection from both floating and dissolved oil. The presence of other protected fauna species in these shoreline cells results in a higher ranking; it is not driven by the presence of the Abrolhos dwarf bearded dragon.

Shoreline Cell 186 contains a known occurrence of the VU *Cyclodomorphus branchialis* (common slender blue-tongue). From a report by GHD (2010) : '*Specimens have been observed under artificial habitat in Acacia scrub on hard red clay soils, under rocks floodplains, under laterite boulders on top of a limestone ridge in Acacia scrub, and below the soil surface in gravelly sand and leaf litter (Shea and Miller, 1995). The Gilled Slender Bluetongue is known from a few locations scattered in Western Australia, from the Irwin River, north to the Murchison River and inland to Mount Magnet. NatureMap also indicates 36 records in Western Australia, with two locations recorded from the vicinity of Mount Magnet in August 2005*'. Shea and Miller (1995) concluded that the *Cyclodomorphus branchialis* species group feeds mainly on arthropods, lizards, fruit and seeds with no evidence in this reference of feeding on marine invertebrates or foraging within the coastal zone. The species is ranked Very Low for protection from both floating and dissolved oil and the presence of other protected fauna species in these shoreline cells results in a higher ranking; it is not driven by the presence of the common slender blue tongue.

Table 3-6: Reptile protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Reptiles			
Critically Endangered species, if: ▪ Breeding, congregation, aggregation or translocated population Known to occur in the area ▪ Caught, trapped or sighted Very Certain/WAM Vouchered/Certain	5	4	**Species considered:** All SNES listed reptiles, State protected species in the DPaW database, and DotE species listed as having BIAs in the area. **Importance:** 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 the areas during these times.
Critically Endangered species, if: ▪ Breeding, congregation, aggregation or translocated population Likely to occur ▪ Migration route, foraging, species or species habitat Known to occur ▪ Secondary signs Very Certain/WAM Vouchered/Certain ▪ Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure Endangered species, if: ▪ Breeding, congregation, aggregation or translocated population Known to occur ▪ Caught, trapped or sighted Very Certain/ WAM Vouchered/Certain	4	3	
Critically Endangered species, if: ▪ Migration route, foraging, species or species habitat Likely to occur in the area ▪ Hair/skin or unknown method Very Certain/WAM Vouchered/Certain ▪ Secondary signs Moderately Certain, Not Defined or Not Sure Endangered species, if: ▪ Breeding, congregation, aggregation or translocated population Likely to occur or low density in the area ▪ Migration route, foraging, species or species habitat Known to occur in the area ▪ Distribution, inter-nesting, known core range and foraging Known to occur in DPaW database ▪ Secondary signs Very Certain/WAM Vouchered/Certain ▪ Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure Vulnerable species, if: ▪ Breeding, congregation, aggregation or	3	2	

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
translocated population Known to occur in the area ▪ Caught, trapped or sighted Very Certain/ WAM Vouchered/Certain			
Critically Endangered species, if: ▪ Migration, connecting habitat and unknown, significant habitat Known to occur, high density ▪ Distribution, resting, nesting, foraging or inter-nesting buffer Likely to occur/low density ▪ Distribution, inter-nesting, known core range or foraging May occur ▪ Breeding and aggregation Former Range ▪ Dead Very Certain/WAM Vouchered ▪ Hair/skin or unknown method Moderately Certain, Not Defined or Not Sure Endangered species, if: ▪ Distribution (low density), nesting, foraging likely or inter-nesting buffer Known to occur ▪ Migration route, foraging, distribution, inter-nesting, known core range, species or species habitat Likely to occur in the area ▪ Hair/skin or unknown method Very Certain/WAM Vouchered/Certain ▪ Secondary signs Moderately Certain, Not Defined or Not Sure Vulnerable species, if: ▪ Breeding, congregation, aggregation or translocated population Likely to occur or low density in the area ▪ Migration route, foraging, species or species habitat Known to occur in the area ▪ Distribution, inter-nesting, known core range and foraging Known to occur in DPaW database ▪ Secondary signs Very Certain/WAM Vouchered/Certain ▪ Caught, trapped or sighted Moderately Certain, Not Defined or Not Sure Conservation Dependent, Other specially protected fauna and P1-P4 species, if: ▪ Breeding, congregation, aggregation or translocated population Known to occur in	2	1	

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
the area ▪ Caught, trapped or sighted Very Certain/ WAM Vouchered/Certain			
Critically Endangered species, if: ▪ Extinct in the area, dead, fossils, subfossil, historical record All Endangered, Vulnerable and Other species with a conservation code with all other information.	1	1	
Terrestrial protected reptiles which do not use the coastal zone for any instance of their lifecycle, and do not use the coastal zone as any component of their habitat.	1	1	This is researched through two sources which cite no use of the coastal/intertidal zone, one of which is SPRAT or DPaW.

Data List

- DotE SNES (22 February 2017)
- *Wildlife Conservation Act 1950* protected fauna (2 March 2017)
- Biologically Important Areas (4 January 2016)
- Gnaraloo Station turtle nesting data (October 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 previous Pilbara zone assessment, 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.

This is the case with the proposed Houtman Abrolhos Islands National Park. While the protection area has been proposed for formal protection under State and Commonwealth legislation, land tenure boundaries have not yet been finalised during this assessment. However, due to the shoreline cells being so broad, the exact boundary locations are not critical and the proposed areas have been included in this assessment, with the broad area of the extent being protected based on a shapefile created from the description provided by the WA DoF.

In the Midwest Steering Committee Workshop held on 16 November 2016, the Houtman Abrolhos Islands were discussed at length. There is an A-Class Reserve (A20253) over the islands, vested in the Minister of Fisheries for the conservation of flora and fauna, tourism, and purposes associated with the fishing industry. It is unique as it is the only terrestrial location in WA that is protected under the *Fish Resources Management Act 1994* and therefore vested with the WA DoF. The vested land was described to cover a vast majority of marine waters as well as the islands. DoF highlighted that there is a proposal for the islands that are inhabited to be reclassified and become a multi-use National Park to be managed by DPaW in the near future. The other uninhabited islands would remain part of the A-Class Reserve. In addition, Landgate is revising the reserve boundary to better reflect the high and low water mark out at the islands. These changes have been reflected in this assessment.

3.2.1 World Heritage Areas

Description

In 2005, Australia had 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 cultural and heritage value. 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).

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 this 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.

The DotE World Heritage Areas dataset was used to delineate the World Heritage areas in the Midwest zone.

Distribution

There are two World Heritage areas in the Midwest zone: the Shark Bay Marine Park which covers 43 shoreline cells (Shoreline Cells 138 to 178 and Dirk Hartog Island Shoreline Cells 330 and 331); and the very southern extent of the Ningaloo Coast area in the northern portion of the zone, which covers three shoreline cells (Shoreline Cells 132 to 134). No additional proposed or nominated evidence for the Midwest zone have been identified. The UNESCO World Heritage Council does not list areas nominated for World Heritage Listing. In 2016, there were 44 nominations, with 40 assessed and four (4) incomplete. There are a further 37 proposed for review in 2017 (UNESCO, 2016).

The areas are recognised for their natural features including rich flora diversity; twenty-five per cent (283 species) of the area's vascular plants are at the limits of their range in Shark Bay. Many vegetation associations and plant species are found only in the areas between different biological

zones. Stromatolites, which are ancient, cemented blue-green algae, are found in Hamelin Pool (Shoreline Cell 146). The presence of these ancient algae was a key driver for nominating Shark Bay as a World Heritage Area. The area south of Freycinet Estuary contains the unique type of vegetation known as tree heath. There are also at least 51 species endemic to the region, and others that are considered new to science (DotE, 2016).

The Shark Bay region is an area of major zoological importance, primarily due to habitats on peninsulas and islands being isolated from the disturbance that has occurred elsewhere. Of the 26 species of endangered Australian mammals, five (5) are found on Bernier and Dorre Islands. These are the boodie or burrowing bettong, rufous hare wallaby, banded hare wallaby, the Shark Bay mouse and the western barred bandicoot.

The Ningaloo Coast is an area of diverse and abundant marine life, amazing cave fauna, and a spectacular contrast between the colourful underwater scenery and the arid and rugged land of the Cape Range. It is one of the best places to encounter the remarkable whale shark, the world's largest fish, which aggregates here in higher numbers than have been recorded anywhere else. The property has outstanding biological diversity, and plays an internationally significant role in protecting marine species. All of these features are extremely well preserved.

Discussion

As a site selected for its outstanding natural value, all World Heritage areas have been given the highest priority for protection from the effects of both floating and dissolved oil. As a result of this classification under World Heritage, the shoreline cells along the western boundary of Zone 3 are given the highest protection priority.

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	**Importance:** World Heritage areas have the highest priority for protection from the effects of both floating and dissolved oil.

Data List

- DotE World Heritage Areas (14 October 2015)

3.2.2 Terrestrial Protection Areas

Description

Terrestrial protection areas have been determined from the DotE Collaborative Australian Protected Areas (CAPAD) database which was created in 2014. The dataset is updated every two years, and DPaW was able to provide an updated marine and terrestrial dataset for lands vested in its department. Protected areas onshore include conservation parks, national parks and nature reserves. Within the CAPAD dataset, the conservation areas under the WA *Conservation and Land Management Act 1984* include:

- IUCN IA (Strict Nature Reserve) and IB (Wilderness Area);
- IUCN II (National Park);
- IUCN III (National Monument);
- IUCN IV (Habitat/Species Management Area);
- IUCN V (Protected Landscape/Seascape);
- IUCN VI (Managed Resource Protected Area);
- Other types of reserves including 5(1)(g) and 5(1)(h);
- Indigenous Protected Areas; and
- Miscellaneous Reserves.

Distribution

In the Midwest zone, over 30 conservation areas are listed as legislatively protected, including nature reserves, national parks, 5(1)(h) reserves, 5(1)(g) reserves and conservation parks. The main national parks with a Terrestrial Protection component include Dirk Hartog Island, Bernier and Dorre Islands Nature Reserve, Francois Peron National Park, Shell Beach Conservation Park and Sedimentary Deposits Reserve, in the Shark Bay area south of Carnarvon. Other terrestrial parks include Beekeepers Nature Reserve and Nambung National Park, adjacent to the Jurien Bay Marine Park in the south of the zone.

One proposed national park has also been identified: the inhabited islands of the Houtman Abrolhos Islands, which are to be managed as a multi-use area. The remaining uninhabited islands will remain part of the A-Class Reserve.

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 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 to become terrestrial protection areas but are not yet legally recognised as such. These should be included in this assessment if any are identified. The proposed Houtman Abrolhos Islands National Park has been included in this category. In addition, if an area cannot legally become a protected area for similar reasons, but the area can be demonstrated as having the ecological value equivalent to a recognised terrestrial park, it should also be included in this assessment. No such areas have been identified for the Midwest zone.

In the previously assessed Pilbara zone, 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.

From the processing and review of the data in the Midwest zone, it was apparent that there were no terrestrial conservation areas which needed to be split for the areas inside and outside of the intertidal zones, to facilitate applying separate rankings. The distinction has however been incorporated in anticipation that it may become a consideration in the other zones of this assessment.

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 WA *Conservation and Land Management Act 1984* (conservation park, national park, nature reserve) ranked IUCN IA (Strict Nature Reserve) and IB (Wilderness Area) *Includes the intertidal zone*	4	3	**Importance:** 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: *Does not include the intertidal zone*	3	N/A	
All conservation areas and proposed conservation areas as defined under the WA *Conservation and Land Management Act 1984* ranked IUCN II (National Park), III (National Monument), IV (Habitat/ Species Management Area), V (Protected Landscape/Seascape) *Includes the intertidal zone*	3	2	**Importance:** 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: *Does not include the intertidal zone*	2	N/A	
All conservation areas and proposed conservation areas as defined under the WA *CALM Act 1984* ranked IUCN VI (Managed Resource Protected Area) and all other types: 5(1)(g) reserves, 5(1)(h) reserves, Indigenous Protected Areas, Miscellaneous Reserves *Includes the intertidal zone*	2	1	**Importance:** 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: *Does not include the intertidal zone*	1	N/A	

Data List

- DotE CAPAD Terrestrial and Marine dataset (30 June 2014)
- DPaW CAPAD Terrestrial dataset update (30 June 2016)
- Houtman Abrolhos Islands A-Class Reserve under the *Fish Resources Management Act 1994*
- Proposed Houtman Abrolhos Islands National Park (Wilson *et al.*, 1994)

3.2.3 Marine Protection Areas

Description

Marine protection areas have been determined from the DotE Collaborative Australian Protected Areas (CAPAD) database which was last updated in 2014. The CAPAD Marine dataset is updated by the DotE every two years, and DPaW was able to provide an updated marine and terrestrial dataset for lands vested in its department. Protected areas offshore include marine parks, marine conservation reserves, marine nature reserves and marine management areas. The types of protected areas include:

- 5(1)(g) Reserve;
- Fish Habitat Protection Area;
- Marine Management Area;
- Marine Nature Reserve;
- Marine Park; and
- Nature Reserve.

These reserves are then classified by the IUCN system and their significance ranked accordingly.

There is one A-Class Reserve (A20253) protected under the *Fish Resources Management Act 1994*, and therefore vested with the WA DoF, surrounding and including the Houtman Abrolhos Islands. It covers both marine and terrestrial lands. It is described to cover a vast majority of marine waters as well as the islands, and the islands that are inhabited islands are proposed to become a National Park to be managed by DPaW in the near future. These proposed changes have been reflected in this report.

Distribution

Within the Midwest zone, there are six legally protected marine areas. These consist of one A-Class Reserve vested with the DoF around Houtman Abrolhos Islands, one IUCN type IA marine nature reserve (Hamelin Pool), one miscellaneous reserve of IUCN II (Monkey Mia) and three IUCN type VI marine parks (Ningaloo, Shark Bay and Jurien Bay). There are also seven areas identified by Wilson *et al.,* (1994) proposed for inclusion as part of a representative marine reserve system for Western Australia. These are distributed along the Midwest zone to incorporate additional representative areas for marine habitats.

The A-Class Fish Reserve vested under the FRMA (1994) incorporates Shoreline Cells 332 to 336, and has the protection priority ranking of High for protection from floating and dissolved oil.

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 ranking for marine protection areas is presented in Table 3-9. 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 protection areas but are not yet legally recognised as such. None have been formally identified, though as described above, seven areas have been identified for

consideration as marine parks in the future. These are Red Bluff to Point Quobba; Shark Bay Bernier, Dorre and Dirk Hartog Islands extensions; Kalbarri; Port Gregory; Seven Mile Beach; Houtman Abrolhos Islands; and the Beagle Islands. In addition, if an area cannot legally become a protected area for similar reasons, but it can be demonstrated as having the ecological value equivalent to a recognised marine park, it should also be included in this assessment. No such areas have been identified for the Midwest zone.

In the previously assessed Pilbara zone, it was highlighted that the designation of the boundary of a marine protection area may be either to the high water mark or to the low water mark, and thus may 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).

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 WA *Conservation and Land Management Act 1984* (marine nature reserve, marine park or marine management area) ranked IUCN IA (Strict Nature Reserve) and IB (Wilderness Area) *Includes intertidal zone*	4	4	**Importance:** 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 *Fish Resources Management Act 1994*	4	4	
Same as above, but: *Subtidal only*	3	4	
All conservation areas and proposed conservation areas as defined under the WA *Conservation and Land Management Act 1984* ranked IUCN II (National Park), III (National Monument), IV (Habitat/Species Management Area), V (Protected Landscape/Seascape)	3	3	**Importance:** The land tenure of the conservation parks, national parks and nature reserves has 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: *Subtidal only*	2	3	
All conservation areas and proposed conservation areas as defined under the WA *Conservation and Land Management Act 1984* 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	**Importance:** 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: *Subtidal only*	1	2	

Data List

- DotE CAPAD Terrestrial and Marine dataset (30 June 2014)
- DPaW CAPAD Terrestrial dataset update (30 June 2016)
- Houtman Abrolhos Islands A-Class Reserve under *Fish Resources Management Act 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.

Three wetlands are adjacent to the western boundary of the Midwest zone: Lake MacLeod; McNeill Claypan System; and Lake Thetis. No known proposed national or international wetlands requiring protection were identified in the zone.

Distribution

No Ramsar or proposed Ramsar wetlands have been identified in the Midwest zone.

There are four *listed* nationally important wetlands in the Midwest zone: Shark Bay East and Hamelin Pool, both located in the Shark Bay area (Shoreline Cells 138 to 173); the Murchison River (Lower Reaches) wetland, located 150 km north of Geraldton (Shoreline Cell 180); and the Hutt

Lagoon System (adjacent to Shoreline Cell 182). These wetlands give those shoreline cells a ranking of High for protection from floating and dissolved oil.

In addition, four nationally important wetlands are located adjacent to the western boundary of the Midwest zone: Lake MacLeod (adjacent to Shoreline Cell 137); McNeill Claypan System (adjacent to Shoreline Cell 138); and Lake Thetis (adjacent to Shoreline Cell 194). They have not been included in the rankings assessment for this zone, however.

No *proposed* nationally important wetlands were identified in the Midwest zone.

Discussion

To produce rankings in anticipation of applying them to subsequent zones of this assessment, the international and national datasets were reviewed and the aspects ranked.

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 is given the highest priority for protection from both floating and dissolved oil.

There may be some duplication between the wetland datasets, for example 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 will prevail.

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	**Importance:** 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	**Importance:** 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 Midwest zone shoreline cells.

The three KEFs found in the Midwest zone are the 'commonwealth marine environment in and adjacent to the west coast inshore lagoons', 'commonwealth marine environment surrounding the Houtman Abrolhos Islands' and 'western rock lobster'. The commonwealth marine environment in and adjacent to the west-coast inshore lagoons is defined as a key ecological feature 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 'commonwealth marine environment in and adjacent to the west coast inshore lagoons' intersects intermittent shoreline cells from Kalbarri south to Lancelin. The western rock lobster KEF intersects all shoreline cells from Kalbarri south to Lancelin (Shoreline Cells 180 to 197) including the shoreline cells surrounding the Houtman Abrolhos Islands (Shoreline Cells 332 to 336). The 'commonwealth marine environment adjacent to the Houtman Abrolhos Islands' also intersects with the shoreline cells of the Houtman Abrolhos Islands (Shoreline Cells 332 to 336). No additional proposed KEFs were identified in the Midwest zone.

Discussion

KEFs are considered to be of regional importance, 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, the shoreline cells mentioned above are ranked Low for protection from floating oil and Medium for protection from dissolved oil due to their inclusion in the KEFs in these cells.

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	**Importance:** As a site selected for regional marine importance, KEFs are given the third highest priority 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 Habitats

Description

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 sensitivity rating when planning a response to shoreline contact from an oil spill.

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. Three of the areas fall in the Midwest zone. This data is available online through the Seamap Australia project, which is hosted on the Australian Ocean Data Network (aodn.org.au) and 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 (refer to 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.

This 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 at the University of Sydney.

The DMP Coastal Landforms dataset was also identified for inclusion in this section, however as described in Section 2.5, this was excluded from the previous Pilbara zone assessment. 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 equivalent to the ESI or DPaW Marine Habitat datasets above. The same approach has been adopted for the Midwest zone.

Distribution

The coastal characteristics in the Midwest zone change from north to south. The northern 45 km of the Midwest is predominantly characterised by coral reef, adjacent to the southern end of the Ningaloo reef. Further south are exposed wave cut platforms and exposed rocky cliffs which dominate the coast north of Carnarvon. South of Carnarvon is the Shark Bay area, which is sheltered by Dirk Hartog, Bernier and Dorre Islands, creating a coastline of exposed tidal flats, mangrove communities, sheltered tidal flats, and fine to medium-grained sand beaches in the bay.

The exposed western side of the coastal bay is also dominated by exposed rocky cliffs and wave cut platforms, which protect some sections of sheltered tidal flats. This is the case further south, past Kalbarri. The coastline past Geraldton, parallel to the Houtman Abrolhos Islands, is a mixture of rocky cliffs and sandy beaches, with some sheltered seawalls. It changes to predominantly fine to medium-grained sandy beaches south of the town, and dominates the southern portion of the Midwest zone to Jurien Bay.

The fine to medium-grained sandy beaches in Shoreline Cell 135 north of Carnarvon, and in Shoreline Cells 184 and 187 north and south of Geraldton, result in the ranking of Low for protection from floating oil and dissolved oil. In this category, there are no other aspects located in that shoreline cell, so the Low ranking is applied due to characteristics and oil sensitivity presented by the data in the ESI dataset. Similarly, Shoreline Cells 183 and 185 immediately north of Geraldton are ranked Medium for protection from floating oil and dissolved oil, due to the presence of sheltered seawalls and sheltered rocky shores in the ESI dataset.

Discussion

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 movement and capacity of oil penetration and/or burial on the shore;
- 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 IPIECA/IMO/OGP (2012).

Shorelines which are sheltered tidal flats incorporating mangrove and swamp habitats are more susceptible to long term impacts from an oil spill of both floating and dissolved oil, while rocky exposed shorelines are the least susceptible. In addition to this, the abundance of mangroves and sheltered tidal flats in each shoreline cell was also taken into account, where the smaller abundance was ranked lower. Any areas of very small abundance but of higher conservation value have already been included in the Protection Areas information, and are ranked higher.

Shorelines which include beaches and sandy areas are considered to be moderately difficult to rehabilitate, moderately ecologically sensitive, and are also likely to contain areas which are used for human resources purposes such as beaches and archaeological sites.

The DPaW Marine Habitat dataset contains predominantly marine habitats, so is included in Section 3.2.7.

Table 3-12: Coastal 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	**Importance:** 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 http://response.restoration.noaa.gov/sites/default/files/ESI_Guidelines.pdf 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 Steering Committee Workshop for the Midwest zone.

It is noted that seagrass and algae fall under the definition of 'fish' in the *Fish Resources Management Act 1994*.

Distribution

Coral distribution has been determined from the coral reef data in the OSRA ESI data layer and the DPaW Marine Habitat dataset. Coral reefs are limited to the southern end of Ningaloo Reef in the far northern portion of the zone (Shoreline Cells 132 to 134). The ranking created by the presence of coral is superseded by a higher protection priority ranking due to the World Heritage Area covering these shoreline cells.

CAMRIS was used to determine the seagrass distribution, supplemented by the DPaW Marine Habitat database. Based on these datasets, seagrass distribution is abundant in the Shark Bay area, with extensive seagrass meadows throughout the bay (Shoreline Cells 140-176). Seagrass is also found in stretches along the southern-most portion of the Midwest around Jurien Bay (Shoreline Cells 190 to 192). In Shoreline Cells 190 to 192, the presence of seagrass drives a ranking of Medium for protection from dissolved oil. For the rest of the shoreline cells, other aspects in the Protection Areas category drive the rankings.

Algae and filter feeding community distribution is limited to siz Shoreline Cells in the Shark Bay area, including Shoreline Cells 150 to 154, 158 and 165. The ranking created by the presence of algae communities is superseded by a higher protection priority ranking of Very High due to the World Heritage Area covering these shoreline cells.

Stromatolites are ancient, cemented blue-green algae and are found in Hamelin Pool (Shoreline Cell 146.

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 corals to small amounts of oil for an extended period can be just as harmful as large amounts of oil for a brief time.

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 was ranked lower than coral, but still ranked Medium as they provide habitat for 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).

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.

Stromatolites are not represented in the available datasets as a discrete layer, so their presence in Shoreline Cell 146 was not ranked as Algae, but is considered as part of the protection priority associated with the World Heritage Area.

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	**Importance:** Corals are particularly sensitive to dissolved hydrocarbons.
Seagrass	2	3	**Importance:** Seagrasses are grazed by protected animals and provide refuge areas for fish and invertebrates.
Algae and filter feeding communities	1	2	**Importance:** 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 (FHPA). 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 are five FHPAs in the Midwest zone. These are: Point Quobba (Shoreline Cell 137); Miaboolya Beach (Shoreline Cell 138); Kalbarri Blue Holes (Shoreline Cell 180); Abrolhos Islands (Shoreline Cells 332 to 336); and Lancelin Island Lagoon (Shoreline Cell 197). The presence of an FHPA in

Shoreline Cells 136 and 137 results in the ranking of Medium for protection from floating oil and dissolved oil.

There are seven Closed Waters notices, including for the Houtman Abrolhos (Shoreline Cells 332 to 336), Jurien Bay (193 and 194), Ningaloo Marine Area (132 to 134) and Shark Bay (138 to 176, 330 to 331). These are for both commercial and recreational fishing. There is also one prohibition on fishing for the South Tomi wreck site off Jurien Bay (Shoreline Cell 194). The presence of closed waters results in the ranking of High for protection from floating oil and dissolved oil.

Discussion

FHPAs protect the continued sustainability of a particular species, or multiple species. Fish in a key habitat exposed to dissolved aromatic hydrocarbons are at risk of toxic effects; they 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.

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 *Fish Resource Management Act 1994*	4	4	**Importance:** 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	**Importance:** 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).

There are no legally protected aquaculture or pearling areas in WA waters. Areas for protection would include wild spat stock for pearls.

Note that the economics of the fishery and fishing extent is included in the Economic section (Section 3.4).

Distribution

No aquaculture protected areas have been identified in the Midwest 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 would be able to be resourced from a number of areas and even from other aquaculture farms.

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	**Importance:** 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 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 preserved 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 *[Register of the National Estate (which was phased out in 2012 and is now an historic list)]* 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:

- World Heritage Areas;
- National Heritage Areas; and
- 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 Midwest zone, there are no World Heritage areas designated for *cultural* heritage values. Shark Bay was inscribed on the World Heritage List in 1991 for its *natural* heritage values, and therefore is included in Section 3.2.1.

There is one Commonwealth Heritage listed place adjacent to the Midwest zone, being the Lancelin Defence Training Area, and one area on the National Heritage List, being the southern end of the Ningaloo Coast which intersects with the northern portion of the Midwest zone.

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).

There are no areas in the Midwest zone which have been assigned World Heritage status due to cultural heritage only, so no shoreline cells have been ranked Very High due to cultural heritage.

National Heritage Places

National Heritage Properties data 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 3-16 above, 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.

The National Heritage Properties list 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 confidential 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 the assessment.

There are four National Heritage places located in the Midwest zone: Shark Bay (Shoreline Cells 141-178 and 330-331); the Dirk Hartog Landing site (located in the Shark Bay area in Shoreline Cells 168-169); the Batavia Shipwreck (the Abrolhos Islands in Shoreline Cell 333); and the Ningaloo Coast (intersects the northern-most cells, Shoreline Cells 132-134). As a result of these significant places, these 46 shoreline cells are ranked High for protection from floating oil and dissolved oil.

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 3-18 above, 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.

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 and there are no areas identified in the current assessment.

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 floating oil and dissolved oil impacts.

The Lancelin Defence Training Area (Shoreline Cell 197) which is a Commonwealth Natural site is classified Medium for protection from floating oil and dissolved oil.

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	**Importance:** 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	**Importance:** 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	**Importance:** 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	**Importance:** As a site selected for its significant cultural heritage value, these Commonwealth Heritage Areas have been given a medium priority for protection from floating oil as these sites are nationally significant 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	3	3	**Importance:** As a site selected for its significant natural heritage value, these Commonwealth Heritage Areas have been given a medium priority for protection from 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

Type	Organisation	Legislation	What is Listed	No. of Places in WA
State Register	Heritage Council (assisted by the State Heritage Office)	*Heritage of Western Australia Act 1990*	Places of state significance included in the State Register of Heritage Places	1,400
Conservation Order	Heritage Council (assisted by the State Heritage Office)	*Heritage of Western Australia Act 1990*	Places of state significance or potential state significance (special cases)	5
Heritage Agreement	Heritage Council (assisted by the State Heritage Office)	*Heritage of Western Australia Act 1990*	Places protected by long-term agreement between the parties	100
Town Planning Scheme ('Heritage List')	Local Governments	*Planning and Development Act 2005*; Local Planning Schemes	Places of local heritage significance	9,000

Places of local significance which are managed by Local Governments under the *Heritage of Western Australia Act 1990* have been excluded as there are too many (>20,000). Data for places of local, state or national significance managed by Local Governments under the *National Trust of Australia (WA) Act 1964* has been requested (~2,300).

The DAAs 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 previous Pilbara zone assessment as the DAA list is largely incomplete; 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.

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 25 State Registered Protected Heritage sites in the Midwest zone including caves, lighthouses and jetties:

- Red Bluff Cave (Shoreline Cell 134);
- Norwest Seafood Factory, The Fascine, Babbage Island Lighthouse, Former Meatworks Site, Prawning Jetty, Carnarvon Lighthouse Keepers Cottage, Wooramel Seagrass Bank, Gascoyne Hotel, The Stroud Building Garage and Babbage Island Causeway Bridge (Shoreline Cell 138);
- Wooramel Seagrass Bank (Shoreline Cells 139 to 142);
- Gladstone Jetty (Shoreline Cell 143);
- Lynton Convict Hiring Depot (Shoreline Cell 181);
- Two Obelisks and Commemorative Plaques (Shoreline Cell 189);
- Lancelin Jetty (Shoreline Cell 197); and
- Lock Hospital Ruins (Shoreline Cells 330 to 331).

There are no Conservation Order sites in the Midwest, but there is one Heritage Agreement: Rose Cottage built in 1898, located approximately 18 km south-east of Geraldton (Shoreline Cell 186).

From the records of State Protected Heritage in all of the shoreline cells identified above, the shoreline cells are ranked Medium for protection from floating and dissolved oil, however it is only in Shoreline Cells 181 and 189 where the State Protected Heritage aspect is ranked higher than other aspects in that shoreline cell. The data appears in the attribute table.

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 are ranked equally high for protection from the impacts of floating oil and dissolved oil.

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	**Importance:** 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 uses only ships wrecked before 1941. All shipwrecks have been given a single rating.

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 this dataset was sourced from them.

Distribution

There are almost 100 Commonwealth protected and over 50 State protected shipwrecks and marine archaeology sites along the Midwest coastline. Many of these sites are duplicates, protected under both State and Commonwealth legislation. The most famous shipwreck is the Batavia, which was a wooden Dutch East India Company ship, shipwrecked in 1629 on Morning Reef in the Houtman Abrolhos Islands.

Many other protected shipwrecks are found on the Houtman Abrolhos Islands. Other notable locations for protected maritime history are in Shark Bay, and a large concentration along the coastline from Geraldton south towards Perth.

In the coastal area between Kalbarri and Lancelin (Shoreline Cells 135, 180 to 196 and 334 to 336), there are 20 shoreline cells which contain Commonwealth protected shipwrecks. They are ranked Medium for protection from floating oil and dissolved oil.

Discussion

All shipwrecks, aircraft, relics and other underwater cultural heritage provide national heritage history, however it is not anticipated that floating or dissolved oil will destroy the wrecks. The fact that a shipwreck is protected under Commonwealth Maritime Cultural Heritage means it is ranked higher than under State protection mechanisms.

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	**Importance:** 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 given a Medium priority for protection from both dissolved oil and floating oil.
State Protected Shipwrecks			
WA protected shipwrecks and maritime archaeology	2	2	**Importance:** 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 also 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 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.

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 gross state product 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. The table also includes the time taken for fisheries and aquaculture stocks to recover.

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).

Pearls are cultivated in oysters below the water's surface. There are many different varieties such as the blacklip oyster (*Pinctada margaritifera*), which is the most lucrative, but also the naturally-occurring Akoya oyster (*Pinctada imbricate*) and to a smaller extent the Shark Bay shell (*Pinctada albina*) and penguin's wing oyster (*Pteria penguin*).

Coral and live rock and associated products (e.g. live sand) are used by aquarium enthusiasts for display and to maintain healthy water quality conditions in their aquariums. These products invariably use suspended culture, or bottom culture on racks, baskets, panels or cages, or suspended culture.

Finfish such as the yellowtail kingfish are being trialled for aquaculture development in the Midwest zone. These are cultivated in sea cages.

Distribution

Aquaculture in WA is managed through the licencing of permits through the Department of Fisheries (DoF). There are six managed bioregions that cover WA. The two relevant to the Midwest zone are:

- West Coast Bioregion, which extends from Black Point to the Zuytdorp Cliffs, north of Kalbarri; and
- Gascoyne Coast Bioregion, which extends from the Zuytdorp Cliffs to the Ashburton River, south of Onslow.

The Midwest zone intersects with more than 20 aquaculture sites. These include both existing and proposed locations. The Houtman Abrolhos Islands area is used by the pearling industry based on species such as the blacklip oyster and Akoya oyster. In addition, in the vicinity of the Houtman Abrolhos Islands there is increasing interest in the aquaculture of species that include coral and live rock.

A finfish trial for aquaculture has occurred outside Geraldton, farming yellowtail kingfish in sea cages. There is now a proposal to grow the trial up to 30,000 yellowtail kingfish.

The Aquaculture Sites described in the DoF Aquaculture Licenses dataset include:

- Shoreline Cell 139: Carnarvon Oyster Creek Aquaculture Site;
- Shoreline Cell 153: Shark Bay and Hopeless Reach Prawn Aquaculture Site;
- Shoreline Cell 159: Proposed Aquaculture Site (Shark Bay);
- Shoreline Cells 165 and 166: Shark Bay Aquaculture Site;
- Shoreline Cell 186: Geraldton Champion Bay Aquaculture Site;
- Shoreline Cell 194: Jurien Bay Essex Rocks Aquaculture Site; and
- Shoreline Cells 333-336: Abrolhos Islands Aquaculture Sites (>20 sites).

Discussion

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, 2013).

Coral and live rock are widely varied and the diversity of coral and associated species provides considerable flexibility in the range of culture systems and technologies that can be employed. In the event of a spill, as these species are subsurface, they are expected to be affected greater by dissolved oil than floating oil, with a year's worth of stock lost or affected. The species vary from very common to very rare and therefore recovery time is just as varied.

Finfish take about six to ten years to mature and reach a size appropriate for market. In a spill, dissolved oil is expected to have the most impact, however the total impact will depend on their age and maturity.

Individual values for each aquaculture type is not available, so all aquaculture licence areas have been given a single ranking.

Table 3-23: Aquaculture protection priority ranking

Type (in each Region)	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Aquaculture Licenced Areas			
Aquaculture licenced areas	2	3	**Importance:** Other aquaculture is currently valued at $17M, mostly consisting of finfish (DoF, 2016a).

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).

Prawns harvested for commercial use in WA mostly consist of brown tiger (tiger), western king (king) and banana prawns, and live in nearshore coastal waters (DoF, 2013b). They typically don't surface so they are not expected to be directly affected by floating oil. If affected in oceanic waters recovery time is typically one to two years, as they take six to eight months to reach maturity, but not all species spawn throughout the year (DoF, 2013b). All commercial data for prawn fisheries was multiplied by a recovery factor of two years. Prawns are collected using an otter trawler at water depths around 15-60 m (Kangas *et al.,* 2006).

Crabs targeted for commercial fishing in WA are typically blue swimmer crabs. They live in estuaries, sheltered bays and offshore waters up to 50 m deep. They typically don't surface, so they

are not expected to be directly affected by floating oil. Recovery time if affected by dissolved oil is one to two years for complete biological recovery as they take a year to reach maturity (DoF, 2015a). Commercial data for crab fisheries was multiplied by a recovery factor of two.

Demersal fisheries, including the West Coast Demersal Gillnet and Demersal Longline Interim Fishery and the West Coast Demersal Scalefish Fishery, occur in waters 20-250 m deep with approximately 100 species targeted. The most important species are West Australian dhufish and pink snapper, with other species captured including redthroat emperor, bight redfish and baldchin groper (DoF, 2015c). Pink snapper mature at around four years (DoF, 2015b) and are demersal (bottom-dwelling) but also spend some of their lives in the mid to upper water levels. Therefore they are likely to take 4-10 years to recover.

State managed commercial fisheries are administered by the WA Department of Fisheries (DoF).

There are 17 commercial fisheries in the Midwest zone; eight of these are State managed commercial fisheries:

- Abalone Managed Fishery;
- Abrolhos Islands and Mid-West Trawl Managed Fishery;
- Gascoyne Demersal Scalefish Fishery;
- Mackerel Managed Fishery;
- Marine Aquarium Fish Fishery;
- Octopus Interim Managed Fishery;
- Shark Bay Beach Seine and Mesh Net Fishery;
- Shark Bay Crab Managed Fishery;
- Shark Bay Prawn Managed Fishery;
- Shark Bay Scallop Managed Fishery;
- Specimen Shell Managed Fishery;
- West Coast Deep Sea Crustacean Managed Fishery;
- West Coast Demersal Gillnet and Demersal Longline Interim Fishery;
- West Coast Demersal Scalefish Fishery; and
- Western Rock Lobster Fishery.

Annual value has been indicated below, with recovery of fisheries also considered and ranked in reference to Table 3-22. In the extreme, pink snapper for example reaches maturity (which allows them to reproduce) between the ages of four to eight years, and lives to the age of 30-45 years. Therefore recovery time may be in the decades if the entire population was impacted. However as the fishery area is so large, while this is possible, it is not probable, and in all cases the economic annual value has been used as the primary indicator of protection priority.

The commercial information for each State managed commercial fishery includes data around its annual value in millions of dollars (AUD). This information is available from the DoF, contained in the Status of Fisheries Annual Reports.

Distribution

The location for each fishery and their key fishing areas, if known, are outlined below.

Abalone Managed Fishery targets Roe's abalone and 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. Details on key commercial fishing locations are not known, so this fishery has been included in Shoreline Cells 140 to 197.

Abrolhos Islands and Mid-West Trawl Managed Fisheries occur around the Abrolhos Islands (Shoreline Cells 332 to 336) and all the waters of the Indian Ocean adjacent to Western Australia, between 27°51′ south latitude and 29°03′ south latitude on the landward side of the 200 m isobath.

Gascoyne Demersal Scalefish Fishery operates in the waters of the Indian Ocean and Shark Bay between latitudes 23 07′30″S and 26°30′S, however vessels are not permitted to fish in inner Shark Bay, nor between 21°56′ and 23°07′30″S ('Point Maud-Tantabiddi Well' closure). Therefore the fishery is included in Shoreline Cells 132 to 138, 166 to 174, and the islands of 330 and 331.

Mackerel Managed Fishery extends from Augusta south of Perth to the WA/NT border. Catches are reported separately for three areas; described here is Area 3: the Gascoyne (27º S to 114º E) and West Coast (Cape Leeuwin to 27º S). 10% of the total catch for 2014-15 was from the Gascoyne coast, so this fishery is included in all shoreline cells of the Midwest zone.

Marine Aquarium Fish Fishery is primarily a dive-based fishery that uses hand-held nets and operates throughout all WA waters. This fishery is therefore included in all shoreline cells of the Midwest zone.

The extent of Octopus Interim Managed Fishery in the Midwest zone is the same as the West Coast Rock Lobster Managed Fishery, because the Lobster Managed Fishery harvests octopus as a by-product. This extent is the west coast of WA between Shark Bay and Cape Leeuwin (Shoreline Cells 140 to 196).

Shark Bay Beach Seine and Mesh Net Fishery operates in the inner Shark Bay area. This affects Shoreline Cells 140 to 168.

Shark Bay Crab Managed Fishery operates between Point Quobba and north of Cape Inscription/ Cape Peron North, in the northern end of Shark Bay. It affects Shoreline Cells 137 to 141, 154, 155, 168 and the islands of 330 and 331.

Shark Bay Prawn Managed Fishery and Shark Bay Scallop Managed Fishery are localised to Shark Bay, however much of the nearshore waters are closed to these fisheries. They therefore affect Shoreline Cells 132 to 137, 155 and 167 to 175. They also operate off the islands of Shoreline Cells 330 and 331.

Specimen Shell Managed Fishery gathers individual shells for display, collection, cataloguing, classification and sale (DoF 2015). While the fishery covers the entire Western Australian coastline, some effort is concentrated in areas adjacent to population centres, which in the Midwest zone consists of Shark Bay. However, this fishery is included in all shoreline cells of the Midwest zone as the concentration of effort is likely only due to convenience, not abundance.

West Coast Deep Sea Crustacean Managed Fishery, West Coast Demersal Gillnet and Demersal Longline Interim Fishery and West Coast Demersal Scalefish Fishery operate in waters of the West Coast Bioregion of WA. These fisheries are therefore included in all Shoreline Cells 177 to 197 of the Midwest zone.

Western Rock Lobster Fishery targets the western rock lobster, on the west coast of WA between Shark Bay and Cape Leeuwin (Shoreline Cells 140 to 196).

Discussion

The potential impacts considered for dissolved or floating oil on each fishery are outlined in Table 3-24. The key fisheries and their rankings are described below.

Abrolhos Islands and Mid-West Trawl Managed Fishery mostly takes saucer scallops, with a small component targeting the western king prawn in the Port Gregory area, 80 km north of Geraldton (DoF, 2016). Before the marine heat wave in 2011, the fishery was worth $10-$20 M/year (DoF, 2012). Stock levels of scallops have not recovered since 2011, and may need several more years of good environmental conditions to recover (DoF, 2016). The rankings consider the typical estimated income, loss of economic income over multiple years and large area that the fishery can take from. Therefore these shoreline cells are given a protection priority ranking of Low for protection from floating oil and Medium for protection from dissolved oil.

The Western 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, 2016). The fishery is an important sector of WA's 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 plants, located in the Perth metropolitan area (two), Geraldton (one) and Cervantes (one), serviced practically every location where fishing occurred (DoF 2016). They mature at six to seven years old, so are expected to take 12-15 years to recover. This gives this fishery a high ranking and influences the protection priority ranking of 33 shoreline cells, giving them a ranking of Low for protection from floating oil and Medium for protection from dissolved oil.

The Shark Bay Prawn Managed Fishery is the highest producing WA fishery for prawns. It was worth $25.1M in 2014, which is typical for this fishery, with a 25% increase in good years. It targets the western king prawn and brown tiger prawn but also takes a variety of smaller prawns (DoF, 2016b). The industry is a major contributor to regional employment (DoF, 2016b). Recovery time would typically be two to four years as they take six to eight months to reach maturity, but not all species spawn throughout the year (DoF, 2013b). The fishery covers 82 shoreline cells, however the ranking of Low and Very Low for protection from dissolved oil and floating oil is superseded by the higher-ranked Western Rock Lobster Managed Fishery which encompasses the same shoreline cells.

All other State managed fisheries are given a Low or Very Low protection priority ranking for protection from floating or dissolved oil in line with Table 3-24, due to being wide spread along the WA coastline and low economic value, taking into account their respective recovery times.

Table 3-24: State Managed Commercial Fishing 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	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	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

- Western Rock Lobster (24 March 2015)
- Abrolhos Islands and Mid-West Trawl (3 June 2015)
- Shark Bay Prawn (11 September 2015)
- Abalone (11 September 2015)
- Gascoyne Demersal Scalefish (20 April 2015)
- Shark Bay Beach Seine and Mesh Net (11 September 2015)
- Shark Bay Crab (11 September 2015)
- Shark Bay Scallop (11 September 2015)
- Mackerel (3 January 2013)
- Marine Aquarium Fish (11 September 2015)
- Octopus Interim (3 January 2013)
- Specimen Shell (8 November 2012)
- West Coast Deep Sea Crustacean (Crab) (24 March 2015)
- West Coast Demersal Gillnet and Demersal Longline Interim Fishery (11 September 2015)
- West Coast Demersal Scalefish (11 September 2015)
- DoF Annual Fisheries Report (2014-15)

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 for the years of 2000 to 2015 has been used. This was provided by AFMA. 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 Midwest zone. These are:

- Western Tuna and Billfish Fishery;
- Western Skipjack Tuna Fishery; and
- Southern Bluefin Tuna Fishery.

Distribution

All three of the Commonwealth managed fisheries listed above cover the entire Midwest zone.

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).

The Western 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.

The Southern Bluefin Tuna Fishery covers the entire sea area around Australia, out to 200 nm from the coast. The species is most commonly caught off the New South Wales coastline.

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 Midwest zone. Using the rankings from Table 3-25, all shoreline cells in the Midwest zone are given a protection priority ranking of 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 Other Commercial Operations

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

Associated infrastructure are port facilities and seawater intakes. Refer to Section 3.4.6 and Section 3.4.7. Salt works are covered under Water 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 or determine a protection priority ranking.

The cost impact of shutting down an export facility may be as much as $180M per day ($67B over 365 days) in the case of export from Barrow Island (Chevron), however the responsibility for responding to an oil spill is not diminished by the presence or absence of an oil and gas operator in an area. The major LNG export locations are captured in the Ports ranking in Section 3.4.6.

Mining facilities are also included in the Ports and Shipping section.

3.4.5 Tourism

Description

A distinction has been made between activities that draw tourists to a site and generate economic income, and activities undertaken by locals for recreational purposes. This section assesses activities that generate economic income via tourist activities in the Midwest, such as:

- Whale, whale shark and manta ray watching;
- Scuba diving and snorkelling;
- Beaches; and
- Hotel revenue.

Tourism Research Australia publishes data annually on the income from tourism. This data is available per tourism region; and in the Midwest zone, the following regions have been assessed:

- Coral Bay;
- Carnarvon;
- Denham;
- Horrocks;
- Geraldton;
- Useless Loop;
- Greenhead;
- Jurien Bay;
- Cervantes;
- Kalbarri;
- Gregory;
- Dongara;
- Leeman; and
- Lancelin.

To produce an opportunity cost for tourism to include in this assessment, the value of the tourism in millions of dollars per annum was assigned to the shoreline cell where each of the major centres are located in these regions. Realistically in the event of 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.

Distribution

The contribution from tourism ranges from $208M per annum in Geraldton to $68M per annum in Kalbarri. The total revenue from tourism in Western Australia is $10,954M in 2015, of which 1-2% comes from the Midwest region (TRA, 2016).

The Midwest zone shoreline cells are all ranked Very Low for Tourism; in the Economic category, there are other aspects ranked higher so tourism does not feature in the attribute table.

Discussion

Tourism is a key economic driver, generating more than 97,000 jobs and injecting $10B into the Western Australian economy by Gross State Product (Tourism WA 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 new TSAs should be considered to provide the most recent and accurate data on tourism's contribution to the economy.

Table 3-26: Tourism protection priority category

Tourism Area	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Tourism Region key population centre more than 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 is <5% of total revenue from tourism in Western Australia, indicating that the priority for protection at a state level is less than for other areas contributing more revenue.
Data List ▪ TRA (2014)			

3.4.6 Ports and Shipping

Description

Ports are used for importing and exporting goods. An oil spill impacts ports through the safety requirement to reduce or cease operations in the port to allow spill recovery activities to occur. This results in a direct net loss to the operators in a port.

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

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*.

In the Midwest zone, these ports are:

- Cape Cuvier and Useless Loop (Port of Carnarvon) in Shoreline Cells 135 to 169, 330 and 331; and
- Geraldton Port in Shoreline Cells 185 to 187.

For completeness, proposed ports have also been included to account for future development beyond the time of this assessment. There is only one proposed for the Midwest zone: Oakajee Port in Shoreline Cell 184.

The Port of Geraldton handled 16 million tonnes in 2015-16. Seventy seven per cent (77%) of this export is iron ore, with grain, copper and zinc making up the balance (DoT, 2015). The estimated export value is ~$1.4M. It is the state's fourth largest export port and is ranked Medium for protection from floating oil and dissolved oil.

Within the Port of Carnarvon boundary is Cape Cuvier. Cape Cuvier is a privately owned and operated port exporting salt (Shark Bay Salt); exports in 2015 were 1.4 million tonnes per annum. Useless Loop is also a privately owned and operated port exporting salt (Dampier Salt Pty Ltd); exports in 2015 were 3 million tonnes per annum. The shoreline cells within the boundary of the Port of Carnarvon are ranked Low for protection from floating oil and dissolved oil.

Discussion

Ports are used for importing and exporting goods. An oil spill impacts ports through the safety requirement to reduce or cease operations in the port to allow spill recovery activities to occur. This results in a direct net loss to the operators in a port.

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.

Table 3-27: Ports protection priority ranking

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Ports			
>401 million tonnes annually	5	5	**Importance:** 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	**Importance:** Major import and export for the State, resulting in an estimated high economic value equivalent to between $501M-$1B annually, in line with Table 3-22.
11-100 million tonnes annually	3	3	**Importance:** 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	**Importance:** 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	**Importance:** 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)

3.4.7 Water Intake Locations

Description

Oil sucked into an intake location can damage an operating facility. The DoT's dataset includes point locations of prescribed premises that take in ocean water. The dataset includes locations of known major outfalls, and locations of proposed major industrial developments that may require seawater intake.

This 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.

Distribution

There are two intake locations in the Midwest zone, both using water to manufacture solar salt. These are the salt works at Useless Loop (Shoreline Cell 160, Shark Bay Salt) and Lake MacLeod (Shoreline Cell 135, Dampier Salt Pty Ltd). The salt works operate either using sea water directly (Shark Bay Salt) or saline water which has a link to the sea (Dampier Salt). These shoreline cells have been ranked Low for protection from floating oil and dissolved oil due to the presence of salt works seawater intakes.

Discussion

Water intakes will generally stop operating to limit the impact the oil spill will have on their product. While the intake locations are fixed and are impacted equally by floating and dissolved oil, the scale of the impact is very low due to the likely dilution and monitoring processes in place at these facilities.

The economic impact of the ocean intake ceasing pumping at a solar salt facility is likely to be moderate in terms of the state's GDP, with Dampier Salt in Karratha producing 3 Mtpa and Onslow Salt producing 1.5 Mtpa (EPA, 1991). The revenue of salt is in the order of $44 per tonne (Freedonia, 2014), meaning a potential impact of $133M if an oil spill were to impact a year's production of salt. This is however unlikely because a salt facility has the ability to stop pumping seawater into the evaporation ponds for a period of time.

In this assessment, intakes were identified in the shoreline cells they occurred, and ranking assigned as per Table 3-28.

Table 3-28: Water 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	**Importance:** The seawater intake points in WA are positioned at the mid water depth and normally offshore so as 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 to replace all membranes in a reverse osmosis plant would cost an estimated $20M-$100M, and cost the State many more millions of dollars to source drinking water while the replacement is occurring.
Cooling water intakes for power stations	3	3	**Importance:** 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	**Importance:** 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	**Importance:** 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	**Importance:** 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 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)

3.5 Social, Amenity and Recreation

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

- Town population;
- Recreational fishing/boating zones; and
- Beaches.

The towns located in the Midwest zone are listed in Table 3-29.

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

Town	Population
Coral Bay	190
Carnarvon	4,500
Denham	600
Kalbarri	1,400
Gregory	45
Horrocks	130
Geraldton	40,000
Useless Loop	950
Dongara	3,500
Leeman	350
Greenhead	256
Jurien Bay	1,500
Cervantes	450

3.5.1 Recreational Fishing/Boating Zones

Description

Recreational fishing and boating zones in the Midwest are often associated with marine management areas and marine parks. The marine park dataset includes areas in the marine park category with designations including:

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

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

Distribution

In the Midwest zone the Ningaloo Marine Park is the most well-known, located at the northern edge of the zone. The Shark Bay area also has a number of parks and is located just south of Carnarvon. An extensive marine park is also located near Jurien Bay, called the Jurien Bay Marine Park.

Discussion

The use of the marine park and management areas is related to water-based recreational pursuits. The impact from an oil spill will be a tendency for people to avoid the area, with flow-on effects in local regional commercial benefit. When ranking the marine parks for impacts from an oil spill, 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 limited to the amount of oil which comes ashore and is present in the fishing and recreational zones; and its impact on visual amenity.

Based on these rankings, shoreline cells associated with the marine parks in the Midwest zone are ranked Low for protection from floating oil and dissolved oil. These shoreline cells include the ones encompassing Ningaloo Marine Park (Shoreline Cells 132 to 134), Shark Bay Marine Park (Shoreline Cells 138 to 143 and 149 to 173), Hamelin Pool Nature Reserve (Shoreline Cells 144 to 148) and Jurien Bay Marine Park (Shoreline Cells 192 to 197).

Table 3-30: Recreational fishing/boating zones

Value Measure	Ranking		Main Factors Considered in Ranking
	Floating	Dissolved	
Multi-Use Zones (for Boating and Fishing)			
Marine management areas	2	2	**Importance:** 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	**Importance:** 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	**Importance:** 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)
- Marine Parks, CAPAD dataset (DotE)
- DPaW CAPAD (updated 2016)

3.5.2 Beaches

Description

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 for patrolled beaches was obtained from Surf Life Saving WA, however few of these beaches fall in the Midwest zone. There are no 'Blue Flag' beaches in Australia (Denmark, 2016) and there is no standardised ranking system for beaches in Australia in terms of amenity, patronage and popularity.

The protection priority of beaches associated with tourism has been captured indirectly in Tourism (Section 3.4.5), where the experiences associated with a major centre includes those associated with beach-based activities, e.g. fishing from shore.

Beaches are also covered under Section 3.2.6 (Coastal Habitats) because the more popular beaches tend to be those with wide sandy beaches (i.e. fine- to medium-grained sand beaches).

Distribution

Mahomets Beach, Monkey Mia, Shark Bay, Jurien Bay/Greenhead and Lancelin beaches are scattered along the Midwest zone. Shell Beach at Monkey Mia is ranked by Tourism WA as one of the top ten beaches in Western Australia, and has been included in this assessment as a geospatial location within the shoreline cell where the beach is located, and ranked for protection accordingly.

Discussion

Dissolved oil will not affect the amenity of the beach as much as floating oil, so this has been given a lower ranking. With less than 100,000 visitors per year, shoreline cells associated with key beaches, including Kalbarri (Shoreline Cell 180), Champion Bay Geraldton (Shoreline Cell 186), Dongara Denison (Shoreline Cell 189) and the Abrolhos Marine Recreation Area (Shoreline Cells 332 to 336), are ranked Very Low for protection from floating oil and dissolved oil.

Shell Beach (Shoreline Cell 150) has been given a ranking of Low for protection from floating oil and Very Low for protection from dissolved oil, based on its inclusion by Tourism WA as one of the top ten beaches in Western Australia. This is the same treatment as Turquoise Bay in the Pilbara zone, which has the same key classification characteristics.

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	**Importance:** The ranking is based on the amenity impact from floating oil being more socially unacceptable and more visually impacting than dissolved oil.
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, 2016)
- Surf Life Saving WA patrolled beaches (2016)
- DMP Coastal Landforms dataset (May 2016)

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
Protected Fauna	▪ CR species if extinct (birds, mammals, invertebrates, reptiles) ▪ Normal range for EN species (fish) ▪ Normal range for VU, Migratory or Marine species (mammals and fish) ▪ All areas Known for VU species (invertebrates) ▪ All other conservation codes (birds) ▪ Terrestrial species which do not use the coastal zone for any instance of their lifecycle and do not use the coastal zone as any component of their habitat	▪ Known/migration area for CR species which are Very Certain or Moderately Certain (birds, mammals) ▪ Normal range for EN species (birds, mammals and terrestrial invertebrates) which are Moderately Certain ▪ Normal range for VU, Migratory or Marine species (birds, furry marine mammals) which are Certain or Moderately Certain ▪ Southern right whale: all calving areas ▪ Breeding/aggregation area for VU, CD and P1-P4 Migratory OR Marine species and Normal range for CR species (fish) Certain ▪ 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	▪ Likely/Moderately Certain habitat for CR species. Breeding areas for EN species (birds) if Moderately Certain ▪ Breeding/aggregation for VU species if sighting Very Certain (birds) ▪ Breeding/aggregation area for VU, Normal range for CR species (mammals, furry marine mammals and terrestrial invertebrates) Certain and Moderately Certain ▪ Normal range for EN species (furry marine mammals) ▪ Breeding/aggregation area for CR species (fish) Moderately Certain and EN species Very Certain or Certain ▪ Foraging and inter-nesting for EN species and nesting/breeding area for VU species (reptiles) Certain or Very Certain	▪ Known habitat for CR species breeding area/migration route for EN species (birds) and sighting is Certain ▪ Breeding/aggregation area for EN species (birds, mammals, furry marine mammals and terrestrial invertebrates) is caught/trapped or sighting Very Certain or Certain ▪ Normal range for CR species (furry marine mammals) and Certain or Very Certain ▪ Breeding/aggregation area for CR species (fish) and caught, trapped or sighted and Certain/Very Certain ▪ Foraging and inter-nesting for CR species and nesting/breeding area for EN species (reptiles) Certain or Moderately Certain	▪ Breeding area for CR species (birds and terrestrial invertebrates) which are caught/trapped and sighting is Very Certain/WAM Vouchered/Certain ▪ Breeding/calving/ congregation/aggregation areas for CR species (mammals and furry marine mammals) Certain and Very Certain ▪ Nesting/breeding area for CR species (reptiles) where sighting is Very Certain
Protection Areas	▪ 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 <1,000 ha per shoreline cell ▪ 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 ▪ 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	▪ 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 ▪ All terrestrial and marine conservation areas and proposed conservation areas ranked IUCN II, III, IV, V which do not include the intertidal zone ▪ 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 ▪ Seagrass ▪ Fish habitat protection areas	▪ 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 ▪ All terrestrial and marine conservation areas and proposed conservation areas IUCN IA, IB which do not include the intertidal zone ▪ All terrestrial and marine conservation areas and proposed conservation areas ranked IUCN II, III, IV, V which include the intertidal zone ▪ Coral	▪ ESI 10: 10A Salt and brackish water marshes; 10B Freshwater marshes; 10C Swamps; 10D Mangroves with >3,000 ha per shoreline cell ▪ All terrestrial and marine conservation areas and proposed conservation areas IUCN IA, IB which include the intertidal zone ▪ Nationally Important wetlands ▪ Areas closed under the *Fish Resource Management Act 1994*	▪ World Heritage areas ▪ Ramsar wetlands ▪ Shoreline types: Sheltered tidal flats; Vegetated low banks; Hypersaline tidal flats; Salt and brackish water marshes; Freshwater marshes; Swamps

	Very Low	Low	Medium	High	Very High
Cultural Heritage		▪ State protected shipwrecks	▪ National Indigenous and historic heritage places and Natural heritage places ▪ Commonwealth Maritime Cultural Heritage	▪ Commonwealth National and Indigenous and historic heritage places and Natural heritage places	▪ World Heritage areas
Economic	▪ Ports throughput <1 million tonnes annually ▪ <$20M (<0.01% State GDP) and recovery of species is <10 years ▪ Commonwealth managed fisheries ▪ Majority of State managed commercial fishing locations ▪ Tourism Region key population centre <5% of State income from tourism	▪ Ports throughput 1.1-10 million tonnes annually ▪ $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 ▪ Aquaculture licence areas ▪ Water intake locations for aquaculture seawater intakes ▪ Tourism Region key population centre 5-10% of State income from tourism	▪ Ports throughput 11-100 million tonnes annually ▪ $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 ▪ Cooling water intakes for power stations ▪ Tourism Region key population centre >10% of State income from tourism	▪ Ports throughput 101-400 million tonnes annually ▪ $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	▪ Reverse osmosis potable water plant seawater intakes ▪ Ports throughput >401 million tonnes annually ▪ >$1B (>0.5% of State GDP) OR $501M-$1B (0.25-0.5% of State GDP) and recovery of species is >11 years
Social, Amenity and Recreation	▪ Beaches with >100,000 visitors a year	▪ Marine Parks, Marine Management Areas & Marine Nature Reserve ▪ Coastal Landforms' 'fine- to medium-grained sand beaches ▪ Beaches with >100,000 visitors a year	▪ Beaches with >1 million visitors a year		

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

	Very Low	Low	Medium	High	Very High
Protected Fauna	▪ Other known areas for VU, CR, EN species (birds) if Moderately Certain ▪ CR species if extinct (birds, mammals, invertebrates, reptiles, fish) ▪ Normal range for EN species and Normal range for VU, Migratory or Marine species (mammals and fish) ▪ Normal range for VU (furry marine mammals) ▪ All areas for terrestrial invertebrates ▪ Foraging and inter-nesting for VU species and all Migratory and Marine species (reptiles) ▪ Terrestrial species which do not use the coastal zone for any instance of their lifecycle and do not use the coastal zone as any component of their habitat	▪ 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) ▪ Known habitat for CR species Moderately Certain. Breeding area for VU, EN species Very Certain (birds) ▪ Normal range for CR species. Breeding area for VU species (mammals and fish) Certain or Moderately Certain ▪ Normal range for EN species. Breeding/Aggregation areas for VU (furry marine mammals, fish) Certain or Moderately Certain ▪ Nesting/breeding area for VU species (reptiles, fish) Certain, Moderately Certain	▪ Known habitat for CR species. Breeding areas for EN species (birds) ▪ Breeding/aggregation area for EN species (mammals, furry marine mammals and fish) Very Certain, Certain ▪ Known habitat for CR species migration or foraging Moderately Certain to occur (Fish) ▪ Normal range for CR species (furry marine mammals) known or Very Certain ▪ Foraging and inter-nesting for CR species and nesting/breeding area for EN species (reptiles) Certain or Very Certain	▪ Breeding and nesting area for CR species (birds, mammals, furry marine mammals and fish) which are Certain ▪ Breeding and EN species (fish) Very Certain ▪ Nesting/breeding area for CR species (reptiles) Certain or Very Certain	▪ Known habitat for CR species breeding, congregation caught or Certain (fish)
Protection Areas	▪ 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 <1,000 ha per shoreline cell ▪ All conservation areas and proposed conservation areas as defined under the WA *Conservation and Land Management Act 1984* ranked IUCN VI (Managed Resource Protected Area) and all other types: 5(1)(g) reserves; 5(1)(h) reserves; Indigenous Protected Areas; Miscellaneous Reserves ▪ 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	▪ All conservation areas and proposed conservation areas ranked IUCN II (National Park), III (National Monument), IV (Habitat/Species Management Area), V (Protected Landscape/Seascape) ▪ All conservation areas and proposed conservation areas as defined under the *WA Conservation and Land Management Act 1984* 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 ▪ Algae	▪ 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 ▪ 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 ▪ All conservation areas and proposed conservation areas as defined under the WA *Conservation and Land Management Act 1984* ranked IUCN II (National Park), III (National Monument), IV (Habitat/Species Management Area), V (Protected Landscape/Seascape) ▪ Fish habitat protection areas ▪ Seagrass	▪ ESI 10: 10A Salt and brackish water marshes; 10B Freshwater marshes; 10C Swamps; 10D Mangroves with >3,000 ha per shoreline cell ▪ 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 ▪ Nationally Important Wetlands ▪ 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 ▪ Coral ▪ Areas closed under the *Fish Resource Management Act 1994*	▪ World Heritage areas ▪ Ramsar wetlands ▪ Shoreline types: Sheltered tidal flats; Vegetated low banks; Hypersaline tidal flats; Salt and brackish water marshes; Freshwater marshes; Swamps

	Very Low	Low	Medium	High	Very High
Cultural Heritage		▪ State protected maritime archaeology	▪ National Heritage Properties, Indigenous and historic heritage places ▪ Commonwealth heritage places, Indigenous and historic heritage places ▪ Commonwealth Maritime Cultural Heritage	▪ National Heritage Properties, natural heritage places ▪ Commonwealth heritage places, natural heritage	▪ World Heritage areas
Economic	▪ Ports throughput <1 million tonnes annually ▪ <$20M (<0.01% State GDP) and recovery of species is <10 years ▪ Commonwealth managed fisheries ▪ Majority of State managed commercial fishing locations ▪ Many State and all Commonwealth managed fisheries locations ▪ Tourism Region key population centre <5% of State income from tourism	▪ Ports throughput 1.1-10 million tonnes annually ▪ $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 ▪ Aquaculture licence areas ▪ Water intake locations for aquaculture seawater intakes ▪ Tourism Region key population centre 5-10% of State income from tourism	▪ Ports throughput 11-100 million tonnes annually ▪ $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 ▪ Cooling water intakes for power stations ▪ Tourism Region key population centre >10% of State income from tourism	▪ Ports throughput 101-400 million tonnes annually ▪ $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 ▪ Reverse osmosis potable water plant seawater intakes	▪ Ports throughput >401 million tonnes annually ▪ >$1B (>0.5% of State GDP) OR $501M-$1B (0.25-0.5% of State GDP) and recovery of species is >11 years
Social, Amenity and Recreation	▪ All town sites ▪ Beaches with >100,000 visitors a year ▪ Beaches with <100,000 visitors a year	▪ Recreational fishing/boating zones ▪ Marine Parks, Marine Management Areas & Marine Nature Reserve ▪ Beaches with >1 million visitors a year			

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 areas for each category, for protection from both floating hydrocarbons and dissolved hydrocarbons. Figure 5-1 illustrates the process. Each layer has been ranked, then combined to give a 'heat map' showing the highest priority areas for protection.

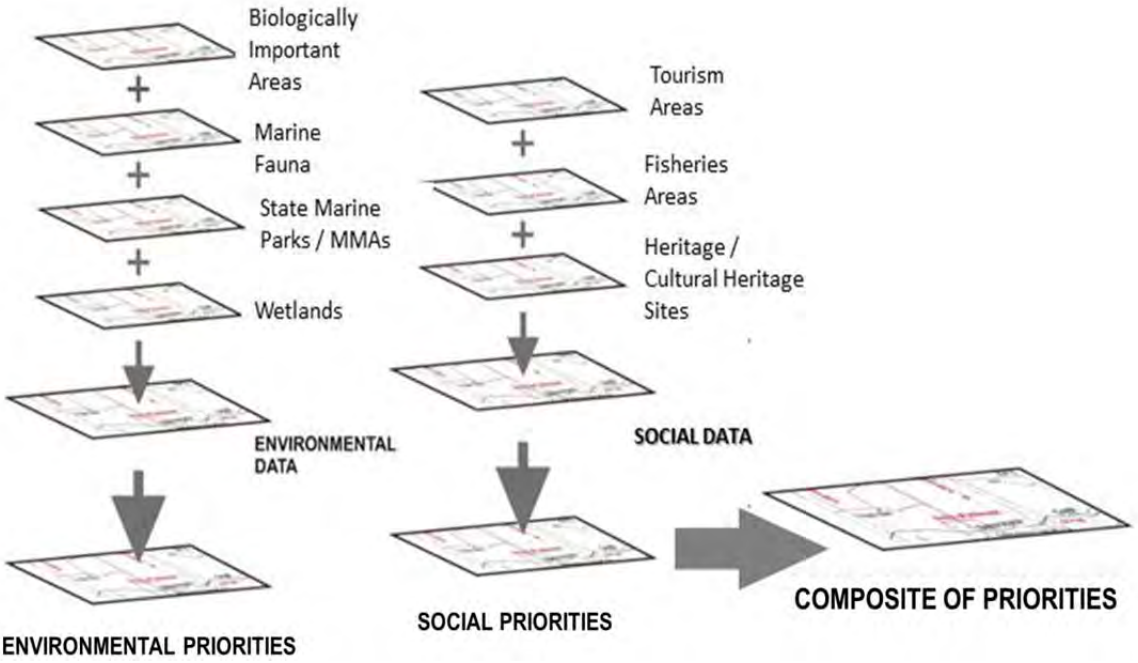

Figure 5-1: Example illustration of composite of ranked geospatial data

The heat map has been derived from the ranking information developed during the weighting of criteria in the Steering Committee Workshop held on 16 November 2016, and the revised rankings developed during the State Wide Overview assessment.

The weighted importance of all criteria have 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 that 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 highest protection priority, and details what aspect 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. A raster has been created from the overall ranking for each category, assigning the weighting value to grids of 2 km x 2 km cells. The raster is the product of each of the overall rankings, one each for 'floating oil', 'dissolved oil' and 'overall'.
7. 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', 'dissolved oil' and 'overall'.

A geodatabase houses the layers and the shapefiles as well as the raster which have been used to identify the overall weighting for the shoreline cells.

This has been used to create the heat 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 provided. These will consist of the following headings:

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 1-5 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 1-5 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 – This is a brief description of the priority(ies) identified that have given the category its highest ranking for priority from assessment of floating hydrocarbons. NOTE: Limit is 256 characters.
8. Brief Description Dissolved – This is a brief description of the priority(ies) identified that have given the category its highest ranking for priority from assessment of dissolved hydrocarbons. NOTE: Limit is 256 characters.
9. Data Source – This is the source of the data for that category that has given the cell it's ranking either for floating or dissolved hydrocarbons.

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

The attribute table data will be incorporated into the WA OSRA database. It will provide a link between the work undertaken as part of this project to identify the shoreline cells with protection priorities and the underlying aspects. This will provide a mechanism for the OSRA to obtain additional information regarding the aspects which contributed to a high ranking in a shoreline cell.

Table 5-1: Attribute table format (Extract, Shoreline Cell 173)

Shoreline Cell ID	Category ID	Category Name	Floating Ranking	Dissolved Ranking	Overall Ranking	Brief Description Floating	Brief Description Dissolved	Data Sources
132	1	Protected Fauna	4	3	4	Reptiles: EN loggerhead turtle (*Caretta caretta*) breeding, congregation or aggregation Known/Certain to occur in area	Reptiles: EN loggerhead turtle (*Caretta caretta*) breeding, congregation or aggregation Known/Certain to occur in area	DotE SNES (22 February 2017), Gnaraloo Station dataset (October 2016)
132	2	Protection Areas	5	5	5	World Heritage (The Ningaloo Coast)	World Heritage (The Ningaloo Coast)	DotE World Heritage Areas (14 October 2015)
132	3	Cultural Heritage	4	4	4	National Heritage (The Ningaloo Coast)	National Heritage (The Ningaloo Coast)	DotE National Heritage (Public) (22 January 2016)
132	4	Economic	2	3	3	West Coast Rock Lobster Managed Fishery	West Coast Rock Lobster Managed Fishery	DoF State Managed Commercial Fisheries (7 April 2017)
132	5	Social, Amenity and Recreation	2	2	2	Marine Park (Ningaloo) Multiple Use Zone (IUCN VI)	Marine Park (Ningaloo) Multiple Use Zone (IUCN VI)	DotE CAPAD – Marine (30 June 2014) with DPaW update (30 June 2016)
132	6	Overall	5	5	5	World Heritage (The Ningaloo Coast)	World Heritage (The Ningaloo Coast)	DotE World Heritage Areas (14 October 2015)

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 (DoT). This step will occur once an Oil Spill Risk ranking has been produced for floating 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 shown 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.

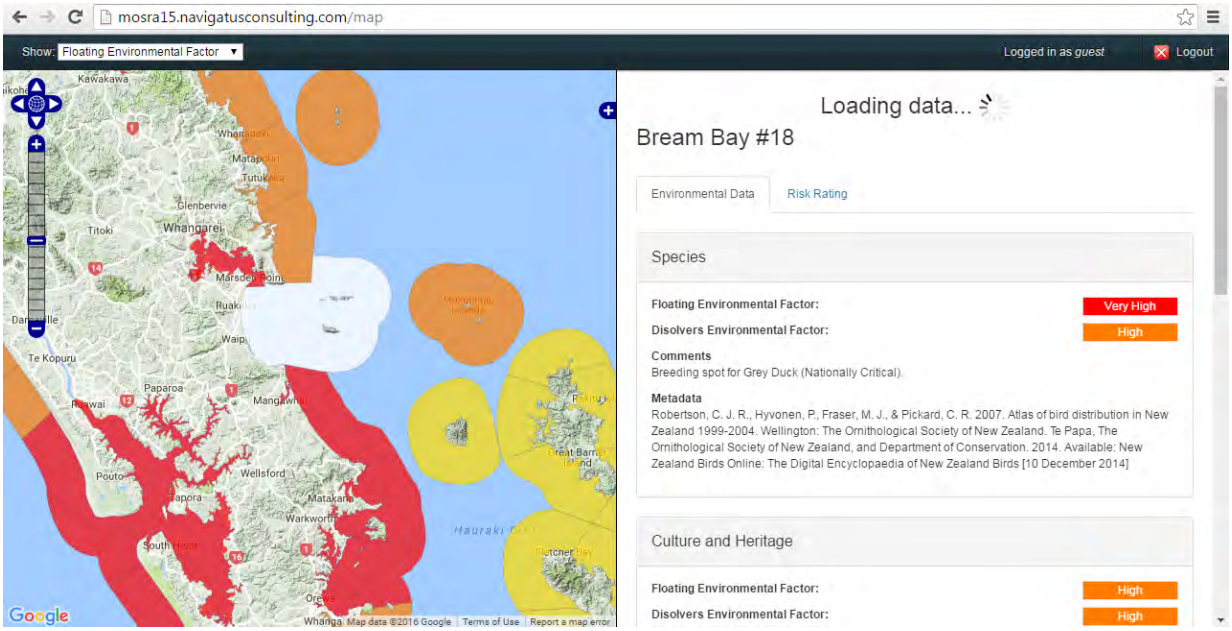

Figure 6-1: Marine Oil Spill Risk Assessment WebMap sample by Navigatus for New Zealand (accessed 31 July 2016)

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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 7-2. These maps summarise the protection priorities that have been identified as a result of this project. An overall map of the combined effect of both dissolved oil and floating oil is presented in Figure 7-3.

Included in Appendix A are a series of maps which provide additional granularity which underpins the results of the assessment. The maps are grouped into each category, i.e. Protected Fauna, Protection Areas, Heritage, Economic, and Social, Amenity and Recreation. Summary maps depict the shoreline cells in the Midwest 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 effect of the rankings of floating, dissolved and overall oil effects for each of the categories, the following is apparent:

- For the impacts to protected fauna, half of the Midwest zone has been ranked High for protection from floating oil, but mostly Low for protection from dissolved oil (Appendix A: Figure A1 and Figure A2);
- Shark Bay World Heritage Area (Protection Area) and other marine protection areas associated with fish habitat protection, has caused half of the Midwest zone to be ranked Very High for protection from floating oil and High for protection from dissolved oil (Appendix A: Figure A3 and Figure A4);
- The ranking of economic impacts to ports, which ranked Geraldton Port as Medium for protection from floating oil and dissolved oil, had a localised effect on three shoreline cells (Appendix A: Figure A5 and A6). The other two key ports in the Midwest ranked Low for floating oil and dissolved oil are in the Shark Bay area, and stand out for protection from floating oil (Appendix A: Figure A5). However, for dissolved oil, the ports are equal with the Western Rock Lobster Managed Fishery which is also ranked Medium for protection from dissolved oil. The entire zone is ranked Medium for protection from floating oil and dissolved oil, reflected in the overall figure for Economic priorities for the Midwest zone (Figure 7-3); and
- The cumulative ranking for all categories for both floating and dissolved oil effects sees half of the Midwest zone being ranked Very High due to the Shark Bay World Heritage Area, and the remainder a combination of High and Very High due to protected fauna and the Western Rock Lobster Managed Fishery (Figure 7-3).

Protected Fauna

The **Protected Fauna** category had the most comprehensive dataset coverage of all the categories. The datasets incorporated into this category included the SNES (Commonwealth) and the BIA polygons, while the DPaW dataset provided discrete points.

The majority of the Midwest zone has been ranked High for protection from floating oil and Medium for protection from dissolved oil. This is due to the majority of the coastline being habitat for Endangered species, including many species of birds and reptiles. The key species which use

the majority of the coastline and are driving this High classification in the Protected Fauna category are the Endangered loggerhead and leatherback turtles that congregate along this section of WA coastline.

Protection Areas

The **Protection Areas** which have been ranked Very High are associated with important habitat protection zones in the Shark Bay World Heritage Area, and the areas which have been ranked High are those with habitat protected under Commonwealth and Federal legislation. Where the coastline has been ranked High for protection from dissolved oil in protection areas, these are the areas which contain seagrass and fish habitat protection areas. The majority of the coastline has been ranked High for protection from floating oil in protection areas, with the exceptions being those shoreline cells which are classified as rocky cliffs, coarse grained beaches and exposed rocky cliffs. The dataset which influenced the prevalence of the Very High ranking in the floating oil protection priority were the OSRA ESI data layer that identifies sheltered tidal flat, and other datasets such as the CAMRIS that identifies seagrass and coral reefs. As the coastal cells are of a 10 km x 20 km size, the sheltered tidal flats could be small and surrounded by exposed rocky cliffs for protection, but the cell has been given the highest ranking in its boundary.

Cultural Heritage

The impact on **Cultural Heritage** and shipwrecks aspects from an oil spill is the same for protection from floating and dissolved oil. The Midwest zone has been ranked High for impact to heritage in the area of Shark Bay Marine Park, which is a National Heritage Area. The other cultural heritage is the National Heritage listed Batavia Shipwreck site and survivor camps area from 1629, located on the Houtman Abrolhos islands.

More than 100 other historic shipwrecks are found along the Midwest coastline, and the presence of these has given the majority of the zone a ranking of Medium, indicating the rich history of the Midwest area.

Economic

The impact from floating oil on **Economic** aspects has been ranked mostly Low for the Midwest zone and Medium for dissolved oil. The coastline has been ranked Medium for protection from dissolved oil due to the presence of the State Managed Commercial Fisheries zone, the Western Rock Lobster Fishery. For protection from floating oil, the Port of Geraldton has been ranked Medium which is a small cluster in the remainder of the coastline which has been ranked Low.

Social, Amenity and Recreation

The results for the assessment of protection priority for **Social, Amenity and Recreation** aspects have indicated that, due to the low numbers of datasets used in this category, the only aspects which have been represented in this dataset are the beaches and areas used for recreational fishing in the Marine Parks of Shark Bay and Jurien Bay. The key protection priorities associated with these Marine Parks have been ranked Low for social aspects, however have been ranked higher in Heritage and Protection Areas. The impacts of floating oil and dissolved oil have been ranked the same, so the cumulative ranking has not changed and those shoreline have all been ranked Very Low.

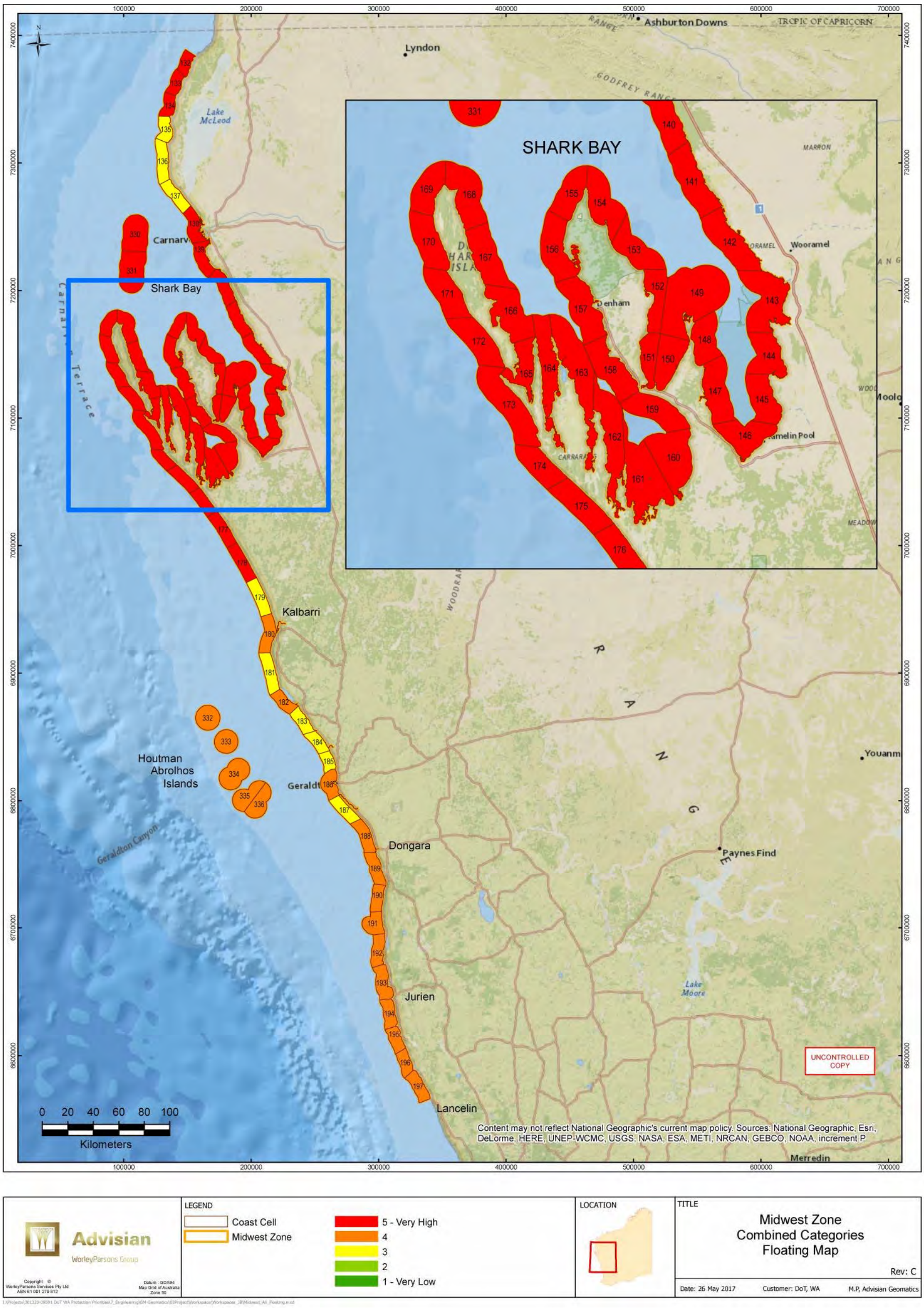

Figure 7-1: Cumulative (including all category rankings) Shoreline Cell protection priority ranking for floating hydrocarbons effects

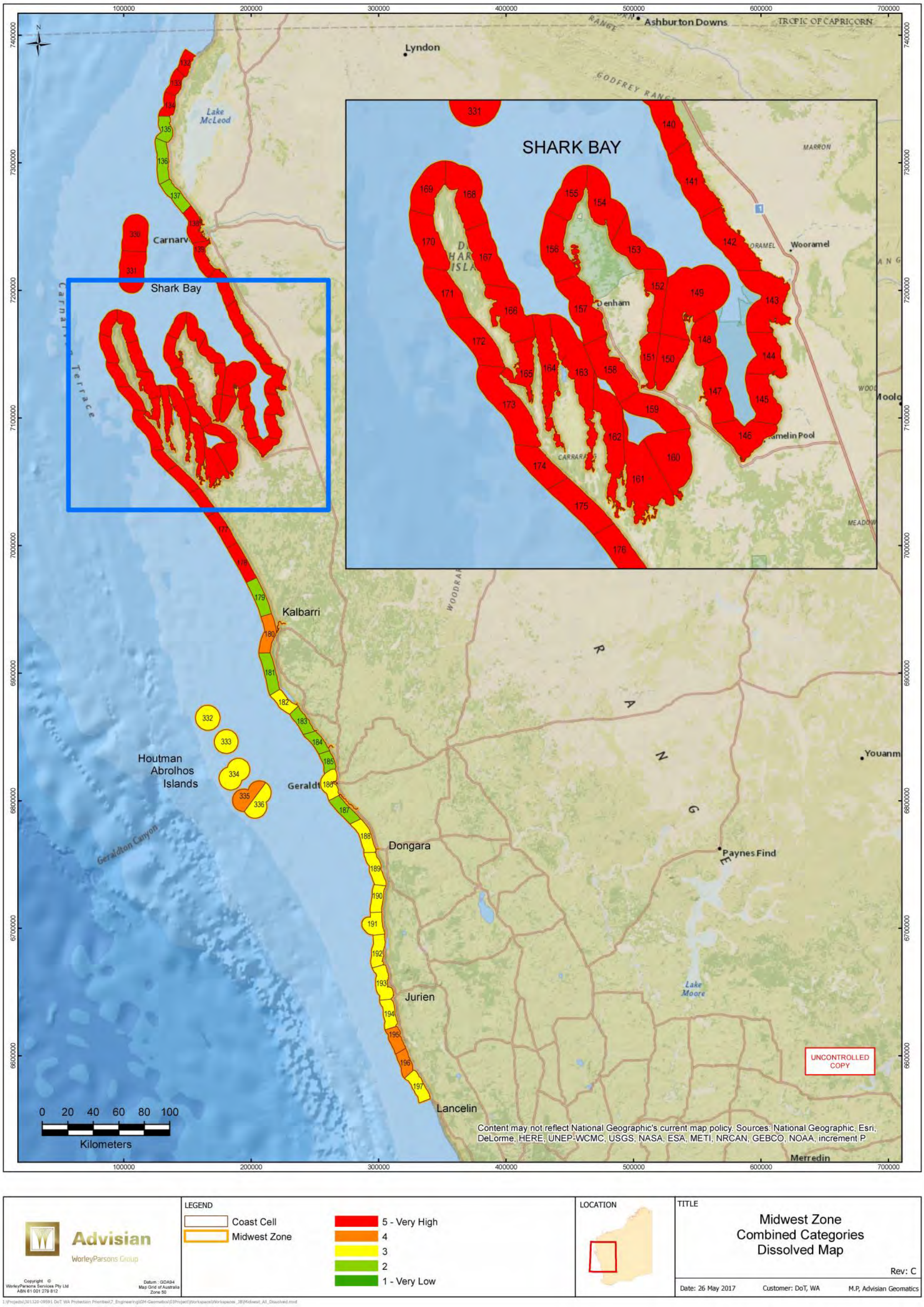

Figure 7-2: Cumulative (including all category rankings) Shoreline Cell protection priority ranking for dissolved hydrocarbons effects

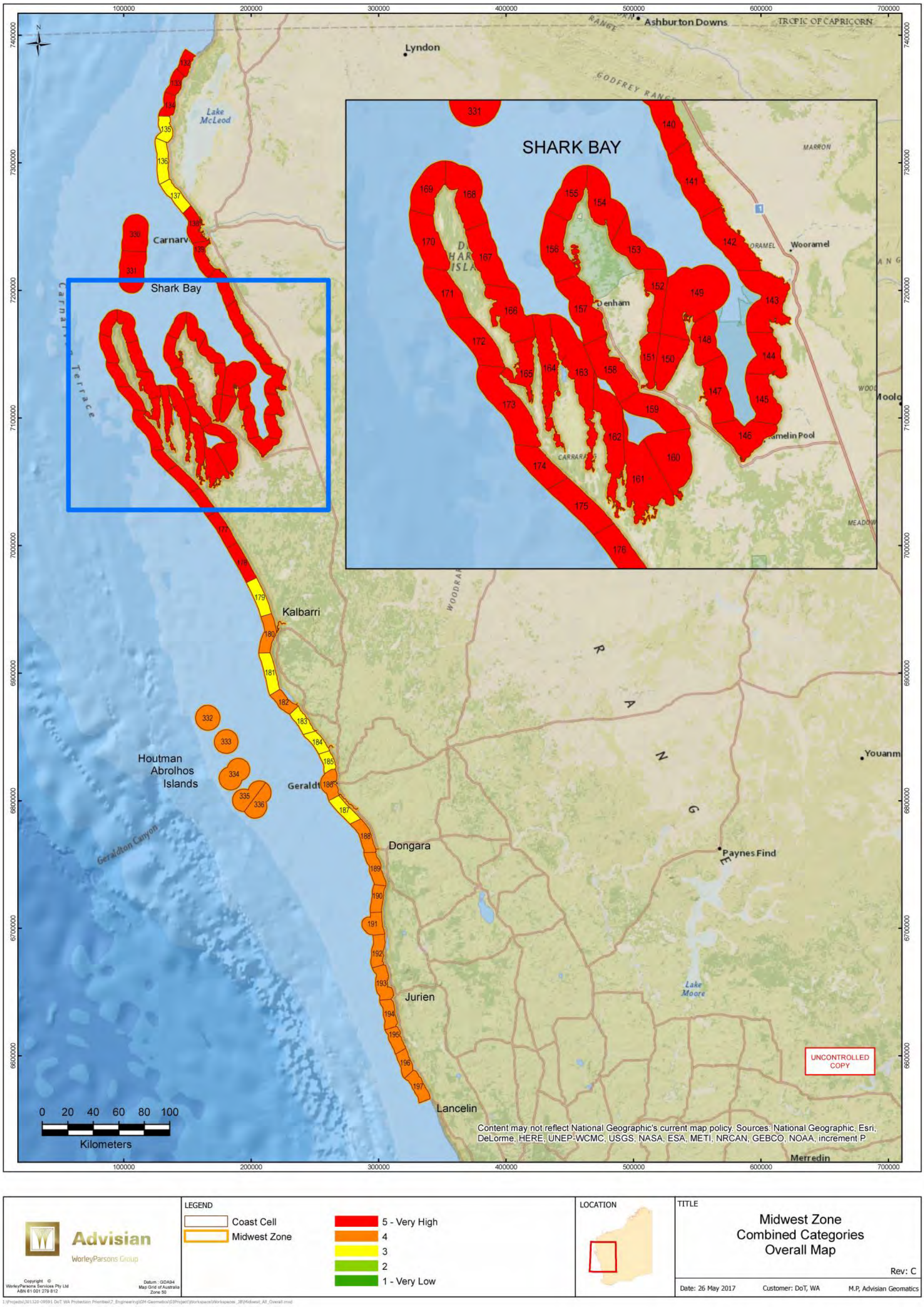

Figure 7-3: Cumulative (including all category rankings) Shoreline Cell protection priority ranking, for both floating and dissolved hydrocarbons effects

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8 Discussion

The key discussion points from the Midwest zone are:

- Dataset Comparison;
- Multi-Criteria Analysis;
- Timeframes;
- Attribute Table; and
- Terrestrial fauna data treatment.

8.1.1 Dataset Comparison

More than 60 datasets have been incorporated for use in the Midwest 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 regarding comparing different datasets between zones. For example, the Pilbara zone completed in August 2016 has had many regional scale studies done in the area, such as the Pilbara Oiled Wildlife Response Plan, while the Midwest has not.

The Midwest zone has therefore relied on data sourced from studies done in the marine and coastal protection areas by DPaW and for fisheries related investigations by the DoF, as well as the DoT ESI dataset for regional comparison. Though there have been some gaps with the ESI dataset (some areas 'unclassified'), in general the predominant coastal characteristics have been identified (e.g. exposed sea cliffs).

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 Midwest 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.

8.1.2 Data from Tertiary Institutions and Research Centres

Each year 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 the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Australian Institute of Marine Science. This includes the $20 million Strategic Research Fund for the Marine Environment between the Government of WA and CSIRO, and the WA Marine Futures Project undertaken with the University of Western Australia.

Through the West Australian Marine Sciences Institution (WAMSI) and connections with DPaW, DoT and DoF, benthic habitat data has been collected from the University of Western Australia 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.

8.1.3 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 Midwest zone, may not be the most accurate representation of current protected fauna locations. 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 for 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 not published, it 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 engagement 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, but has not been incorporated. This is because data on the extent of the damage is not available. 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.

8.1.4 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 that have been involved in government-funded projects, 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 different engagement methods. However, when compared to the data available and already acquired, either during the previous Pilbara zone assessment, or during the

data collection for this Midwest zone assessment, the opinion is that there is sufficient data coverage for the Midwest 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 Midwest 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 Habitats).

8.1.5 Relevant Discussions from Previous Zones

It was discussed in the Steering Committee Workshop for the previous Pilbara zone assessment whether, in the event of 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 the event of 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.

8.1.6 Terrestrial Fauna Data Treatment

Terrestrial fauna has been considered for re-ranking after identifying that certain species were being ranked as Very High or High where they are unlikely to use the coastal zone. In this context, the coastal zone 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).

In all zones, the terrestrial fauna data was interrogated further including a review of all birds, mammals, reptiles and invertebrates. Fauna habitat information from secondary credible sources was evaluated to determine if they spend any part of their lifecycle in the coastal zone. The secondary 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, reptiles and invertebrates.

Any fauna which was found to use the coastal zone retained its ranking in accordance with the ranking system according to classification, habitat use and record certainty. Any fauna which was found to not use the coastal zone was given a ranking of Very Low for protection from both floating 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 coastal zone. By giving it the lowest ranking possible, the data is still considered in the assessment but does not influence the planning of an oil spill response.

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9 Conclusions

The following are key conclusions of this study:

- The Midwest zone contains key areas that are quite vulnerable to marine oil pollution, both from floating and dissolved hydrocarbons;
- Datasets are suitably comparable between the initial zone assessed by this project (the Pilbara zone) and the Midwest zone;
- The prevalence of migratory Endangered fauna, such as the loggerhead and leatherback turtle, has led to a High protection priority for a majority of the coastline and the distribution of the Fish Habitat Protection Areas which are closed under section 43 of the *Fish Resource Management Act 1994*;
- The Steering Committee once again provided invaluable 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 in an oil spill. The Environmental Scientific Coordinators will still be called upon in the event of 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 Midwest coast.

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10 Recommendations

A number of recommendations have been identified when assessing the Midwest 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 became 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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Appendix A Shoreline Cell Maps

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Protected Fauna

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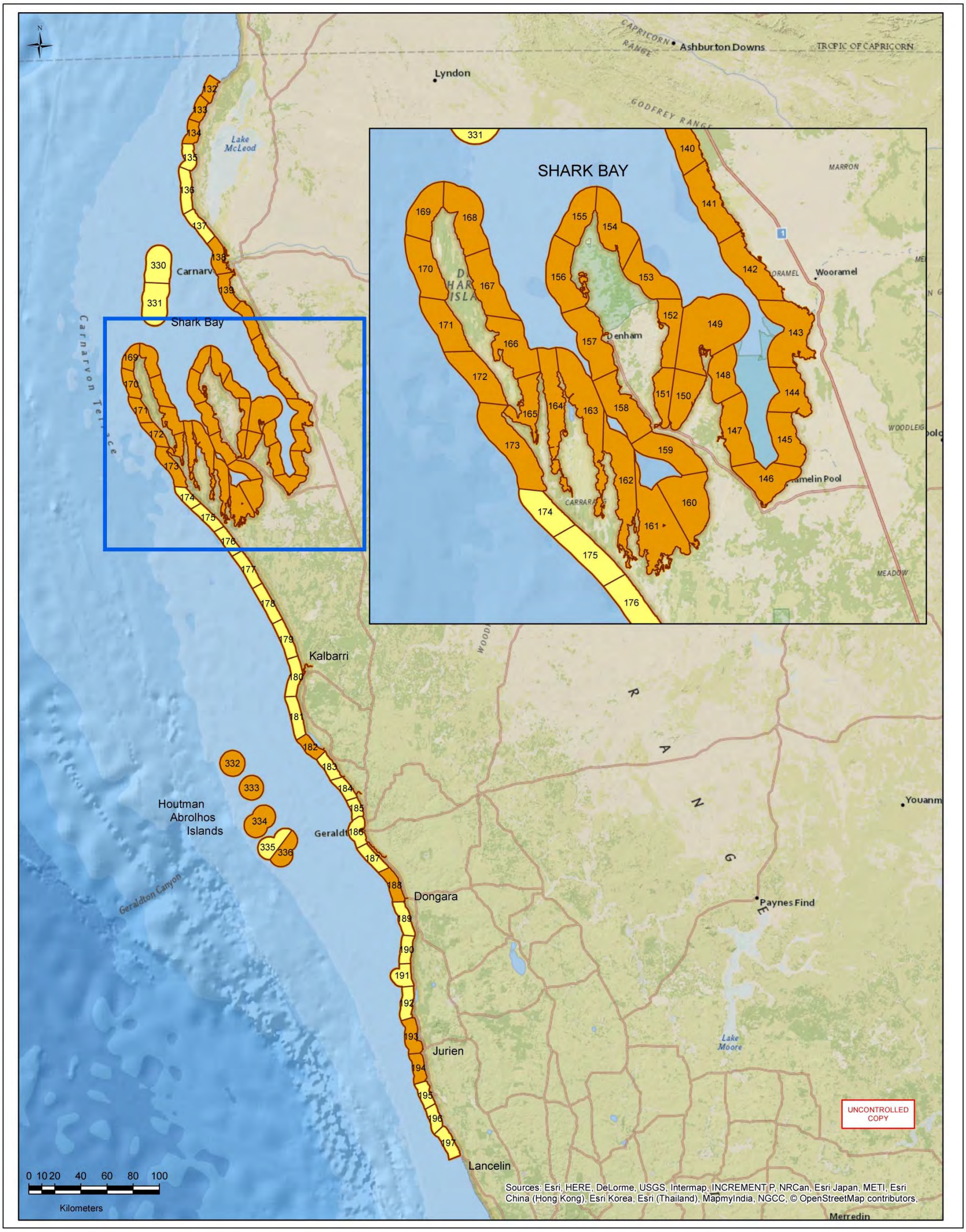

Figure A1: Protected Fauna shoreline cell protection priority ranking for floating hydrocarbons effects

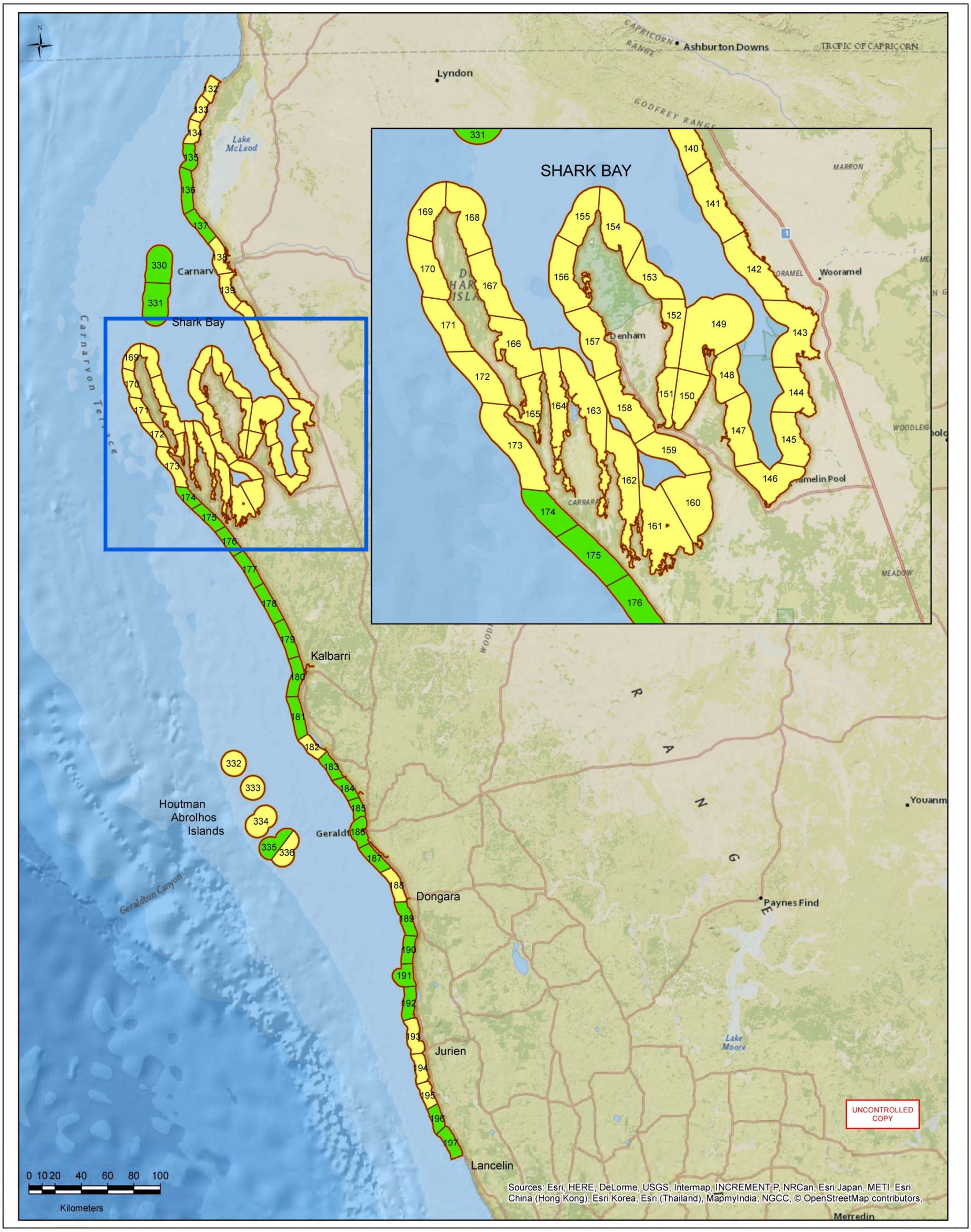

Figure A2: Protected Fauna shoreline cell protection priority ranking for dissolved hydrocarbons effects

Protection Areas

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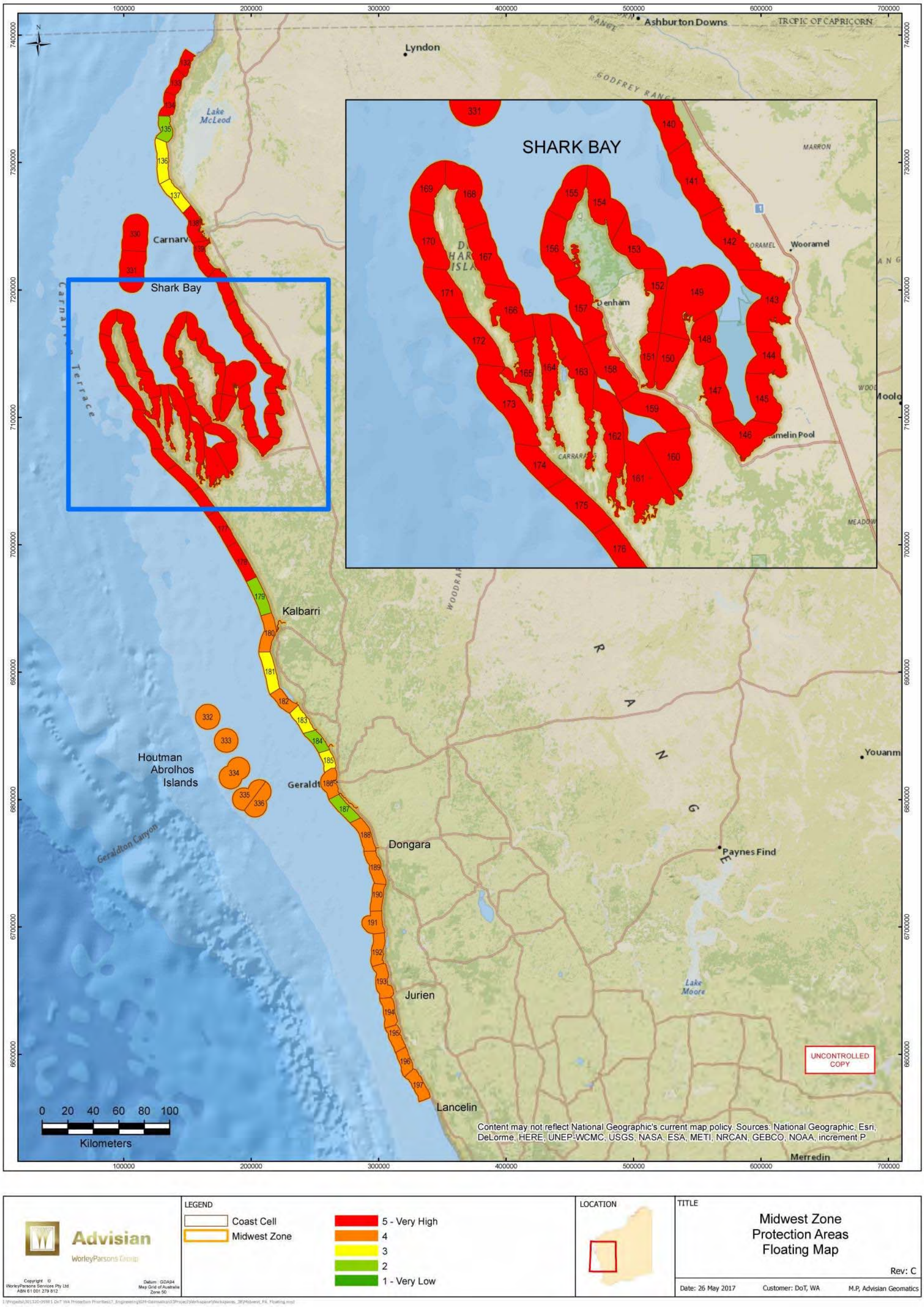

Figure A3: Protection Areas shoreline cell protection priority ranking for floating hydrocarbons effects

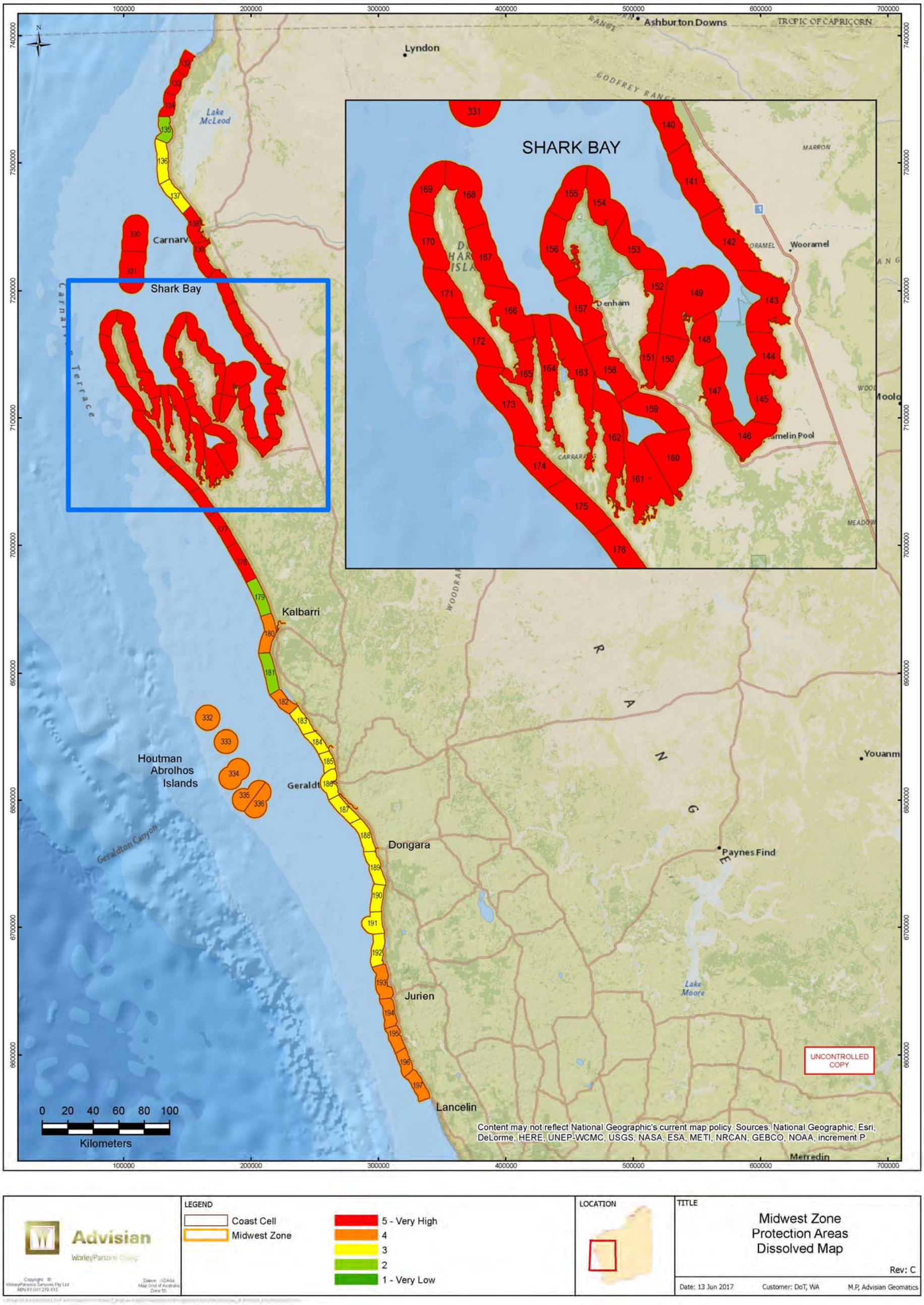

Figure A4: Protection Areas shoreline cell protection priority ranking for dissolved hydrocarbons effect

Cultural Heritage

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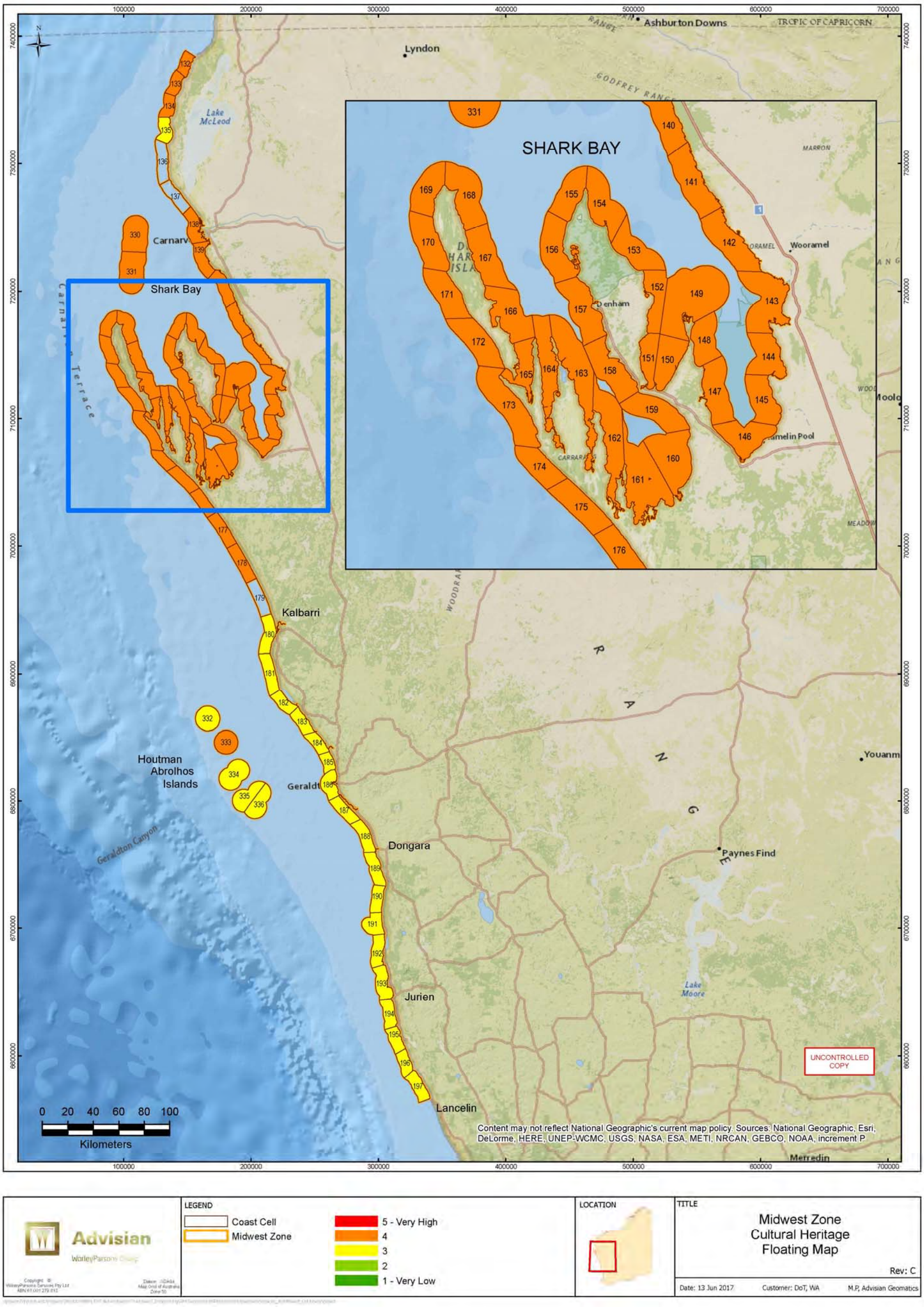

Figure A5: Cultural Heritage shoreline cell protection priority ranking for floating hydrocarbons effects

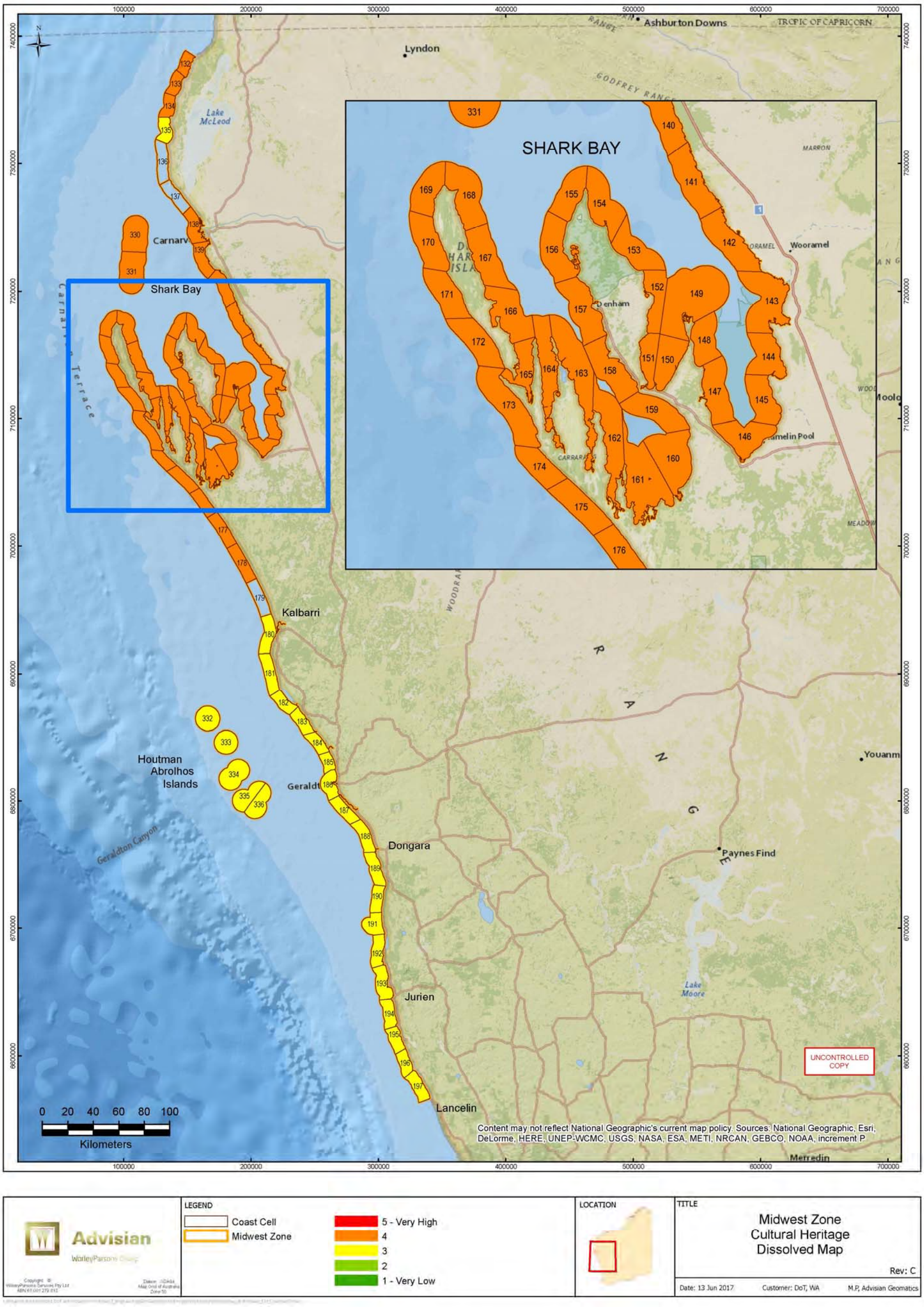

Figure A6: Cultural Heritage shoreline cell protection priority ranking for dissolved hydrocarbons effects

Economic

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

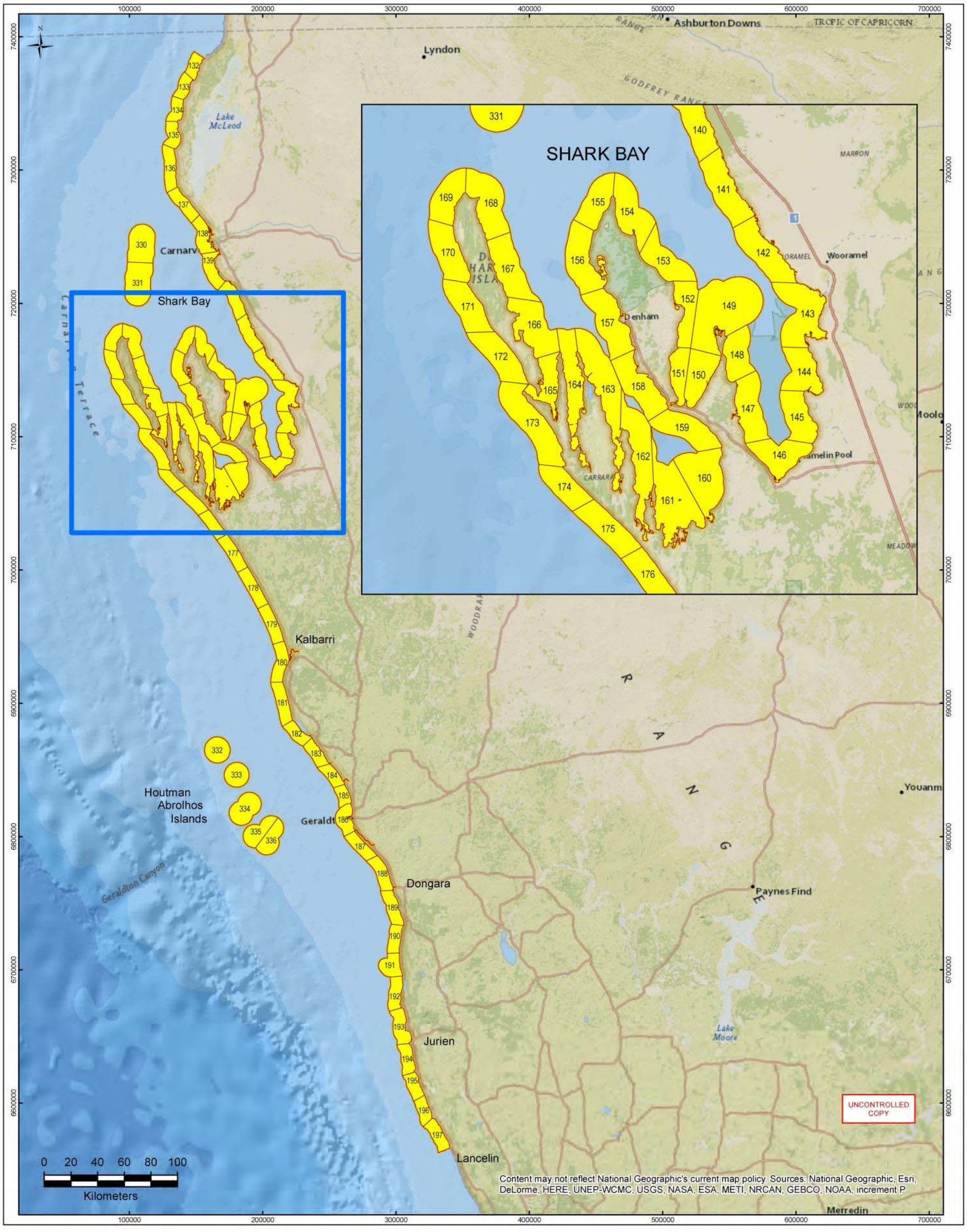

Figure A8: Economic shoreline cell protection priority ranking for dissolved hydrocarbons effect

Social, Amenity and Recreation

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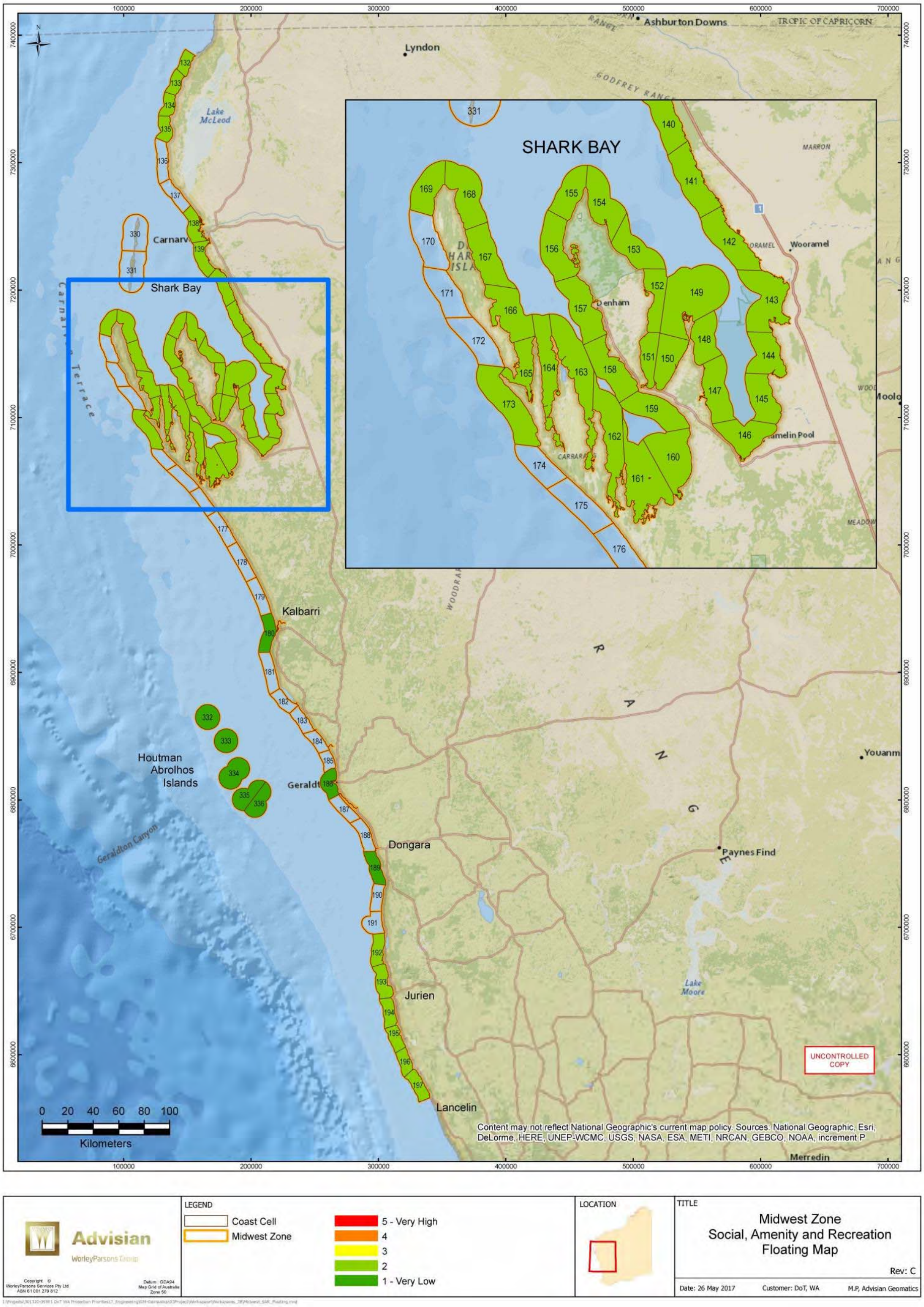

Figure A9: Social, Amenity and Recreation shoreline cell protection priority ranking for floating hydrocarbons effects

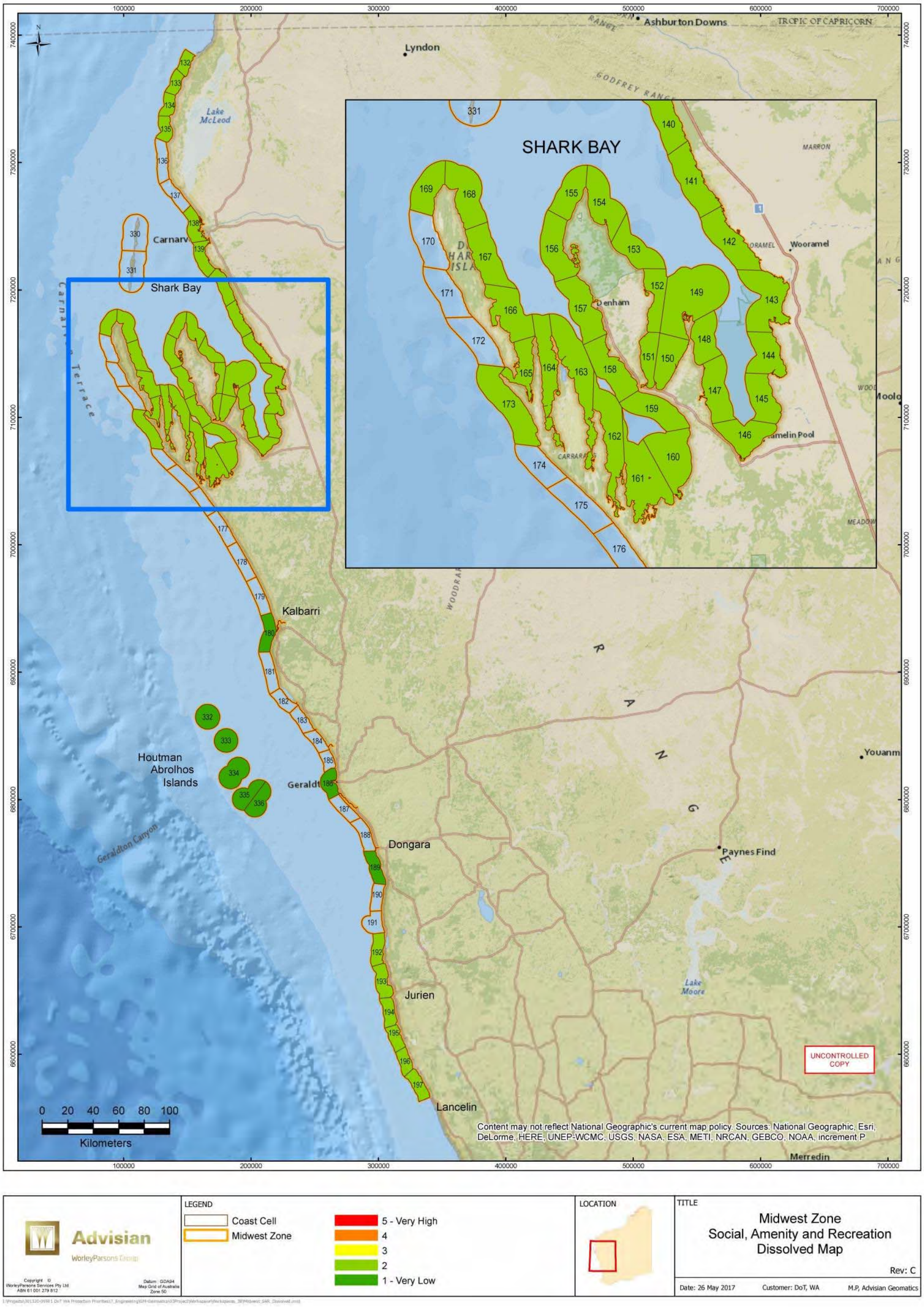

Figure A10: Social, Amenity and Recreation shoreline cell protection priority ranking for dissolved hydrocarbons effects