Western Australia

Marine Oil Pollution Risk Assessment

South West Zone Report

Prepared for Department of Transport

by Navigatus Consulting

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Outputs in this Series

Web

Interactive webmap application: http://wamopra.navigatusconsulting.com/login

Data

GIS attribute tables for DoT internal system.

Reports

- Navigatus, 2016 – WAMOPRA Preliminary State-Wide Assessment (*published*)
  - Appendix A – Exposure Results by Category
  - Appendix B – Web Based Interface
- WAMOPRA Pilbara Zone Report (published)
- WAMOPRA Mid-West Zone Report (published)
- WAMOPRA Swan Zone Report (published)
- WAMOPRA Kimberley Zone Report (*scheduled FY 2018*)
- **WAMOPRA South West Zone Report (this report)**
- WAMOPRA South Coast Zone Report (*scheduled FY 2018*)

1. Introduction

1.1. Overview

The Western Australian Department of Transport (DoT) is currently running a programme of work looking at matters around marine oil spills. One component of the work is the Western Australia Marine Oil Pollution Risk Assessment (WAMOPRA).

The WAMOPRA is being undertaken in two stages. In Stage One, Navigatus undertook a preliminary state-wide exposure assessment. Stage Two builds on the work developed in Stage One. It consists of specific zone-by-zone assessments and involves incorporating protection priorities and navigational hazard to create a full risk profile.

This document should be considered a companion report to the WAMOPRA webmap application: http://wamopra.navigatusconsulting.com/. It summarises the context, methodology and results for the South West Risk Assessment Zone. The other zones are: Pilbara, Kimberley, Swan, Midwest and South Coast.

1.2. Programme Background

The purpose of the overall WAMOPRA programme is to build an assessment of the oil spill risk in Western Australia State waters. This assessment considers regional, national and international data for maritime activity and marine oil spills, current and future levels of activity and protection priorities including environmental sensitivities.

To undertake the WAMOPRA, DoT has commissioned two consultancies. Navigatus Consulting Limited is engaged to collect and analyse information on potential marine oil pollution exposure and build a risk model. Navigatus has special expertise in this field and have undertaken similar work in Victoria and New Zealand (Navigatus 2015).

The second consultant, Advisian, is collecting environmental data to identify protection priorities in the event of a marine oil spill. Protection priority data is fed into the risk model developed by Navigatus to create a picture of oil spill risk including likelihood and consequence.

The results will guide oil spill contingency planning and will enable future resource allocations for oil spill response to take account of the level of identified risk. The main purpose of the risk profile is to inform:

- Decisions about resource allocation.
- Identification of areas where management is required to reduce risk.
- Evaluation of whether there is adequate spill response capability in areas of high risk.

Other requirements include:

- Fulfil obligations under WestPlan: Marine Oil Pollution (MOP).
- Ensure Western Australia is up to date with world standards in oil spill response.
- Complement the Oil Spill Response Atlas as a decision-making tool.

2. Scope

2.1. South West Zone

This report summarises the context, methodology and results for the South West Risk Assessment Zone. It builds on the work undertaken in the preliminary state-wide assessment. The geographical extents of the South West Zone shoreline are shown in Figure 2.1 along with the other zones.

Figure 2.1 Marine Oil Pollution Risk Assessment Zones

The primary output of this assessment is the webmap application located at: http://wamopra.navigatusconsulting.com. GIS attribute tables are also held by DoT for use in internal systems. This report is a companion report to the website. Outputs in this report are in the form of heat maps, charts and tables.

2.2. Report Outline

The remainder of this report is structured as follows:

- **Context** – a brief overview of the contextual background informing the WAMOPRA. This includes shipping trends, the current state of the offshore petroleum industry and discussion of short and long-term scenarios.
- **Data Sources** – a summary of the data sources used in the WAMOPRA. As the South West Zone report builds on the preliminary state-wide assessment some data sources are already discussed in the Stage One report. In these cases a shorter summary is provided and the reader is referred to the Stage One report.
- **Methodology** – a summary of the methodology used to develop the WAMOPRA. As with the data sources section there are elements of the methodology which are covered in the Stage One report. In these cases a shorter summary is provided and the reader is referred to the Stage One report.
- **Results** – a presentation of the various results produced by the WAMOPRA:
  - *Exposure* – outputs relating to exposure, i.e. the expected amount of oil in a given shoreline or sea location. Includes breakdown by vessel types and spill sizes. Exposure is combined with protection priorities to produce the South West risk profile.
  - *Protection Priorities* – the primary output shown is a heat map of the overall protection priority ratings for the South West Zone as provided by Advisian. These ratings are combined with exposure to produce the South West risk profile.
  - *Risk Profile* – the primary output shown is a heat map which combines exposure and protection priorities to form a full risk profile. The risk profile is the primary risk output in this report and is the synthesis of all inputs into the WAMOPRA.
  - *Sub-Zone Drill Down* – a short section on each of four sub-zones within the South West Zone (refer Section 5.2 for an explanation of sub-zones). A table is presented for each sub-zone which shows, for each of the shoreline cells in that sub-zone: cell name, overall risk rating, protection priorities ratings, a brief description of the overall protection priority rating and a brief comment on the key drivers of shoreline exposure. The key benefit of these tables is allowing trends in risk drivers to be seen across multiple cells.
- **Summary** – summary of the key findings.

3. Context

3.1. Level of activity

The South West region has one commercial port – Bunbury, and so has a generally low level of trade compared to some regions of Western Australia. The level of trade volume is similar to the Midwest region, which also has only one commercial port (Geraldton). In addition, there are reasonably high levels of passing traffic transiting to ports along the southern coast of Australia.

There is a minor port frequented by recreational users (Port Geographe) – however the vessels using this port are not typically of a size that could give rise to large oil spills (Fremantle Sailing Club 2014).

There are no exploration or production permits in the South West region.

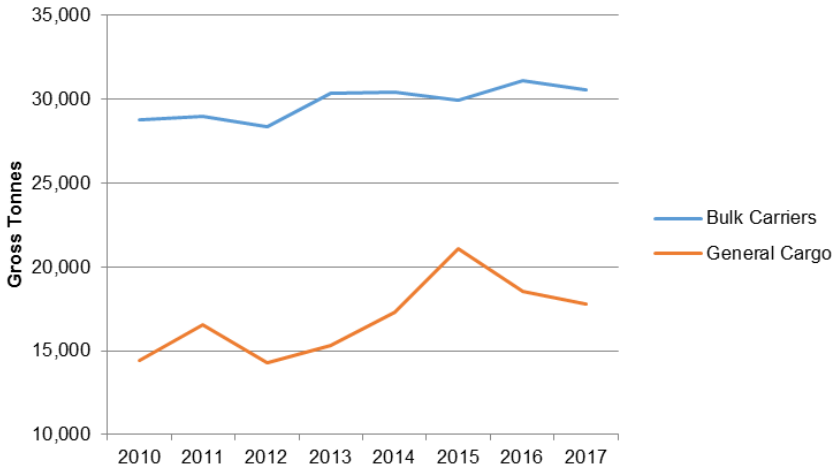
Figure 3.1 Overview of WA trade volumes 2015– 2016 (Department of Transport 2016)

3.2. Vessel Trends

Vessel Size

There is a general trend in shipping towards larger vessels as industry strives to realise gains from economies-of-scale. This is illustrated in Figure 3.2, which shows the change in the average size of bulk carriers and general cargo vessels visiting the Port of Bunbury.

Figure 3.2 Average Bulk Carrier Size, 2010 – 2017

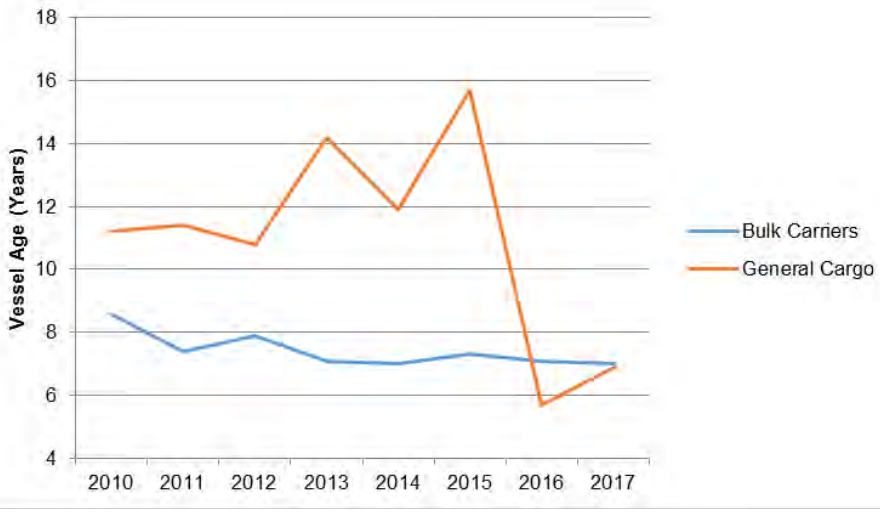


Data source: AMSA

Vessel Age

Vessel age is another factor to consider and has been identified by the Australian Maritime Safety Authority (AMSA) as one of the key predictive factors in overall vessel safety. Figure 3.3 shows the average vessel age for bulk carrier and general cargo vessels visiting Bunbury Port. There was a sudden reduction in general cargo vessel age in 2016, accompanied by a reduction in the number of visits.

Figure 3.3 Average Vessel Age, All Vessels, 2010 - 2017 (AMSA)

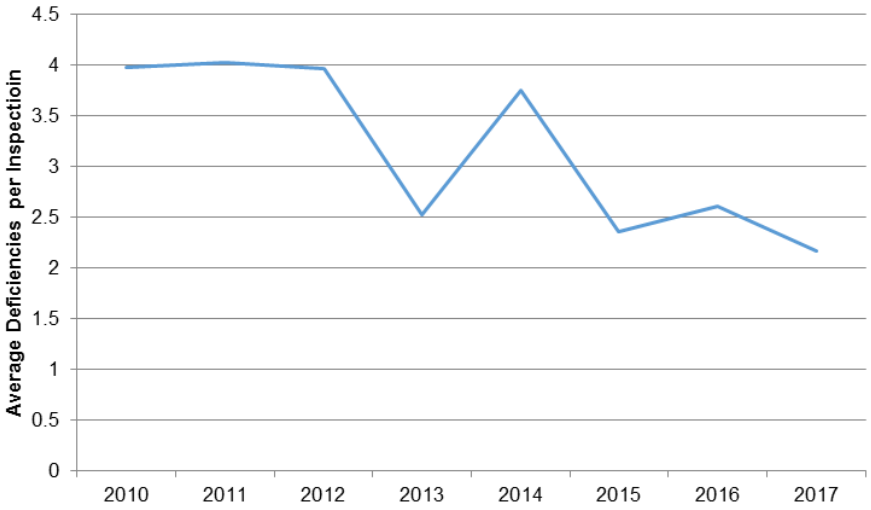


Data source: AMSA

Vessel Deficiencies

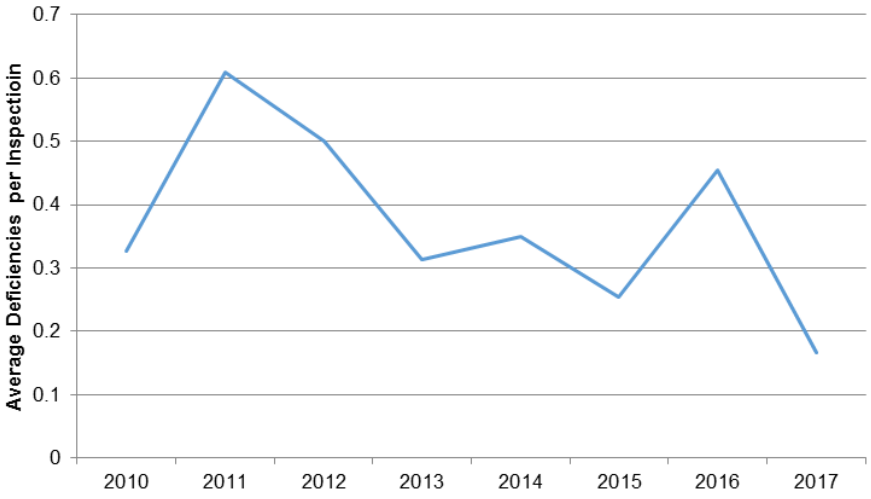
AMSA collects data on the numbers of vessel deficiencies found by the Port State Controls and Flag State Control inspections. Figure 3.4 shows the average number of deficiencies found per inspection at the Port of Bunbury. In 2010 to 2012 the average number of deficiencies was around four per inspection. The trend is improving, reducing to less than three per inspection since 2015.

Figure 3.4 Average Deficiencies per Inspection



There are around 30 major deficiency categories in the AMSA data. These categories cover a wide range of administrative, procedural, structural and operational factors. Figure 3.5 shows the average number of deficiencies per inspection categorised as 'Safety of Navigation' at Port of Bunbury. This has trended down since 2011.

Figure 3.5 Average 'Safety of Navigation' Deficiencies per Inspection



3.3. Vessel Routes

Figure 3.6 and Figure 3.7 show vessel tracks for medium and large tankers off the Western Australia coast. A relatively small proportion of these vessels visit the Port of Bunbury.

Figure 3.6 Medium Tankers

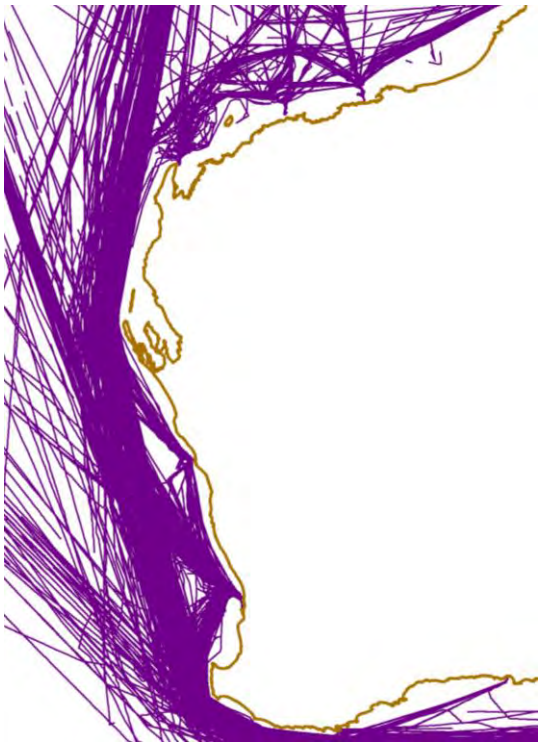
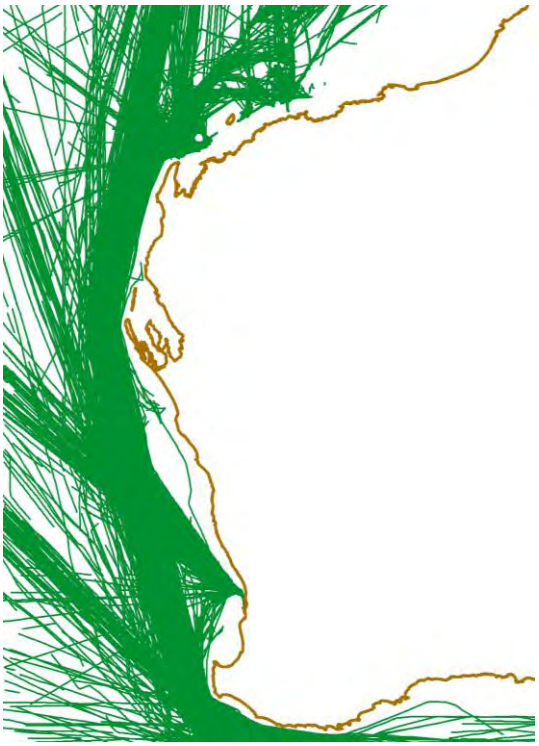


Figure 3.7 Large Tankers

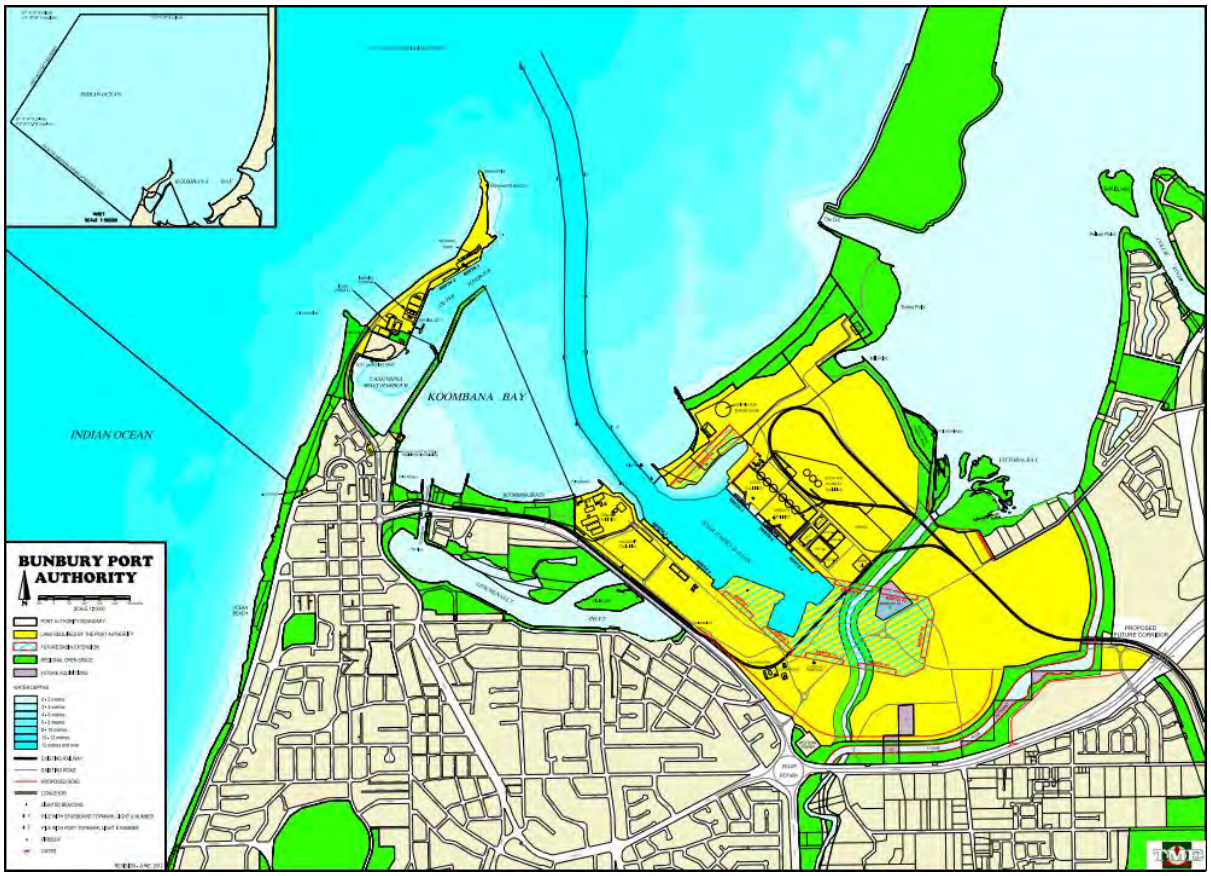


Other trends such as changes from heavy bunker fuels to distillate fuels in response to IMO regulations are discussed in the state-wide report. It is not expected these will have an immediate effect on the risk profile for the South West zone.

3.4. Port of Bunbury

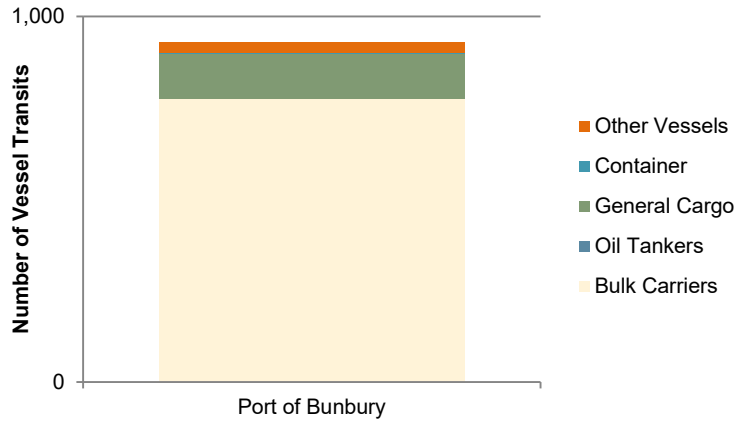
The largest port in the South West zone is the Port of Bunbury.

Figure 3.8 Map of the Port of Bunbury



As an indication of activity levels at the port, Figure 3.9 shows the numbers of transits[1] by different vessel types. The vast majority of visits are by bulk carriers.

Figure 3.9 Annual Vessel Transits to and from Ports[2]



[1] A transit is defined as a single movement. A ship visiting a port will usually comprise two transits.

[2] Data excludes commercial.

The Port of Bunbury is primarily a bulk commodity port. The major commodities are alumina, mineral sands, woodchips, caustic soda and silica sands. There are also regular visits by cruise ships to this port. Freight traffic through the port is dominated by exports.

Port of Bunbury conducted a trial export of leucoxene in 2016 (22,075 tonnes) (Department of Transport 2016).

Figure 3.10 Exports and imports through the Port of Bunbury[3]

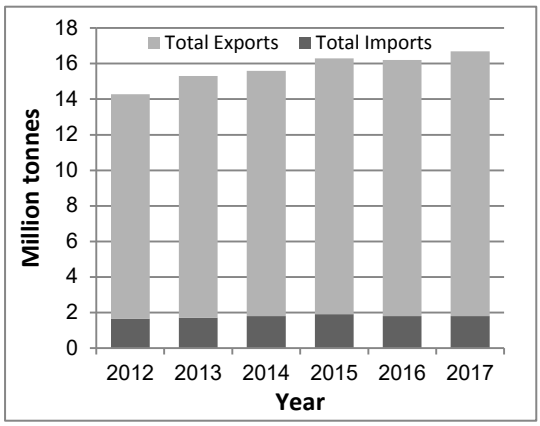


Figure 3.11 Annual imports through the Port of Bunbury[4]

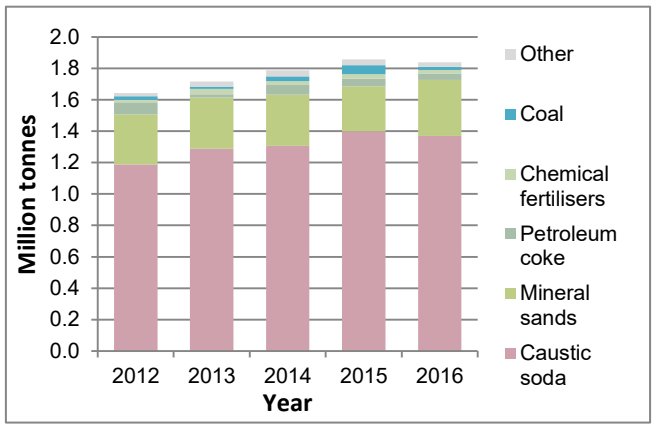
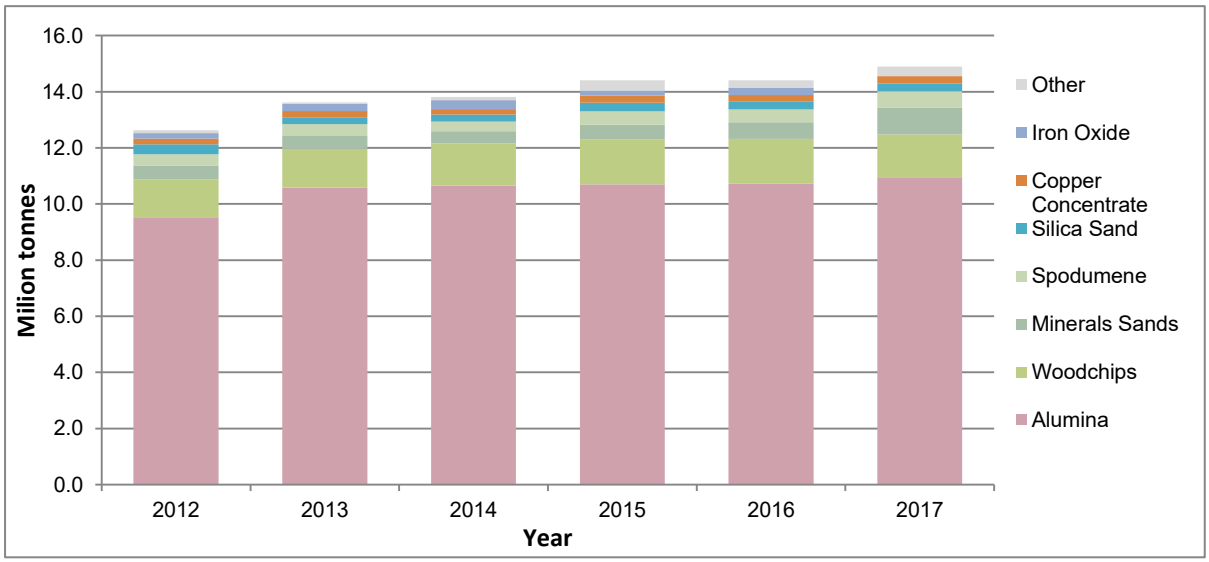


Figure 3.12 Annual exports from the Port of Bunbury [5]



The Port of Bunbury is situated in Koombana Bay and is entered between Point Casuarina. The approach is either the coastal route from Rottnest Island (approaching from the North), the offshore route passing north of Naturaliste Reefs (approaching from the West), or the coastal route from Cape Naturaliste through Geographe Bay (from the South West) (Australian Hydrographic Dervice and the United Kingdom Hydrographic Office 2014).

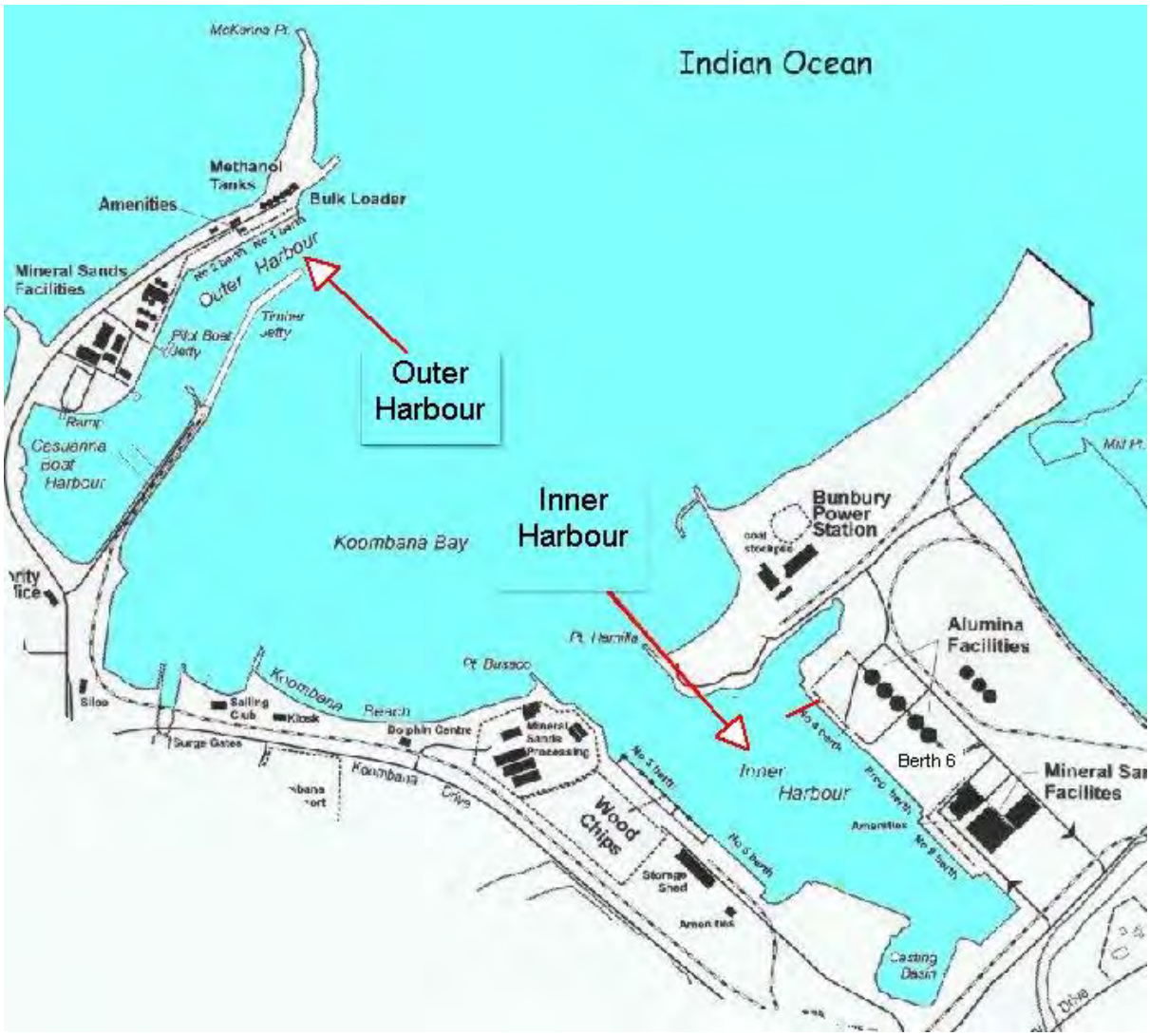
[3] Data: Trade Statistics and Port Information, Bunbury Port Authority (South West Development Commission 2018)

[4] Data: Department of Transport 2016

[5] Data: Trade Statistics and Port Information, Bunbury Port Authority (South West Development Commission 2018)

The outer harbour has a mole and breakwater (1 mile in length), with berths on the inner side of the mole. There is a dredged channel to the inner harbour with depths in the harbour subject to siltation, marked by leading lights and light beacons.

Figure 3.13 Inner and outer harbour of the Port of Bunbury (Bunbury Port Authority 2018)



Pilotage is compulsory for all commercial vessels over 150 gross tonnage (gt). Maintenance dredging occurs around every three years to ensure the access channel and inner harbour are maintained to their design depth.

The port is currently progressing an Outer Harbour Relocation Plan, which considers the trading of containers through the Port of Bunbury Inner Harbour.

3.5. Petroleum Industry

In recent times there has been no petroleum exploration activity offshore of the South West zone.

4. Data Sources

4.1. Overview

The analysis used a range of data inputs, including:

- Vessel activity:
  - Vessel types, routes and number of transits.
  - Vessel cargo types and volumes.
- Ports and marine terminals:
  - Port locations, bunkering and transfers.
- Petroleum industry activity - locations, purpose, phase, oil types and related activity for; wells, platforms, pipelines, FPSOs.[6]
- Spill events:
  - Event occurrence frequencies for vessels and offshore infrastructure.
  - Resulting spill size probability density functions.
- Environmental conditions - wind and current data.
- Oil classifications.

These data sources are discussed in the preliminary state-wide report and a brief outline of vessel activity, petroleum industry data and navigational hazard data is provided below as these data sources have seen updates since the state-wide report.

4.2. Vessel Activity

Vessel activity inputs in the model are primarily based on Automatic Identification System (AIS) data which is collected and held by AMSA. Navigatus commissioned AMSA to interrogate the AIS information system and provide three years of processed data in a suitable format for further pre-processing and incorporation into the model. The steps taken by AMSA were:

- Filter data set for relevant geographic scope and three-year time period from 2013 to 2015.
- Use ship inspections ('ShipSys') database to populate vessel type and size information missing from AIS data.
- Use GIS tool to convert individual AIS 'point' reports to 'line' voyages based on report time.

The resulting data was then provided to Navigatus and a density analysis was undertaken on the vessel tracks. This determined the number of vessel transits per year through each 10km hexagon sea cell for each vessel type/size category. The process included grouping vessels into the following categories for the WAMOPRA outputs:

- Bulk Carriers
- Chemical Tankers
- General Cargo

[6] Not present in the South West zone.

- Container
- Gas Carrier
- MODUs and FPSOs[7] (in transit)
- Commercial
- Oil Tankers
- Passenger

The use of AIS data to populate vessel activity information is described in the state-wide report (Navigatus 2016). The model simulates the potential for vessels to be off track as well as coastal operations of smaller vessels whose behaviour is less predictable.

Vessels smaller than 100GT are not considered in the analysis for the following reasons:

- Smaller vessel activity is typically more erratic and unpredictable.
- Below this size vessels tend to store fuel in separate tanks rather than against the hull so are less likely to spill in the event of a collision.
- To reduce the 'noise' from small vessels which do not have the potential to add significantly to the risk profile (although spill responders will typically respond to spills from smaller vessels with greater frequency than larger vessels).

4.3. Navigational Hazard

The analysis incorporated a navigational hazard factor, determined from the following inputs:

- Examination of navigation charts and the Australian Pilot *(Admiralty Sailing Directions Australian Pilot Volume 1).*
- A workshop with expert mariners who are familiar with the Western Australian coastline facilitated by Navigatus and held in Fremantle.

The development of the navigational hazard ratings and incorporation into the model are outlined in the Methodology section.

4.4. Petroleum Industry

There is no petroleum exploration or production activity in the South West zone.

[7] MODUs – mobile offshore drilling units, FPSOs – floating production integrity services.

5. Methodology

5.1. Overview

The following sections outline key elements of the WAMOPRA methodology, or elements that have been introduced or modified in Stage Two. These include:

- Spatial Framework – the spatial basis for the WAMOPRA modelling and outputs.
- Navigational Hazard
- Exposure and Risk – an explanation of two key output measures, how they are defined and displayed.
- Limitations – a brief note on the limitations of the WAMOPRA given its primary use as a strategic-level tool.

While the broad model approach and outputs are similar, the methodology used in this report is not identical in all respects to that used in the reports previously prepared for the Pilbara, Swan and Midwest Zones. This is due to ongoing developments in the model methodology, as described in Section 5.3 below, and due to context changes since issue of the previous regional reports. The rationale includes;

- accounting for a large reduction in oil exploration activity as a result of the lower oil price, which has fallen significantly over the duration of this project[8],
- introducing improvements to the modelling engine as a result of ongoing research and development.

While the refinements in the method have changed some of the individual cell ratings, the overall patterns of risk and areas of focus remain the same.

5.2. Spatial Framework

The model is based on two layers of cells; shoreline cells and sea cells.

Shoreline cells are used for visualising shoreline risk and exposure. The shoreline cell layer consists of cells which are 20km long (along the coast) by 10km wide (seaward extent) and which are compliant with shoreline features and shape.

The shoreline cells display exposure, protection priorities and risk for shoreline areas that could credibly be affected by contact with, or proximity to, either floating or dissolving oil. Therefore, the 10km width is a nominal distance, rather than representing the true seaward extent of oil impact, and primarily set for visualisation purposes.

There are 22 shoreline cells in the South West region. For the purposes of this report, shoreline cells are also grouped into three ‘sub-zones’ to facilitate comparisons between wider areas in the South West zone.

The three sub-zones from West to East are: WA06, WA05, and WA04. The shoreline cells and sub-zones within the South West zone are shown in Figure 5.1.

Sea cells are arranged on a 10km hexagonal grid which covers all marine areas. The grid extends approximately 200-300km seaward off all shorelines, excluding Christmas Island.

[8] There is no oil exploration activity in the South West zone.

The grid enables modelling of potential oil release, oil dispersion and the likelihood of reaching shore.

The grid is used for managing vessel activity information, positions of offshore elements and environmental factors of the modelling. This system includes flags for cells representing ports and harbours to account for vessel related activity, oil-handling-processes and constrained waterways. The hexagonal grid is also the basis of Navigatus modelling of oil dispersion, with the geometry enabling the computational efficiency needed for such a large geographic area.

The state-wide report contains additional information on the shoreline and hexagon cells.

Figure 5.1 South West Shoreline Cells and Sub-Zones

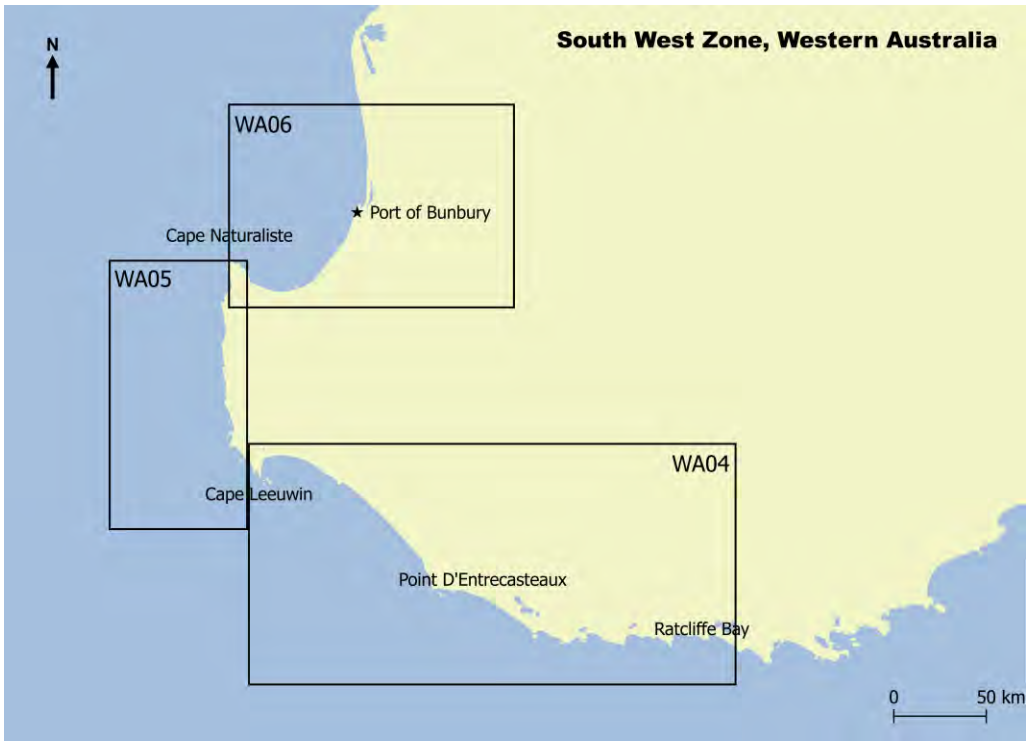


Table 5.1 Cell identity numbers to names listing

Cell ID	Cell Name	Cell ID	
	WA06		***WA04***
207	Binningup - Cape Bouvard (B)	218	Black Point - Ledge Point
208	Point Casuarina - Binningup	219	Point D'Entrecasteaux - Donnelly River mouth SE (A)
209	Capel River mouth - Point Casuarina	220	Point D'Entrecasteaux - Donnelly River mouth SE (B)
210	Point Daking - Bussleton (A)	221	Point D'Entrecasteaux - Donnelly River mouth SE (C)
211	Point Daking - Bussleton (B)	222	Point D'Entrecasteaux - Donnelly River mouth SE (D)
212	Point Daking - Bussleton (C)	338	Point Nuyts - West Cliff Point
		223	Point Nuyts - Cliffy Head (A)
	WA05	224	Point Nuyts - Cliffy Head (B)
213	Cowaramup Point - Cape Clairault (A)	225	Point Nuyts - Cliffy Head (C)
214	Cowaramup Point - Cape Clairault (B)	226	Stanley Island/Point Hillier - Quarram Beach head E (A)
215	Cape Freycinet - Cowaramup Point	227	Stanley Island/Point Hillier - Quarram Beach head E (B)
216	Knobby Head - Cape Freycinet (A)		
217	Knobby Head - Cape Freycinet (B)		

5.3. Navigational Hazard

Overview

The overall navigational hazard factor is comprised of the following factors:

- **Physical Features** – in particular submerged and non-drying features. Considerations include likelihood of groundings, collisions, and ease of navigation using radar.
- **Complexity** – reflects multifaceted operations / mix of vessel types and activities as well as environmental conditions such as wind, currents, swell and lee shore.
- **Activity Density** – this includes number of vessel movements and other marine activities.

These factors are combined into an overall navigational hazard rating.

The overall navigational hazard for each cell around the Western Australia coastline was rated as minor, moderate, significant, major or critical for each of the above factors according to the scoring system in Table 5.2.

Table 5.2 Rating System and Values

Issue Rating	Description	Value Assigned
Critical	Expected to lead to a future incident.	25
Major	Expected to be a key factor in contributing to an incident.	16
Significant	Individually controllable, but in combination with other factors could contribute to an incident.	9
Moderate	A factor that can be managed in normal operations.	4
Minor	Well within normal operation to manage or respond to (minor matter).	1

The following describes how each of the factors was determined:

Physical: Physical hazards were identified in workshops with expert mariners. All non-surface physical features have the potential to be hazardous should a vessel be in the close vicinity. To account for this all shoreline areas received a higher default rating than open sea areas (Low instead of Very Low) and subsequent efforts were focussed around areas with higher traffic density, such as ports.

Complexity: Complexity ratings were identified in workshops with expert mariners. The complexity rating includes the complexity of approach operations as well as environmental conditions wind, currents, swell and lee shore.

Activity Density: The model uses annual vessel transits through a cell as a key input for calculating exposure and risk. This is an arithmetic calculation and increases with the number of transits.

However, as shipping density increases other factors come into play such as the interaction between ships. These interactions can mean higher risk of collision, lower margins of error and the potential need for evasive manoeuvring. Overall, this results in a further increase in risk. This additional risk is captured in the model through the activity density rating.

Strictly the number of vessel transits is incorporated only once in the model, however, the activity density measure represents the risk through the interaction between ships. Activity density was determined based on vessel tracks generated from AIS data.

Synthesis of Hazard Factors

The three separate factors are combined to form an overall Navigational Hazard Rating. This is determined by summing the individual rating values as shown in Table 5.3.

Table 5.3 Overall Navigational Hazard Ratings

Sum of Individual Factors	Overall Rating	Overall Value	Display Colour
>30	Very High	25	
21-30	High	16	
11-20	Moderate	9	
6-10	Low	4	
<=5	Very Low	1	

Vessel Incident Probabilities

For consistency with the analysis undertaken at the national level, the vessel accident probabilities and estimates of likely spill amounts were adopted from Appendix IV and Appendix V of a study undertaken by DNV for AMSA in 2011. The probabilities are developed for a number of different incident categories (e.g. collision, grounding, etc) and for a range of different vessel types.

These probabilities were then converted to a per cell basis. For example, in the open sea, incident probabilities are presented on a per vessel operating hour basis. On average it is expected to take approximately 30mins for a vessel to traverse a cell, so the hourly probability was divided by two.

As incidents are more likely to occur in some areas than others, the base incident probability is modified according to the relative degree of navigational hazard in the area. A modifier is used at a sea-cell level to redistribute the probabilities to areas with higher navigational hazard ratings (ie higher risk). The value of the modifier is set to ensure that the total probability for each combination of incident type and vessel type across Western Australia sums to the same overall probability as the raw probabilities (before distribution). The objective and effect of the modifier is to distribute the global probabilities of incidents to those locations where the contextual information indicates that those types of incidents are more likely.

To develop the modifier, each sea cell was classified as either Port, Restricted Water, or Open Sea, being the three location types presented in the AMSA study. In each sea cell, the number of vessels (e.g. oil tankers) is multiplied by the probability of an incident (e.g.

collision) for that cell location type (e.g. restricted water). When summed across all cells for all of Western Australia, this represents the WA incident probability for that type of vessel and incident. The expected amount of oil spilt in the event of an incident for vessels is estimated using the cumulative probability relationships presented in the above AMSA report.

Care is taken to ensure that the distribution of risks is internally consistent. For instance groundings are only assigned to shore cells even though the base probability is derived from DNV estimates of the global average of groundings per hour steamed. The model allocates the grounding probabilities so that groundings are more likely in areas where higher numbers of vessels travel closer to shore. Conversely, the assigned probability of grounding when on a course more than 50 km from the shore is nil.

Infrastructure[9]

The infrastructure probabilities were adopted from the International Association of Oil & Gas Production's Risk Assessment Data Directory: Blowout frequencies (OGP 2010a) and Riser and Pipeline release frequencies (OGP 2010b).

The infrastructure cumulative spill probability relationships were developed from several sources, including International Association of Oil & Gas Production, AMSA, and Stantec (Stantec 2014).

5.4. Exposure and Risk

Key measures of output are exposure and risk. The first step in calculating risk is determining exposure. Exposure can be considered as the total 'expected' amount of spilled oil that would be spilled in or arrive at a given cell in an 'average' one year period.

Fundamentally exposure is based on:

- Likelihood of a vessel being present (number of transits per year) OR presence of offshore petroleum infrastructure.
- Likelihood of a spill event (e.g. grounding, collision, well blowout) conditional on the above.
- Likelihood of different spill size possibilities (ranging from 1 tonne through to 500,000 tonnes) conditional on the above.
- Movement of oil (taking into account wind, currents and degradation) conditional on the above.

Exposure is presented according to the continuous scale in Figure 5.2.

[9] Not present in South West zone.

Figure 5.2 Exposure Scale

In turn, risk is determined by combining exposure with protection priorities in the following manner:

Figure 5.3 Calculation of Risk

Risk outputs are provided for each shoreline cell on a five step scale ranging from very low to very high. The risk scales are shown in Figure 5.4.

Figure 5.4 Risk Scales

The information presented assesses the risk and exposure for all sources of oil that may end up on the shore in that cell. Some of the oil may originate from spills in other nearby cells, or from more distant seaward sources.

Shoreline risk and exposure outputs are for areas within state waters only.

5.5. Limitations

The WAMOPRA study has the following key limitations:

- The study was carried out at a level of detail appropriate for a strategic level study. The range of spill sizes considered was 1 tonne up to 500,000 tonnes and the physical discrimination for impacts was based upon a 20km coastline distance and 10km hexagonal open water cells.
- The calculated risk profile is built upon available local and global information. Analysis cannot predict specific future events, only likely outcomes over time based on the balance of probabilities. This study is based upon the data available – either via public sources, or as supplied by stakeholders - and the quality of the findings is determined in part by the quality of that data.

6. Results

6.1. Navigational Hazard Results

Navigational Hazard Factors

The results for the individual physical, complexity and activity density factors are shown respectively in Figure 6.1, Figure 6.2 and Figure 6.3. The overall navigational hazard heat map is shown and discussed in the following section. Note that in each of the heat maps navigational hazard information for hexagon cells outside of the South West zone is not shown.

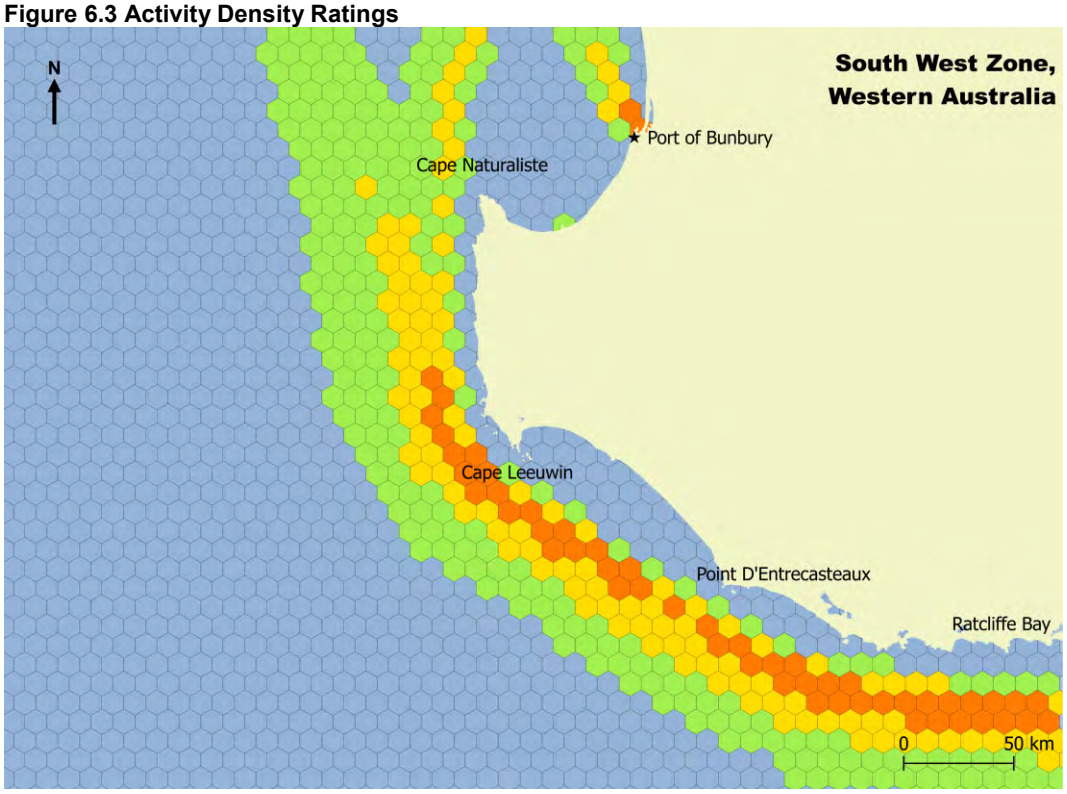
Figure 6.1 Physical Hazard Ratings

Cells near shore have a slightly increased physical hazard rating, however this rating is still low as there are no exceptional hazards in the South West zone.

Figure 6.2 Complexity Ratings

The only area of increased complexity is around the Port of Bunbury, however these cells still have a low rating.

Figure 6.3 Activity Density Ratings

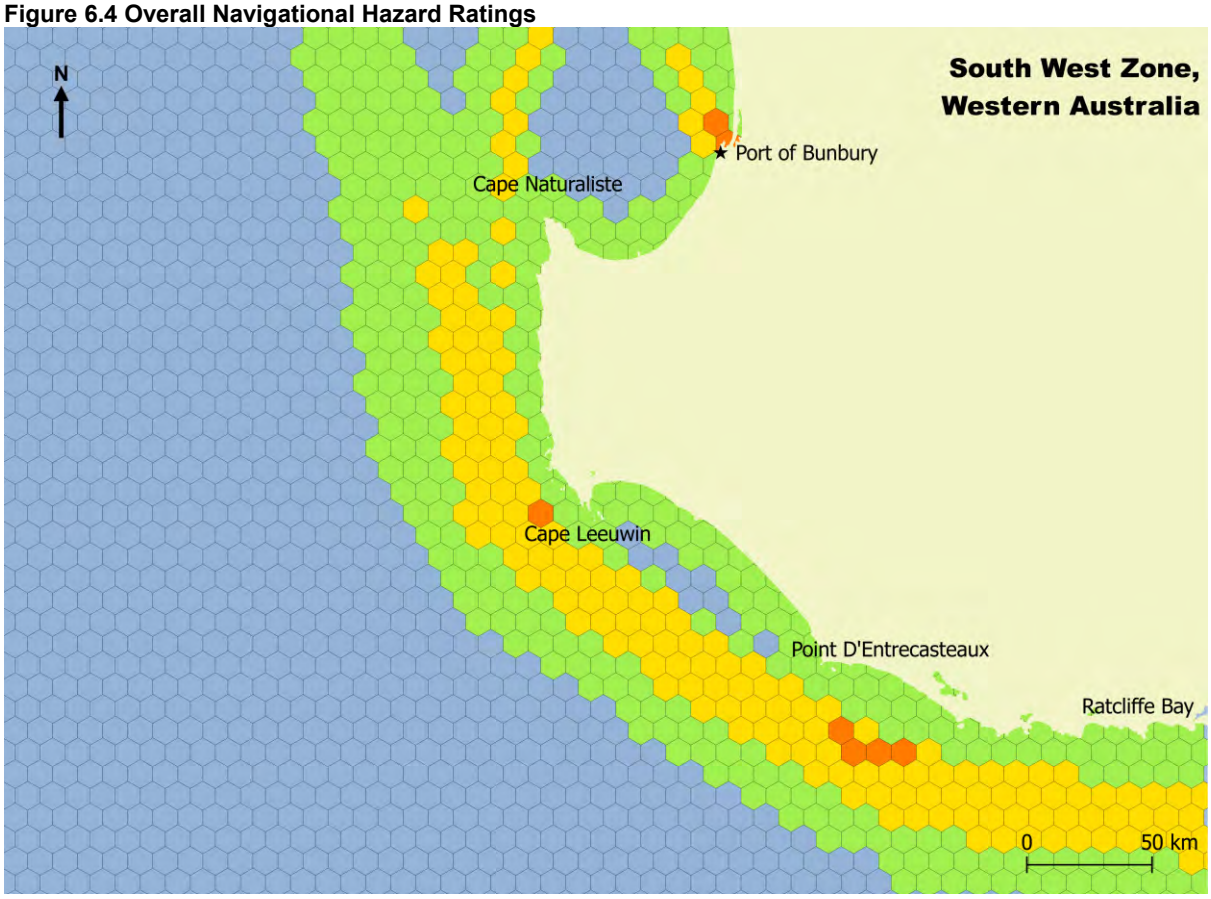


Activity density is highest in the Port of Bunbury and offshore from near Cape Leeuwin to Ratcliffe Bay. This is principally due to ships rounding the South West shore as they transit to and from Adelaide or Melbourne.

Overall Navigational Hazard

The combination of the three factors produces an overall rating as described in Section 5.3. This overall navigational hazard rating is shown in Figure 6.4 and a brief description of the driving factors is provided below.

Figure 6.4 Overall Navigational Hazard Ratings



Overall there is a lower level of navigational hazard in the South West zone compared to some of the other zones (ie. Pilbara and Swan). The highest risk is at the Port of Bunbury. There is a band of moderate navigational hazard between Cape Leeuwin and Ratcliffe Bay (as vessels travel towards southern ports). One of these areas of higher navigational hazard is near Cape Leeuwin, where high traffic passes nearer to the coast. Vessels are often under pressure to take the most direct route around headlands (i.e. as close to the coast as considered safe) to minimise fuel use. The other area of higher risk is between Point D'Entrecasteaux and Chatham Island.

Navigational hazard ratings for the Port of Bunbury is primarily driven by the complexity inherent in any port operation and access by dredged channel. The offshore navigational hazard ratings are driven by activity density from ships transiting past the zone.

6.2. Oil Exposure

Overview

Exposure represents the likely volume of oil that could arrive at a given area, taking into account both the size of spill and the probability of spill (including the influence of overall hazard rating). While the likelihood of any particular spill is low, exposure allows the contribution of different sources to the risk profile to be compared.

The oil exposure in both the shoreline and hexagon cells is dominated by floating oils, although dissolving oils are likely to increase in the future. Oil exposure can be viewed by floating or dissolving oils at the webmap application:

http://wamopra.navigatusconsulting.com

In this section results are presented for exposure to both shoreline cells and hexagon cells.

Shoreline Exposure

Figure 6.5 shows the shoreline exposure profile for the South West zone.

Figure 6.5 Shoreline Exposure

Key for Exposure

Lowest — Highest

Figure 6.6 shows the proportion of shoreline exposure generated by each spill size band. More than a third of the oil expected to arrive at the South West zone shoreline is due to potential spills in the 5,000 – 50,000 tonne band. The 500 to 5,000 tonne band accounts for approximately a third of potential spills.

Figure 6.6 Proportion of Shoreline Exposure by Spill Size (tonnes)

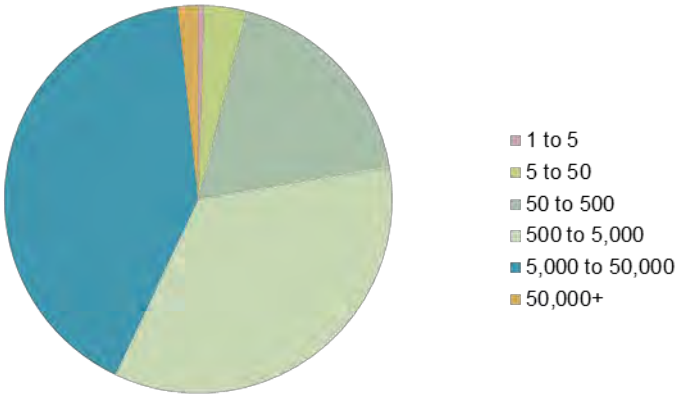


Figure 6.7 is similar to Figure 6.6 in that it shows the proportion of shoreline exposure generated by each spill size band. However, this measure of exposure is further broken down by sub-zone.

Sub-zone WA04 has almost 60% of the oil arriving, while WA06 has the smallest percentage and has proportionately less spills in the 5,000 to 50,000 tonne band compared to the other sub-zones.

Figure 6.7 South West Shoreline Exposure by Spill Size (tonnes) and Sub-Zone

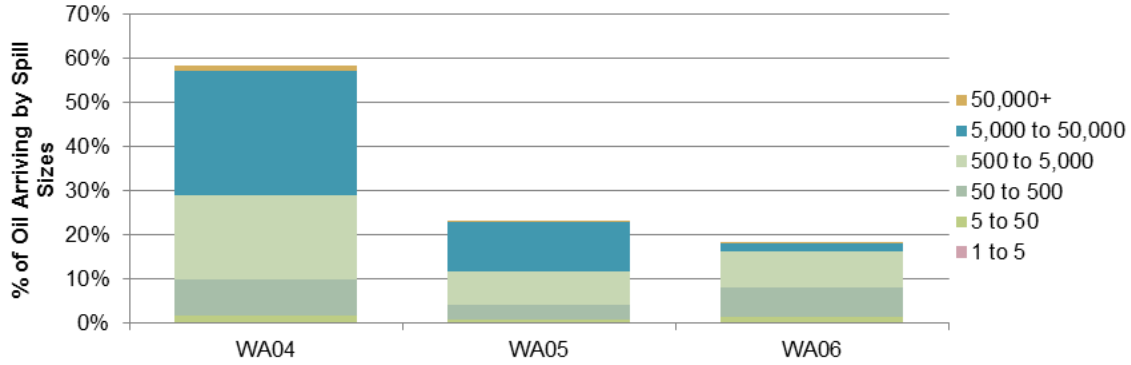
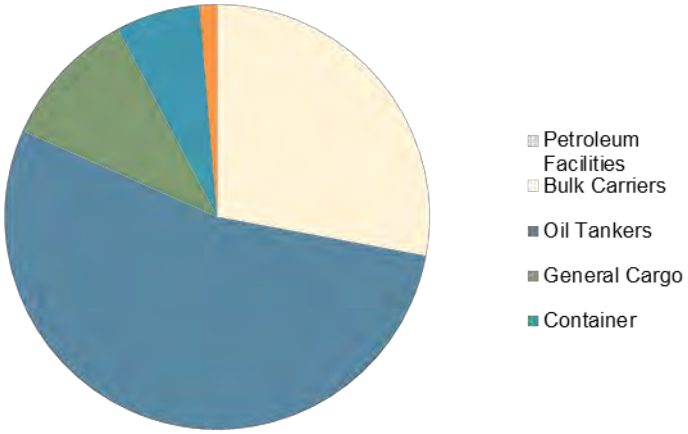


Figure 6.8 shows the proportion of shoreline exposure generated by each spill source. More than half of the oil expected to arrive at the South West shoreline is due to potential spills from oil tankers (mainly from transits through the zone). The majority of vessel transits to and from the Port of Bunbury are bulk carriers, which make up approximately a quarter of the shoreline exposure.

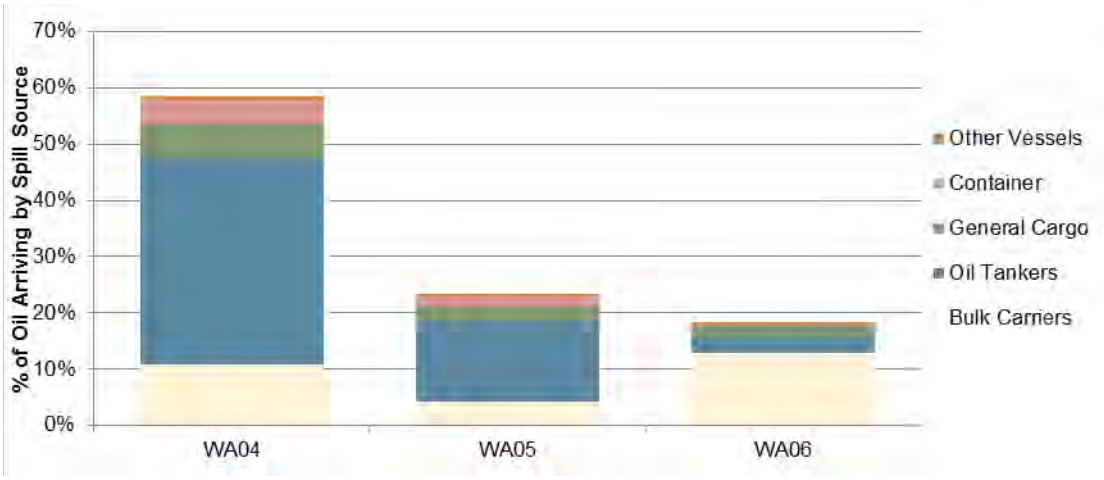
Figure 6.8 Proportion of Shoreline Exposure by Source (tonnes)



Note that the Other Vessels category includes chemical tankers, gas carriers and passenger vessels.

Figure 6.9 is similar to Figure 6.8 in that it shows the proportion of shoreline exposure generated by each spill source. However, this measure of exposure is further broken down by sub-zone.

Figure 6.9 South West Shoreline Exposure by Source and Sub-Zone

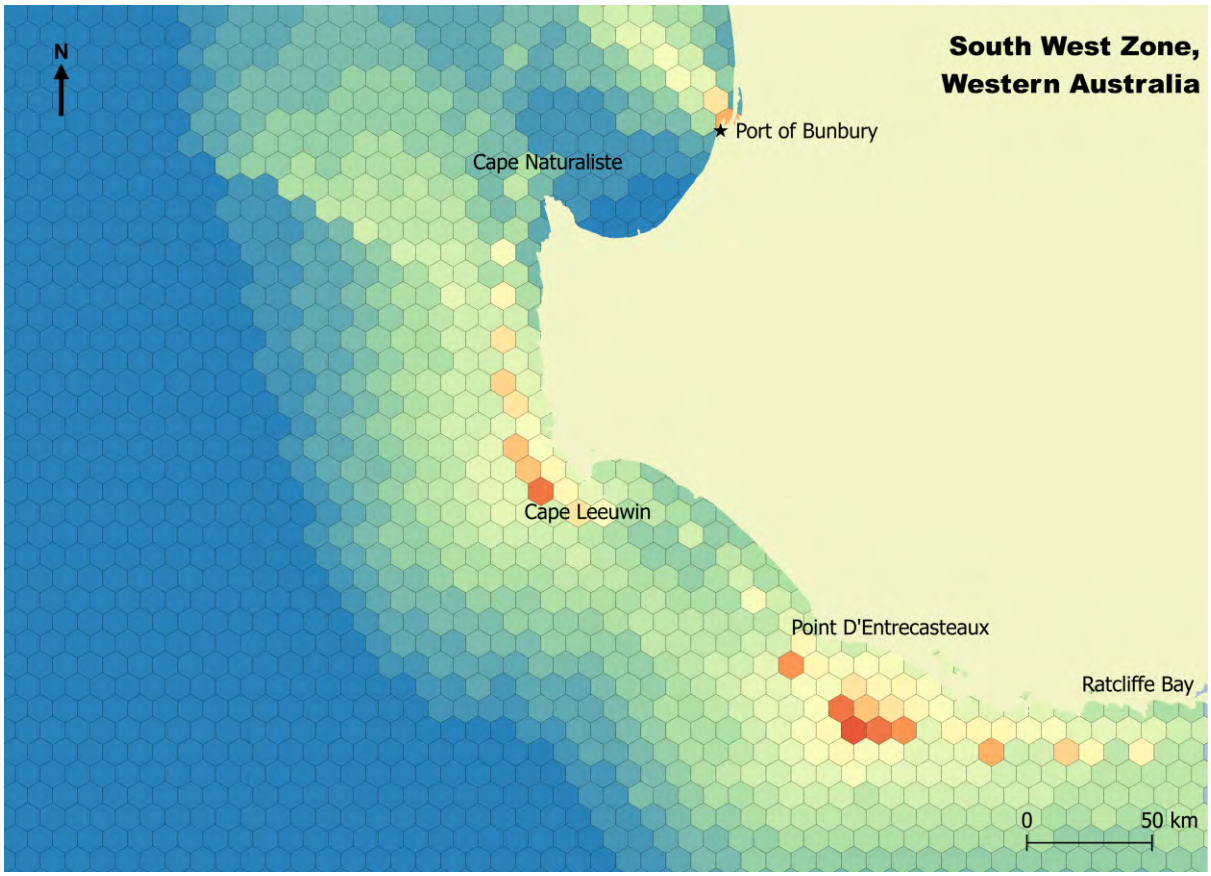


There is lower shoreline exposure in subzones WA05 and WA06 (which contains the Port of Bunbury), compared to WA04. Exposure in the WA04 subzone is driven by the number of oil tankers transiting through the region and the risk of larger (5,000-50,000 tonne) spills.

Sea Cell Exposure

Figure 6.10 shows the oil exposure profile for the hexagon sea cells within the South West zone.

Figure 6.10 Exposure Profile



Key for Exposure

Figure 6.11 shows the proportion of offshore exposure generated by each spill size band. The majority of exposure in the South West zone is due to spills in the 500 – 5,000 tonne range, followed by spills in the 5,000 to 50,000 tonne range.

Figure 6.11 Proportion of Hexagon Cell Exposure by Spill Size (tonnes)

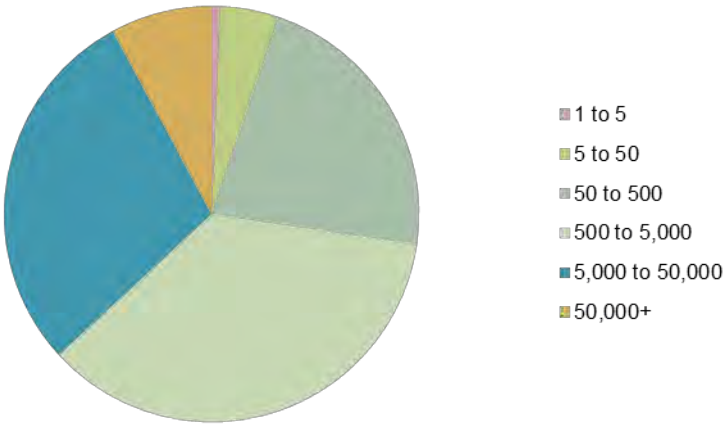
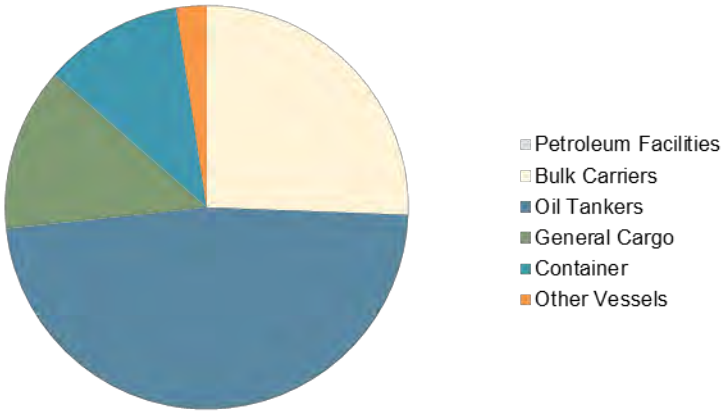


Figure 6.12 shows the proportion of offshore exposure generated by each spill source. The majority of exposure in the South West zone is due to potential spills from oil tankers, followed by bulk carriers.

Figure 6.12 Proportion of Hexagon Cell Exposure by Source (tonnes)



The Other Vessels category includes chemical tankers, gas carriers and passenger vessels.

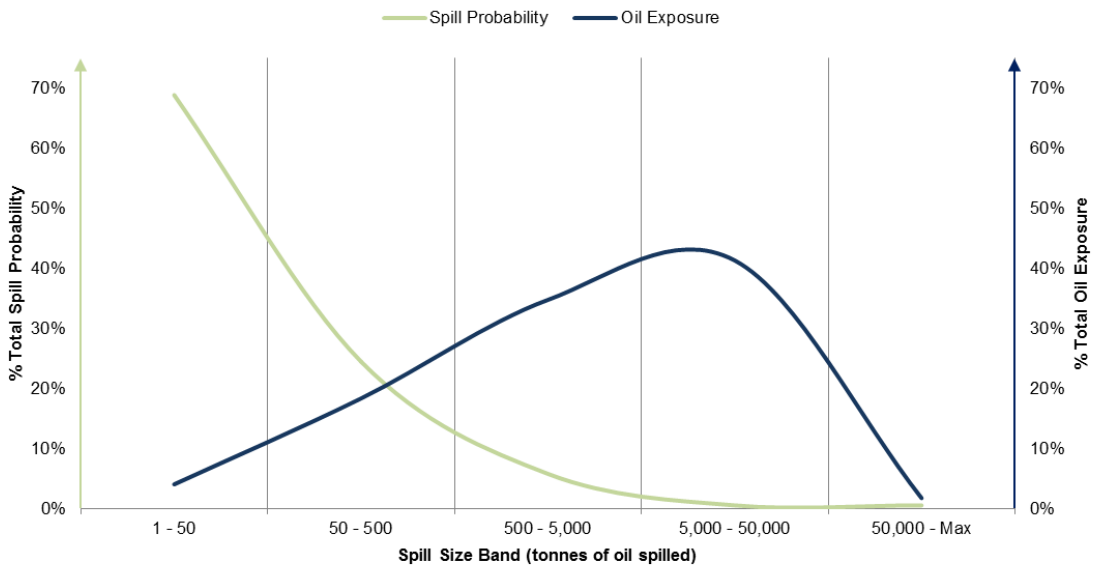
Exposure and Probability

The previous sections find that oil spill exposure in the South West region is largely driven by spills in the 500 to 5,000 and 50 to 500 tonne band. This would seemingly conflict with the typical experience of an oil spill responder who is likely to attend smaller spill events more frequently. However, the result is sound because exposure takes into account both the likelihood and size of spills. Exposure is the expectation of how much oil will arrive at a given area over a very long period of time.

Although smaller spills are much more frequent, over a very long time period, the majority of oil spilled in the South West zone is likely to come from larger incidents.

This is conceptually illustrated in Figure 6.13. This chart shows relative spill probability (in green) and relative oil exposure (in blue) for different spill size bands. Spill probability is very high in the first spill size band. After the first band, spill probability decreases rapidly as spill size increases. Put simply; smaller spills are more frequent than larger spills.

Figure 6.13 Conceptual Comparison of Spill Probability vs. Expected Oil



On the other hand, relative oil exposure (the blue curve) is very low for smaller spill sizes. Although these spills are more frequent, their contribution to the expected amount of oil is small. As spill size increases the contribution to total exposure also increases, peaking at the 5,000 to 50,000 spill size band and then decreasing.

This leaves spill responders with the challenge of regularly dealing with small spills while also ensuring adequate training, capability and resources to respond effectively to larger spills.

6.3. Protection Priority Results

Protection Priority data was developed by Advisian and is fed into the risk model developed by Navigatus to create a picture of oil spill risk including likelihood and consequence. Figure 6.14 shows the overall ranking for Protection Priorities in the South West zone.

Figure 6.14 Protection Priorities Overall Rankings

Key

Very Low	Low	Moderate	High	Very High

A sample of protection priority data is shown for the Port of Bunbury in Table 6.1. It shows the *overall* protection priorities ratings and comments for the Port of Bunbury. Ratings and comments are provided for potential spills of floating oils (e.g. bunker fuel) and dissolving oils (e.g. diesel).

Information on protection priorities can be viewed at the webmap application: http://wamopra.navigatusconsulting.com as well as in the Sub-Zone Drill Down sections of this report. The South West zone report prepared by Advisian for the Department of Transport (Advisian 2018) should be consulted for more context and information.

Table 6.1 Protection priorities for the Port of Bunbury (based on Advisian 2017 data)

Category	Protection Priorities Floating Ranking	Protection Priorities Dissolved Ranking	Protection Priorities Overall Ranking	Brief Description for Spills of Floating Oils / Dissolving Oils	Data Sources
Protected Fauna	**High**	**Moderate**	**High**	Birds: Anous tenuirostris melanops (Australian lesser noddy) (EN) Specimen (WAM Vouchered), Thalassarche carteri (Indian yellow-nosed albatross) (EN & IA) Specimen (WAM Vouchered), Anous tenuirostris melanops (Australian lesser noddy) (EN) Specimen (WAM Vouchered) Reptiles: Caretta caretta (loggerhead turtle) (EN) Caught or trapped (Certain) & Day sighting (Certain) Fish: Carcharodon carcharias (great white shark) (VU) Day sighting (Certain)	DPaW Protected Fauna (2 March 2017)
Protection Areas	**High**	**Moderate**	**High**	Nature Reserve (IUCN IA), Seagrass, Sheltered seawalls	DotE CAPAD - Terrestrial and Marine (30 June 2014) with DPaW update (30 June 2016)
Cultural Heritage	**Moderate**	**Moderate**	**Moderate**	State Heritage: Bunbury Timber Jetty, Picton Inn Hotel Cmlth Protected Shipwrecks: Annie M. Young, Cingalee, Elizabeth, Kormoran Lifeboat 2, Laughing Wave, Midas, North America, Solglyt, Star Of The South, Unnamed Boat, Leschenault Inlet Unidentified	State Register: State Protected Heritage (2016),DotE Australian National Shipwrecks Database (3 February 2016)
Economic	**Moderate**	**Moderate**	**Moderate**	West Coast Rock Lobster Managed Fishery Port: Bunbury	Port
Social Amenity and Recreation	**Low**	**Very Low**	**Low**	Beaches (SW Cape)	Proxy dataset Advisian created, April 2017
Overall	**High**	**Moderate**	**High**	Birds: Anous tenuirostris melanops (Australian lesser noddy) (EN) Specimen (WAM Vouchered), Thalassarche carteri (Indian yellow-nosed albatross) (EN & IA) Specimen (WAM Vouchered), Anous tenuirostris melanops (Australian lesser noddy) (EN) Specimen (WAM Vouchered) Reptiles: Caretta caretta (loggerhead turtle) (EN) Caught or trapped (Certain) & Day sighting (Certain) Fish: Carcharodon carcharias (great white shark) (VU) Day sighting (Certain) Nature Reserve (IUCN IA), Seagrass, Sheltered seawalls State Heritage: Bunbury Timber Jetty, Picton Inn Hotel Cmlth Protected Shipwreck: Annie M. Young, Cingalee, Elizabeth, Kormoran Lifeboat 2, Laughing Wave, Midas, North America, Solglyt, Star Of The South, Unnamed Boat, Leschenault Inlet Unidentified West Coast Rock Lobster Managed Fishery Port: Bunbury	DPaW Protected Fauna (2 March 2017), DotE CAPAD - Terrestrial and Marine (30 June 2014) with DPaW update (30 June 2016)

6.4. South West Risk Profile Results

This section contains the main risk results for the South West zone. Figure 6.15 shows a heat map of risk ratings in each of the South West zone shoreline cells.

Figure 6.15 South West Risk Profile Heat Map

Risk ratings in the heat map are determined relative to the risk score in the second highest shoreline cell for all Western Australia. This decision was made as the highest risk cell (94 – Port Hedland) would otherwise dominate the risk profile reducing the level of discrimination in other areas (see Figure 6.16). The second highest cell (101) is Port Walcott. More detail can be found in the Pilbara Zone Report.

Figure 6.16 - Pilbara Risk Profile (ten highest shoreline cells)

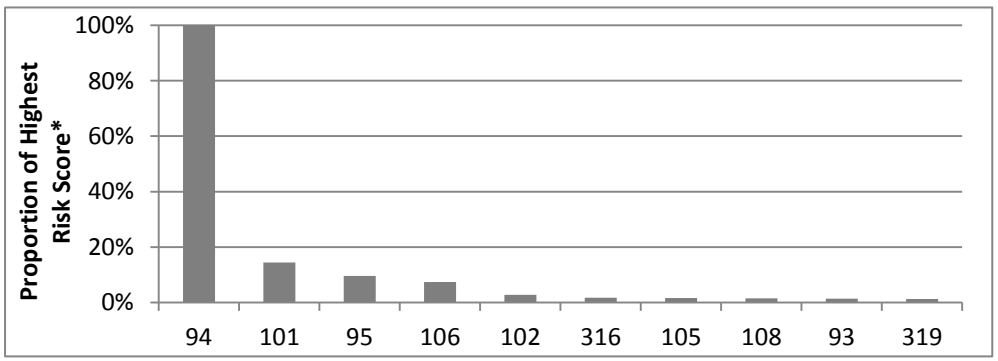
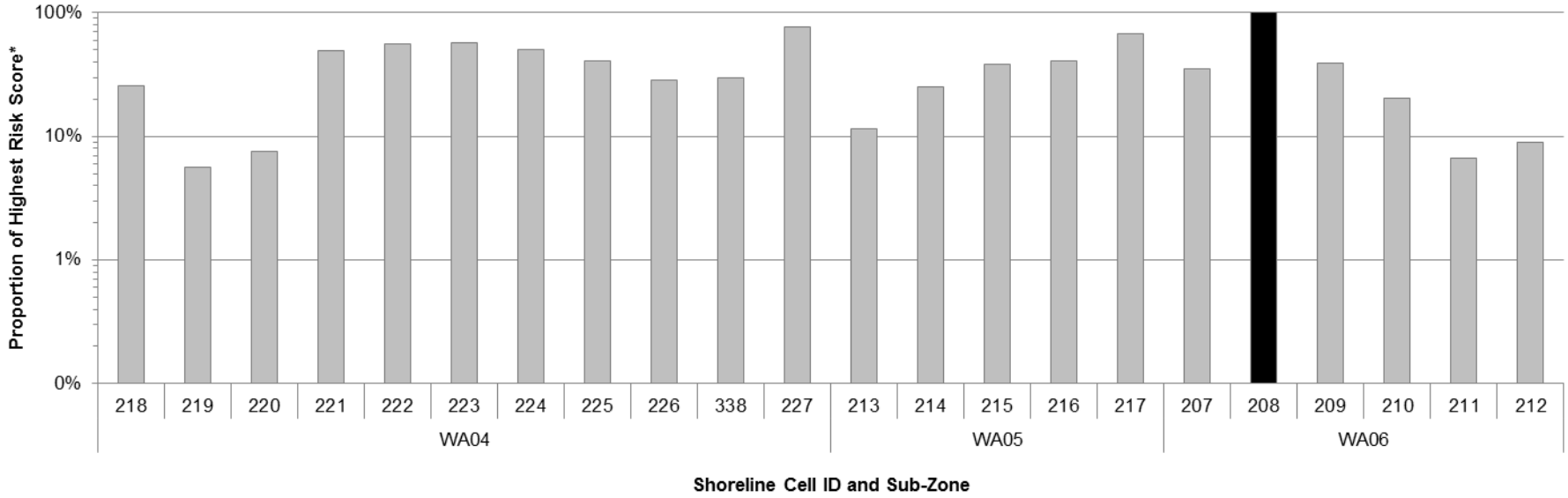


Figure 6.17 shows a column chart of relative risk scores for each of the shoreline cells. The black column represents shoreline cell #208 (the Port of Bunbury ('Point Casuarina – Binningup')), the cell with the highest risk score in the South West zone. The chart uses a log scale for the vertical axis.

Figure 6.17 South West Risk Profile Relative Risk Scores



* Note use of log scale. As with the heat map, risk is shown relative to the second highest cell.

The three cells with the highest risk levels are:

1. ID #208 Port of Bunbury (Point Casuarina – Binningup)
2. ID #227 Denmark (Stanley Island/Point Hillier - Quarram Beach head E (B))
3. ID #217 Augusta (Knobby Head - Cape Freycinet (B))

6.5. Sub-Zone Drill Down

Overview

The following sections contain a brief summary for each of the three sub-zones within the South West Zone (refer Section 5.2 for definition of sub-zones).

Cell counts and heat maps are presented for each of the sub-zones. A summary table is also presented for each sub-zone. The key benefit of these tables is to allow trends in risk drivers to be seen across multiple cells. The tables contain the following fields:

- **ID** – the shoreline cell identification number.
- **Name** – the name assigned to the shoreline cell.
- **Overall Risk Rating** – the primary measure of risk – shown on a five-step rating scale which ranges from Very Low to Very High.
- **Exposure** – represented as a colour on a continuous spectrum which transitions from blue – yellow – red as the level of exposure increases.
- **Overall Protection Priorities Rating** – as determined by Advisian, shown on a five-step rating scale which ranges from Very Low to Very High.
- **Protected Fauna; Protection Areas; Heritage; Economic; Social Amenity Recreation** – these fields show the ratings for each of the protection priority categories as determined by Advisian. The ratings are shown on a five-step rating scale which ranges from Very Low to Very High.
- **Brief Description of Overall Protection Priority Rating** – the protection priorities attribute table provided by Advisian contains a brief overall comment for spills of floating oils and spills of dissolving oils in each shoreline cell. This field represents each of the unique features mentioned in the two overall comments. It is intended to provide a brief overview of key protection priorities in the shoreline cell.
- **Key Drivers of Shoreline Exposure** – this field lists the potential spill sources which contribute most to the risk profile in the given shoreline cell.

WA04 Sub-Zone Summary

Figure 6.18 shows the count of each cell rating within the WA04 Sub-Zone (cells 218 to 227). Figure 6.19 depicts these cell ratings on a heat map.

Figure 6.18 WA04 Sub-Zone Cell Counts

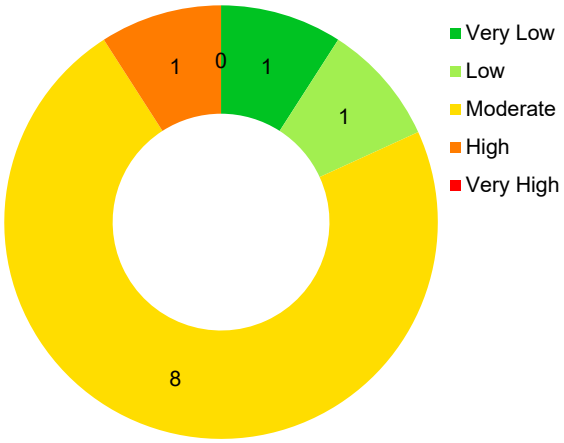


Figure 6.19 WA04 Sub-Zone Risk Profile

The overall risk in this sub-zone is relatively low, with the majority of cells having a moderate risk rating. The table on the following page summarises risk and protection priority information for this sub-zone.

WA04 Summary Table

ID	Name	Overall Risk Rating	Exposure	Overall Protection Priorities Rating	Protected Fauna	Protection Areas	Heritage	Economic	Social Amenity Recreation	Brief Description of Overall Protection Priority Rating	Key Drivers of Shoreline Exposure
218	Black Point - Ledge Point	Moderate		High						*Birds: Calidris ferruginea (Curlew Sandpiper) (CR) Species or species habitat known to occur within area, Thalassarche melanophris (black-browed albatross) (EN & IA) Day sighting (Certain) Reptiles: Caretta caretta (loggerhead turtle) (EN) Caught or trapped (Certain) & Specimen (WAM Vouchered) Nature Reserve (Seal Island, St Alouarn Island, Flinders Bay) (IUCN IA), Important Wetland (Blackwood River (Lower Reaches) and Tributaries System), Marine Park (Ngari Capes) (IUCN VI)*	*Oil Tankers, Bulk Carriers, General Cargo*
219	Point D'Entrecasteaux - Donnelly River mouth SE (A)	Very Low		Moderate						*Birds: Calidris ferruginea (Curlew Sandpiper) (CR) Species or species habitat known to occur within area, Thalassarche melanophris (black-browed albatross) (EN & IA) Day sighting (Certain) Reptiles: Caretta caretta (loggerhead turtle) (EN) Caught or trapped (Certain) & Specimen (WAM Vouchered) Nature Reserve (Seal Island, St Alouarn Island, Flinders Bay) (IUCN IA), Important Wetland (Blackwood River (Lower Reaches) and Tributaries System), Marine Park (Ngari Capes) (IUCN VI)*	*Oil Tankers, Bulk Carriers, General Cargo*
220	Point D'Entrecasteaux - Donnelly River mouth SE (B)	Low		Moderate						*Reptiles: Caretta caretta (Loggerhead Turtle) (EN) Breeding likely to occur within area, Species or species habitat known to occur within area, Dermochelys coriacea (Leatherback Turtle, Leathery Turtle, Luth) (EN) Breeding likely to occur within area, Mammals: Eubalaena australis (Southern Right Whale) (EN) Breeding known to occur within area, Megaptera novaeangliae (Humpback Whale) (VU) Congregation or aggregation known to occur within area, Balaenoptera musculus brevicauda (Pygmy Blue Whale) (EN) as Balaenoptera musculus Distribution (Known to occur), National Park (D'Entrecasteaux) (IUCN II), Seagrass, Cmlth Protected Shipwreck: Elanor*	*Oil Tankers, Bulk Carriers, General Cargo*
221	Point D'Entrecasteaux - Donnelly River mouth SE (C)	Moderate		High						*Reptiles: Caretta caretta (Loggerhead Turtle) (EN) Breeding likely to occur within area & Species or species habitat known to occur within area, Dermochelys coriacea (Leatherback Turtle, Leathery Turtle, Luth) (EN) Breeding likely to occur within area, Mammals: Eubalaena australis (Southern Right Whale) (EN) Breeding known to occur within area, Megaptera novaeangliae (Humpback Whale) (VU) Congregation or aggregation known to occur within area, Balaenoptera musculus brevicauda (Pygmy Blue Whale) (EN) as Balaenoptera musculus Distribution (Known to occur) National Park (D'Entrecasteaux, Greater Hawke) (IUCN II), Seagrass*	*Oil Tankers, Bulk Carriers, General Cargo*

ID	Name	Overall Risk Rating	Exposure	Overall Protection Priorities Rating	Protected Fauna	Protection Areas	Heritage	Economic	Social Amenity Recreation	Brief Description of Overall Protection Priority Rating	Key Drivers of Shoreline Exposure
222	Point D'Entrecasteaux - Donnelly River mouth SE (D)	Moderate		High						*Nature Reserve (Quagering) (IUCN IA), Seagrass, Cmlth Protected Shipwreck: Knowsley Hall, Sulphurs Whaleboat*	*Oil Tankers, Bulk Carriers, General Cargo*
223	Point Nuyts - Cliffy Head (A)	Moderate		High						*Nature Reserve (Quagering) (IUCN IA), Seagrass, Cmlth Protected Shipwreck: Michael J. Goulandris*	*Oil Tankers, Bulk Carriers*
224	Point Nuyts - Cliffy Head (B)	Moderate		High						*Important Wetland (Broke Inlet System)*	*Oil Tankers, Bulk Carriers, General Cargo*
225	Point Nuyts - Cliffy Head (C)	Moderate		High						*Reptiles: Caretta caretta (loggerhead turtle) (EN) Caught or trapped (Certain) Nature Reserve (Chatham Island) (IUCN IA), Seagrass, Sheltered rocky shores Cmlth Protected Shipwreck: Mandalay*	*Oil Tankers, Bulk Carriers*
226	Stanley Island/Point Hillier - Quarram Beach head E (A)	Moderate		High						*Reptiles: Caretta caretta (loggerhead turtle) (EN) Specimen (WAM Vouchered), Marine Park (Walpole And Nornalup Inlets) (IUCN II)*	*Oil Tankers, Bulk Carriers, General Cargo*
338	Point Nuyts - West Cliff Point	Moderate		Moderate						*Reptiles: Caretta caretta (loggerhead turtle) (EN) Caught or trapped (Certain) Nature Reserve (Quarram) (IUCN IA), Important Wetland (Owingup Swamp System)*	*Oil Tankers, Bulk Carriers, General Cargo*
227	Stanley Island/Point Hillier - Quarram Beach head E (B)	High		Very High						*Reptiles: Caretta caretta (Loggerhead Turtle) Species or species habitat known to occur within area Mammals: Eubalaena australis (Southern Right Whale) Breding known to occur in the area & Species or species habitat known to occur within area, Balaenoptera musculus brevicauda (Pygmy Blue Whale) (EN) as Balaenoptera musculus Distribution (Known to occur), Seagrass*	*Oil Tankers, Bulk Carriers*

Key for Risk and Protection Priorities

Very Low	Low	Moderate	High	Very High

Key for Exposure

WA05 Sub-Zone Summary

Figure 6.20 shows the count of each cell rating within the WA05 Sub-Zone (Cells 213 to 217). Figure 6.21 depicts these cell ratings on a heat map.

Figure 6.20 WA05 Sub-Zone Cell Counts

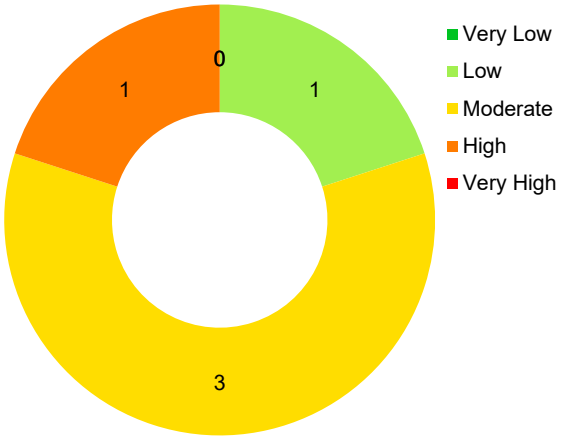
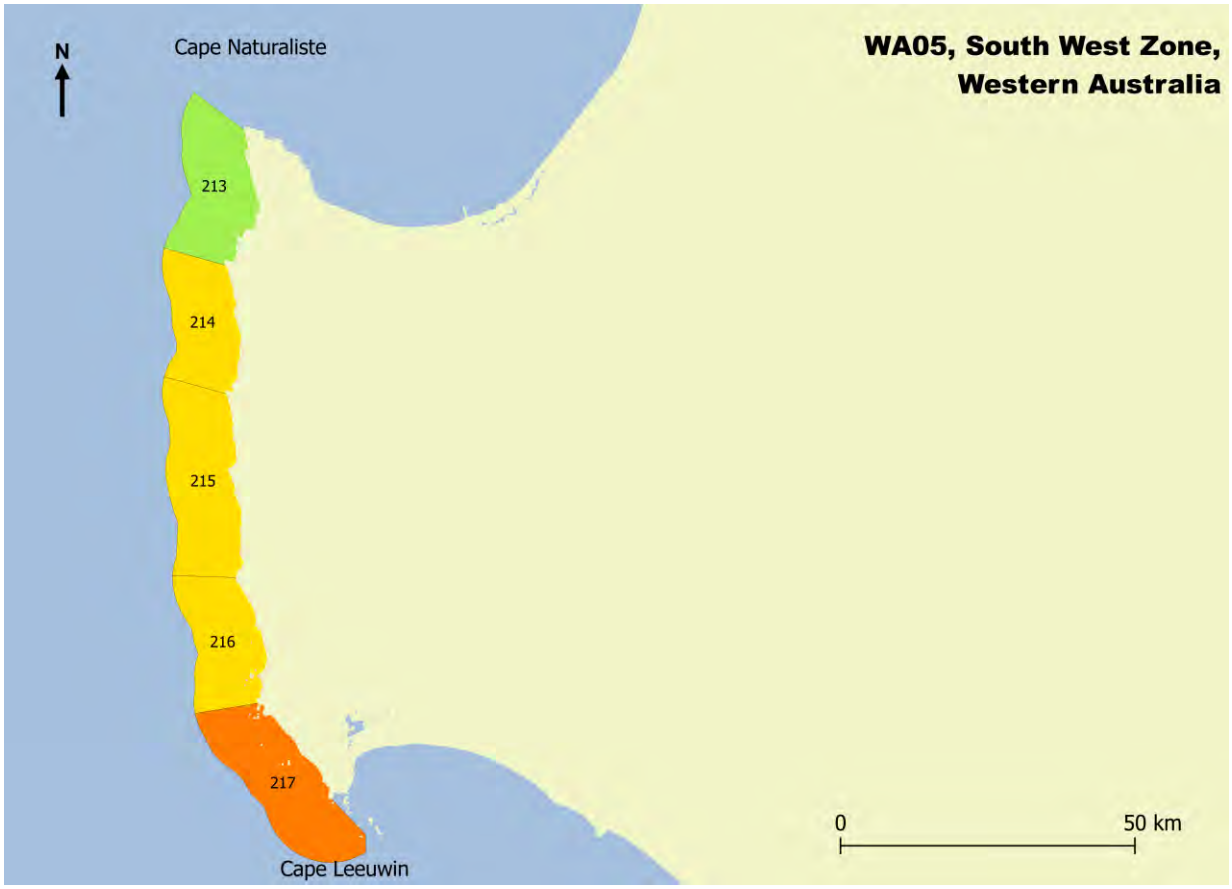


Figure 6.21 WA05 Sub-Zone Risk Profile



The risk in this sub-zone is relatively low, with the majority of cells having a moderate risk rating. The table on the following page summarises the risk and protection priority information for this sub-zone.

WA05 Summary Table

ID	Name	Overall Risk Rating	Exposure	Overall Protection Priorities Rating	Protected Fauna	Protection Areas	Heritage	Economic	Social Amenity Recreation	Brief Description of Overall Protection Priority Rating	Key Drivers of Shoreline Exposure
213	Cowaramup Point - Cape Clairault (A)	**Low**		**High**						*Birds: Thalassarche carteri (Indian yellow-nosed albatross) (EN & IA) Day sighting (Certain) Reptiles: Caretta caretta (loggerhead turtle) (EN) Caught or trapped (Certain) Mammals: Balaenoptera musculus (blue whale) (EN) Survey (Certain) Nature Reserve (Sugar Loaf Rock), Marine Park (Ngari Capes) (IUCN VI)*	*Oil Tankers, Bulk Carriers, General Cargo*
214	Cowaramup Point - Cape Clairault (B)	**Moderate**		**High**						*Reptiles: Caretta caretta (loggerhead turtle) (EN) Caught or trapped (Certain), Marine Park (Ngari Capes) (IUCN VI)*	*Oil Tankers, Bulk Carriers, General Cargo*
215	Cape Freycinet - Cowaramup Point	**Moderate**		**High**						*Reptiles: Caretta caretta (loggerhead turtle) (EN) Caught or trapped (Certain) Mammals: Balaenoptera musculus brevicauda (blue whale) (EN) Specimen (WAM Vouchered) Marine Park (Ngari Capes) (IUCN VI)*	*Oil Tankers, Bulk Carriers, General Cargo*
216	Knobby Head - Cape Freycinet (A)	**Moderate**		**High**						*Reptiles: Caretta caretta (loggerhead turtle) (EN) Caught or trapped (Certain) Nature Reserve (Hamelin Island) (IUCN IA), Marine Park (Ngari Capes) (IUCN VI)*	*Oil Tankers, Bulk Carriers, General Cargo*
217	Knobby Head - Cape Freycinet (B)	**High**		**High**						*Reptiles: Caretta caretta (loggerhead turtle) (EN) Specimen (WAM Vouchered), Nature Reserve (Flinders Bay) (IUCN IA), Important Wetland (Cape Leeuwin System), Marine Park (Ngari Capes) (IUCN VI)*	*Oil Tankers, Bulk Carriers, General Cargo*

Key

Very Low	Low	Moderate	High	Very High

Key for Exposure

Lowest — Highest

WA06 Sub-Zone Summary

Figure 6.22 shows the count of each cell rating within the WA06 Sub-Zone (Cells 207 to 212). Figure 6.23 depicts these cell ratings on a heat map.

Figure 6.22 WA06 Sub-Zone Cell Counts

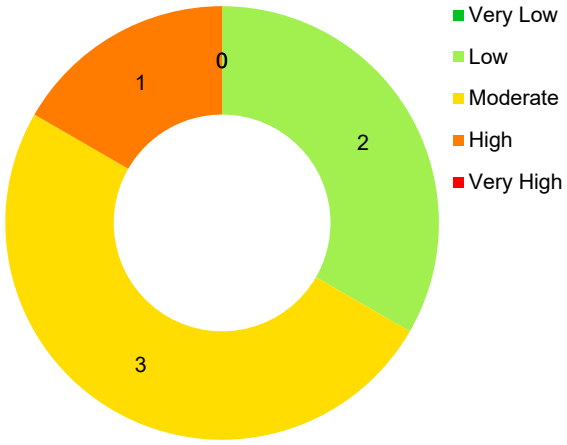
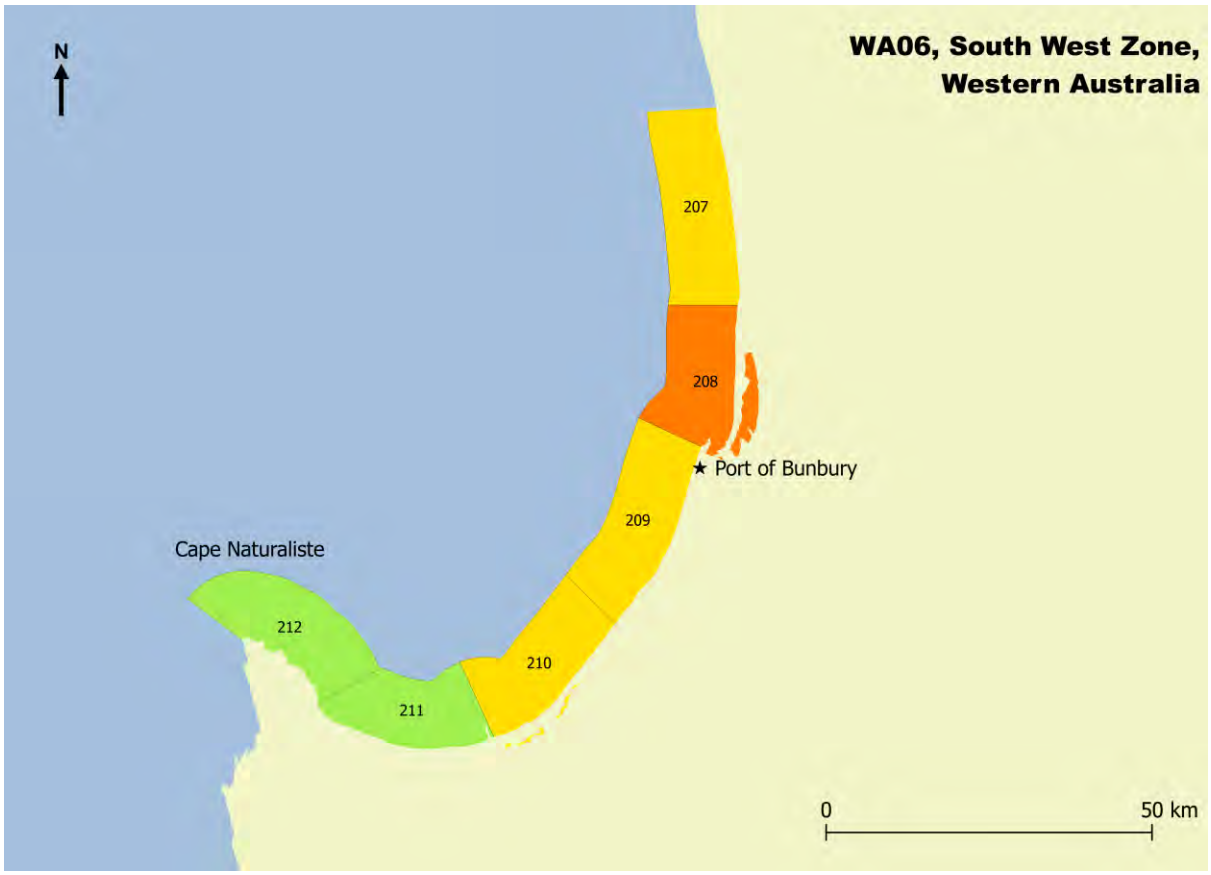


Figure 6.23 WA06 Sub-Zone Risk Profile



The majority of cells in this subzone have a moderate risk rating, with the more elevated risks being in the vicinity of the Port of Bunbury. The table on the following page summarises the risk and protection priority information for this sub-zone.

WA06 Summary Table

ID	Name	Overall Risk Rating	Exposure	Overall Protection Priorities Rating	Protected Fauna	Protection Areas	Heritage	Economic	Social Amenity Recreation	Brief Description of Overall Protection Priority Rating	Key Drivers of Shoreline Exposure
207	Binningup - Cape Bouvard (B)	Moderate		Very High						*Reptiles: Caretta caretta (loggerhead turtle) (EN) Caught or trapped (Certain) & Day sighting (Certain) Seawater Intake: Desalination Plant Binningup*	*Oil Tankers, Bulk Carriers, General Cargo*
208	Point Casuarina - Binningup	High		High						*Birds: Anous tenuirostris melanops (Australian lesser noddy) (EN) Specimen (WAM Vouchered), Thalassarche carteri (Indian yellow-nosed albatross) (EN & IA) Specimen (WAM Vouchered), Anous tenuirostris melanops (Australian lesser noddy) (EN) Specimen (WAM Vouchered) Reptiles: Caretta caretta (loggerhead turtle) (EN) Caught or trapped (Certain) & Day sighting (Certain) Fish: Carcharodon carcharias (great white shark) (VU) Day sighting (Certain) Nature Reserve (IUCN IA), Seagrass, Sheltered seawalls State Heritage: Bunbury Timber Jetty, Picton Inn Hotel Cmlth Protected Shipwreck: Annie M. Young, Cingalee, Elizabeth, Kormoran Lifeboat 2, Laughing Wave, Midas, North America, Solglyt, Star Of The South, Unnamed Boat, Leschenault Inlet Unidentified West Coast Rock Lobster Managed Fishery Port: Bunbury*	*Bulk Carriers, General Cargo*
209	Capel River mouth - Point Casuarina	Moderate		Very High						*Ramsar Wetland (Vasse-Wonnerup System)*	*Bulk Carriers, Oil Tankers, General Cargo*
210	Point Daking - Bussleton (A)	Moderate		Very High						*Ramsar Wetland (Vasse-Wonnerup System)*	*Oil Tankers, Bulk Carriers, General Cargo*
211	Point Daking - Bussleton (B)	Low		High						*Birds: Anous tenuirostris melanops (Australian lesser noddy) (EN) Specimen (WAM Vouchered), Calyptorhynchus latirostris (Carnaby's cockatoo) (EN) Day Sighting (Certain) & Survey (Certain), Phoebetria fusca (sooty albatross) (EN & IA) Specimen (WAM Vouchered), Thalassarche carteri (Indian yellow-nosed albatross) (EN & IA) Day sighting (Certain), Thalassarche melanophris (black-browed albatross) (EN & IA) Day sighting (Certain) Reptiles: Caretta caretta (loggerhead turtle) (EN) Caught or trapped (Certain) Mammals: Balaenoptera borealis (sei whale) (EN) Specimen (WAM Vouchered), Balaenoptera musculus (blue whale) (EN) Survey (Certain) CAPAD: IUCN IA (Nature Reserve), Marine Park (Ngari Capes) (IUCN VI)*	*Oil Tankers, Bulk Carriers, General Cargo*
212	Point Daking - Bussleton (C)	Low		High						*Birds: Thalassarche carteri (Indian yellow-nosed albatross) (EN & IA) Day sighting (Certain), Thalassarche melanophris (black-browed albatross) (EN & IA) Day sighting (Certain) Mammals: Balaenoptera musculus (blue whale) (EN) Survey (Certain), Balaenoptera musculus brevicauda (blue whale) (EN) Survey (Certain) Marine Park (Ngari Capes) (IUCN VI)*	*Oil Tankers, Bulk Carriers, General Cargo*

Key

Very Low	Low	Moderate	High	Very High

Key for Exposure

Lowest — Highest

7. Summary

The WAMOPRA combines regional, national and international data for maritime activity and marine oil spills, levels of activity and protection priorities including environmental sensitivities to develop an overview of oil spill risk in the South West zone. This report summarises the context, methodology and results for the South West Risk Assessment Zone. It builds on the work undertaken in the preliminary state-wide assessment.

All sub-zones in the South West region have a similar risk profile. The highest risk area is around the Port of Bunbury. While the port does not pose exceptional navigational challenges (other than the inherent complexity of any port operation), there are a significant number of bulk carriers transiting the port. Other high risk areas include the area near Denmark and Ratcliffe Bay, which has a *very high* protection priority, and an area at Cape Leeuwin, which has a *high* protection priority and higher levels of traffic transiting near the coastline.

The overall the level of risk-generating activity in the South West region is relatively low. There is no petroleum production nor exploration activity in this region.

This companion report summarises the WAMOPRA results for the South West Risk Assessment Zone. Further risk outputs are available via an interactive website at http://wamopra.navigatusconsulting.com (contact Team Leader Planning and Public Information for username and password).

8. References

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