GOVERNMENT OF
WESTERN AUSTRALIA

Western Australian Shark Hazard Mitigation Drum Line Program 2014-17

Public Environmental Review

EPA Assessment No. 2005 EPBC Assessment No. 2014/7174

June 2014

The Department of the Premier and Cabinet
Dumas House
Locked Bag 3001
WEST PERTH WA 6872

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INVITATION TO MAKE A SUBMISSION

The Environmental Protection Authority (EPA) invites people to make a submission on this Proposal. Both electronic and hard copy submissions are welcome.

The Western Australian Government is proposing to set up to 60 static baited drum lines at approximately 1km offshore of selected high use swimming beaches and surf breaks within designated Marine Monitored Areas in the metropolitan and south west coastal regions of Western Australia. The static drum lines are to be deployed between 15 November and 30 April for a period of three years, commencing in 2014, after which the program will be subject to review. Twelve drum lines will be kept in reserve for temporary deployment in response to a shark threat or incident anywhere in Western Australian waters at any time throughout the year, until 30 April 2017. All operations will occur in state waters and contractor(s) will be procured by the Western Australian Government to undertake the required activities.

In accordance with the *Environmental Protection Act 1986* (EP Act), a **Public Environmental Review (PER)** has been prepared which describes this Proposal and its likely effects on the environment. The PER is available for a public review period of **four (4) weeks** from **Monday 9 June to Monday 7 July 2014**.

Comments from government agencies and from the public will help the EPA to prepare an assessment report in which it will make recommendations to government.

Where to get copies of this document
Copies of the **Public Environmental Review** document may be downloaded from http://www.dpc.wa.gov.au.

Copies of the PER will also be available for examination at:

- Library/Reading Room
  4th Floor, The Atrium
  168 St Georges Terrace
  Perth WA 6000
- JS Battye Library
- State Library Western Australia
- Designated metropolitan and south west Local Government Libraries

A CD version of the PER is available (free of charge) for collection from The Constitutional Centre of Western Australia at 40 Havelock Street West Perth WA 6005 or you may call 6552 5070 to have one posted out to you.

Why write a submission?
A submission is a way to provide information, express your opinion and put forward your suggested course of action – including any alternative approach. It is useful if you indicate any suggestions you have to improve the Proposal.

All submissions received by the EPA will be acknowledged. Submissions will be treated as public documents unless provided and received in confidence, subject to the requirements of the *Freedom of Information Act 1992* (FOI Act), and may be quoted in full or in part in the EPA's report.

Why not join a group?
If you prefer not to write your own comments, it may be worthwhile joining a group interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission
You may agree or disagree with, or comment on, the general issues discussed in the PER or the specific Proposal. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the Proposal more environmentally acceptable.

When making comments on specific elements of the PER:
- clearly state your point of view;
- indicate the source of your information or argument if this is applicable;
- suggest recommendations, safeguards or alternatives.

Points to keep in mind
By keeping the following points in mind, you will make it easier for your submission to be analysed:
- attempt to list points so that issues raised are clear. A summary of your submission is helpful;
- refer each point to the appropriate section, chapter or recommendation in the PER;
- if you discuss different sections of the PER, keep them distinct and separate, so there is no confusion as to which section you are considering; and
- attach any factual information you may wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:
- your name;
- address;
- date; and
- whether, and the reason why, you want your submission to be confidential.

Information in submissions will be deemed public information unless a request for confidentiality of the submission is made in writing and accepted by the EPA. As a result, a copy of each submission will be provided to the proponent but the identity of private individuals will remain confidential to the EPA.

The closing date for submissions is **Monday 7 July 2014**.

The EPA prefers submissions of PER documents to be made electronically on its consultation hub at https://consultation.epa.wa.gov.au.

Alternatively, submissions can be:
- posted to: Chairman, Environmental Protection Authority, Locked Bag 10, EAST PERTH WA 6892
- delivered to the Environmental Protection Authority, Level 4, The Atrium, 168 St Georges Terrace, Perth.

If you have any questions on how to make a submission, please email info@epa.wa.gov.au

EXECUTIVE SUMMARY

Between 25 January and 30 April 2014 the Western Australian Government (the Government) managed the implementation of a trial shark control drum line program. The program aimed to provide additional protection from the risk of shark interactions to water users at a select number of swimming beaches and surf spots in the metropolitan and south west regions of the state. In March 2014, following a third party referral, the Environmental Protection Authority (EPA) announced its decision not to assess the environmental impact of the program given its limited temporal and spatial footprint.

Following the trial program, the Government now proposes to set up to 72 baited drum lines, of which 60 will be at approximately 1km offshore of selected high use swimming beaches and surf breaks within designated Marine Monitored Areas (MMAs) in the metropolitan and south west coastal regions of Western Australia (the Proposal). The proposed action will take place between 15 November and 30 April for a period of three years, commencing 15 November 2014 and ceasing on 30 April 2017, after which the program will be subject to review. The Proposal also contains a provision for responding to identified shark threats and incidents within all Western Australian waters at any time, including the temporary deployment of drum lines until 30 April 2017. It should be noted that the drum line element of the Government's overall shark hazard mitigation strategy is not considered a permanent solution. With continued research into shark ecology and biology and non-lethal deterrent and detection technologies, it is hoped that effective alternative or complementary mitigation measures to drum lines may become available in the future.

The three year Proposal has been referred to the EPA for assessment under section 38(1) of the *Environmental Protection Act 1986* (EP Act) and to the Commonwealth Department of the Environment (DoE) for assessment under Part 3 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The EPA has indicated that the Proposal is suitable for a level of assessment in the form of a Public Environmental Review (PER) (EPA 2014b). The EPA has identified Marine Fauna as the preliminary key environmental factor requiring assessment. The Commonwealth Minister for the Environment has considered the Proposal to be a 'controlled action' due to the likely significant impacts on the following matters of national environmental significance (MNES) protected by the EPBC Act:

- listed threatened species and communities (sections 18 and 18A); and
- listed migratory species (sections 20 and 20A).

The Commonwealth Minister for the Environment considers the proposed action is likely to have a significant impact on the white shark (*Carcharodon carcharias*) which is listed as vulnerable under s 178 and as migratory under s 209 of the EPBC Act and listed in Appendix 1 of the *Convention on the Conservation of Migratory Species of Wild Animals* (CMS).

The purpose of this document is to provide a detailed description of the Proposal and to enable assessment of the potential environmental impacts that may result, should the Proposal be implemented. The assessment will be undertaken by the EPA under the provisions of Part IV of the EP Act and under bilateral agreement with the Commonwealth.

The Proposal contains two drum lining elements; static drum lines which are to be set within two MMAs between 15 November and 30 April for three consecutive years; and temporary drum lines which may be set anywhere in Western Australian waters at any time in response to identified shark threats or incidents until 30 April 2017.

The PER contains a detailed description of the Proposal, the existing environment in which the action is proposed to take place and details on Marine Fauna and MNES. The PER provides an assessment of the potential environmental impacts resulting from the Proposal and alternatives

considered to taking the action. The assessment methodology and the measures proposed to avoid, mitigate, manage and monitor those impacts are considered in detail. The risk assessment examining the element of deploying static drum lines is used as a basis for assessing the potential environmental impacts of the setting of temporary drum lines anywhere in Western Australian waters at any time. A draft Management Plan for the Proposal (at Appendix 2), which will be developed through the assessment process, should be read in conjunction with the PER. For the Proposal to receive approval, the assessment must establish that the environmental objectives of the EPA can be met and that the Proposal is not expected to result in unacceptable or unsustainable impacts on MNES.

The Proposal, which includes significant risk mitigation components, was assessed as posing only either no or negligible, or negligible risks to the population status of two of the three target species, the non-target species and the broader ecosystem.

For white sharks it is expected that fewer than 10 white sharks and even fewer in the target range (≥300 cm TL) will be caught each year. This would lead to a likely cumulative catch of less than 25 white sharks over the three year program and even fewer that are ≥ 300 cm TL. This is substantially lower than the numbers that were estimated to have previously been caught each year as bycatch by commercial fishing operations in Western Australia, South Australia and Victoria. Prior to the major reductions in effort of the commercial fisheries that occurred in the mid-1990s (due to issues with targeted stocks) up to 260 individuals per year were estimated to be captured across the Western Australia/Victorian region. The annual bycatch of white sharks by all fisheries across this region is estimated to still be in the order of 50-100 individuals per year. Based on these estimates, the expected catch levels generated by the Proposal would add less than 10% to the current annual levels of capture. The cumulative impact of the three year Proposal, assuming catch levels close to 10 individuals per year, is therefore assessed as posing only a negligible risk to the population.

Tiger sharks formed the majority of the catch from the trial program (163 of the 172 sharks caught). The risk assessment for the three year Proposal assumed the average catch per day at each of the sites observed during the trial program to be maintained across the entire season (15 November to April 30) for three consecutive years. This generated an expected total number of tiger sharks to be captured per season of close to 300. Accounting for the expected level of release (60%), this equates to a mortality in the order of 25 to 40 tonne per year depending upon the level of release mortality (0-100%). The risk assessment determined that, if the capture of tiger sharks remains within the expected levels, combined with assuming high rates of release mortality, an annual mortality of ~40 tonne per year for three consecutive years would be possible for the Proposal to generate a minor consequence, and therefore represent a low risk to the Western Australian tiger shark population. This acceptable level of risk requires a higher level of monitoring and a specific assessment for tiger sharks to be completed at the end of the three year period.

In terms of potentially generating broader ecosystem effects, the Proposal is expected to generate negligible impacts on each of the species which is also consistent with no trophic impacts being generated. Based on the capture of approximately 40 tonne of tiger sharks, a negligible catch of non-shark species, and up to an additional 5 tonne of other shark species, the cumulative total for all captures of all species is very small (~45 tonne per year) when compared to the total combined levels of commercial capture of sharks that previously occurred within this bioregion (> 500 tonne per year). This historical level was found not to have generated any measurable shift in the community structure for this region (Hall & Wise, 2011). Following a series of management interventions over the past decade (a major component being the removal of commercial shark fishing from the metropolitan region for sectoral allocation purposes), the level of commercial shark capture in the West Coast Bioregion has been reduced from 500 tonne to less than 250 tonne annually, and is expected to operate at this lower level into the future. Consequently, the additional ~45 tonne per year of sharks to be captured under the Proposal poses a negligible risk to the community structure of the Leeuwin-Naturaliste ecosystem (see Table ES 1).

In considering MNES, all listed threatened and migratory species that are known to occur across the two MMAs were assessed as posing either no or negligible, or negligible risk to the species. The exception was the white shark which was assessed as having a remote likelihood of having a minor level of consequence on the total size and migratory patterns of the southwestern Australian population (see Table ES 2).

Based on the above, it is expected that the implementation of the Proposal will not result in significant impacts on Marine Fauna and is not expected to result in unacceptable or unsustainable impacts on MNES. With the application of the proposed draft Management Plan, the EPA and DoE objectives and associated conditions can be met.

Conclusion

The Government has a duty of care to the people of Western Australia. The deployment of drum lines is the most recent shark hazard mitigation measure to be considered by the Government, and complements more than $22million of investment into a suite of existing measures to address the safety of water users.

The temporary drum line element of the Proposal is likely to occur infrequently and for very limited periods of time if enacted. The static drum line element of the Proposal is to occur in a limited area of Western Australian waters and be restricted to only peak ocean usage periods at popular swimming beaches and surf breaks for three consecutive years. It is acknowledged that some of the species of shark that may be captured as part of the Proposal may be migratory and that the impact therefore may extend beyond the immediate spatial confines of the MMAs. It is for this reason that the Government has considered advice provided by stakeholders, and incorporated measures where practicable, to minimise the environmental impacts of the Proposal.

The Proposal has been prepared in conjunction with a draft Management Plan which aims to avoid, minimise or manage the environmental impacts associated with the Proposal. The draft Management Plan will be developed and refined through the assessment process. In respect to Marine Fauna and MNES, the Government has identified environmental objectives that are consistent with state and Commonwealth legislative guidelines. Given the design of the Proposal to avoid significant impacts and its limited temporal and spatial footprint in relation to significant environmental values, the Proposal is not expected to cause a significant environmental impact and is therefore expected to meet both the EPA's objectives (Table ES 3) and the DoE's test of acceptability and sustainability.

Table ES 1. Summary of the risk analysis, risk scores and risk evaluations.

Component	Risk Analysis	Risk Scores	Risk Evaluation
TARGET SPECIES			
White shark	With catch levels expected to be < 10 individuals per year there is only a **remote likelihood** (Likelihood Level 1) that this would have a minor level of consequence (Consequence Level 1) on the total size, or migratory patterns, of the southwestern Australian population of white sharks.	1	Negligible
Tiger shark	If the levels of capture of tiger sharks remain within the expected levels (~40 tonne per year) and assuming high levels of release mortality rates, it would be **possible** (Likelihood Level 3) for the Proposal to generate a **minor consequence** (Consequence Level 1).	3	Low
Bull shark	Expected capture rate is none to a few individuals each year. Therefore there is a **high likelihood** the Proposal will have **no impact** (Consequence Level 0).	0	Negligible
NON-TARGET SPECIES			
Dusky shark	If the annual level of capture and mortality of large dusky sharks remains in the revised expected range (< 10), there is now only a **remote likelihood** (Likelihood Level 1) of **a minor level of impact** (Consequence Level 1).	1	Negligible
Other non- listed elasmobranchs	There is a **high likelihood** (Likelihood Level 5) that few individuals from each of the other species of sharks and rays will be caught and therefore generate **negligible impacts** (Consequence Level 0).	0	Negligible
Demersal scalefish	There is a **high likelihood** (Likelihood Level 5) that **no demersal scalefish** will be caught and also that few, if any, other finfish species will be caught (Consequence Level 0).	0	Negligible
PROTECTED OR LISTED SPECIES			
Grey nurse shark	There is a **high likelihood** that no grey nurse sharks will be caught and, even if a few are caught they will most likely be able to be released alive resulting in **no** or **negligible impacts** (Consequence Level 0).	0	Negligible
Shortfin mako shark	There is a **high likelihood** that the Proposal will have a **negligible impact** (Consequence Level 0) on the shortfin mako shark population of Australia.	0	Negligible
Other listed elasmobranchs	There is a **high likelihood** (Likelihood Level 5) that no whale sharks, manta rays or other listed species of sharks and rays will be caught resulting in **no** or n**egligible impacts** (Consequence Level 0).	0	Negligible
Seals and sea lions	With no seal or sea lion captures anticipated to occur there is a **high likelihood** of **no impact** (Consequence Level 0).	0	Negligible
Turtles	With no captures of turtles anticipated to occur there is a **high likelihood** of **no impact** (Consequence Level 0).	0	Negligible

Whales	With no captures of whales anticipated to occur there is a **high likelihood** of **no impact** (Consequence Level 0).	0	Negligible
Dolphins	With no captures of dolphins anticipated to occur there is a **high likelihood** of **no impact** (Consequence Level 0).	0	Negligible
Seabirds	With no captures of seabirds anticipated to occur there is a **high likelihood** of **no impact** (Consequence Level 0).	0	Negligible
ECOSYSTEM			
Habitat	The extremely small footprint of the anchors used for the drum lines and the high resilience of the sandy substrates where most are deployed results in a **high likelihood** (Likelihood Level 5) of only **negligible impacts** (Consequence Level 0).	0	Negligible
Community structure	The high historical level of commercial catch of sharks in this region was not found to have generated any measurable shift in the community structure for the broader fish community. Now that this catch has been reduced by half, an additional ~45 tonne of sharks to be captured under the Proposal is **highly likely** (Likelihood 5) to have **no measurable effect** (Consequence Level 0) on the community structure of the West Coast Bioregion.	0	Negligible

Table ES 2. Outcomes of the risk assessment for listed threatened and migratory species under the EPBC Act as extracted from the EPBC Act Protected Matters database.

Fauna	EPBC Listing	Likelihood/Impact	Risk Score	Risk
White shark	Threatened Migratory	Remote likelihood of having a minor level of consequence on the total size and migratory patterns of the southwestern Australian population.	1	Negligible
Grey nurse shark	Threatened	High likelihood to have no or negligible impact	0	Negligible
Shortfin mako*	Migratory	High likelihood to have a negligible impact	0	Negligible
Other elasmobranchs (sharks and rays)**	Threatened Migratory	High likelihood to have no impact	0	Negligible
Australian sea lion	Threatened	High likelihood to have no impact	0	No or negligible
Turtles	Threatened Migratory	High likelihood to have no impact	0	No or negligible
Whales***	Threatened Migratory	High likelihood to have no impact	0	Negligible
Dolphins	Migratory	High likelihood to have no impact	0	Negligible
Seabirds	Threatened Migratory	High likelihood to have no impact	0	No or negligible

* Shortfin mako does not appear on the EPBC Act Protected Matters report however has been included due to its listing as a migratory species under the EPBC Act.
** Includes whale sharks, porbeagle, mackerel sharks and manta rays.
*** Includes killer whales.

Table ES 3. Summary of environmental impact assessment of the preliminary key environmental factor

Environmental factor	EPA objective	Existing environment	Potential impact	Environmental management	Predicted outcomes
Marine Fauna	To maintain the diversity, geographic distribution and viability of fauna at the species and population levels.	The metropolitan MMA extends from Ocean Reef (-31°44.6038', 115° 43.3727') to Port Beach (-32° 2.4354', 115° 44.4630'). The area of the metropolitan MMA is 34km² (3 400ha) and is 35km long. The south west MMA extends from Quindalup (-33° 37.8569', 115° 8.9470') to Prevelly (-33°58.9200',114° 59.3834'). The total area of the south west MMA is 81km² (8 100ha) and covers 85km of the coastline The two MMAs account for approximately 0.05-0.07% of all Western Australian waters and approximately 0.5-0.7% of the Western Australian coastline. The metropolitan MMA overlaps with the Marmion Marine Park and Cottesloe Fish Habitat Protection Area. The south west MMA overlaps with the Ngari Capes Marine Park.	**White sharks** It is expected that fewer than 10 white sharks and even fewer in the target range (≥300 cm TL) will be caught each year, leading to a cumulative catch of less than 25 white sharks over the three year program. The expected catch levels would only be increasing annual catch by less than 10%. The cumulative impact of the three year Proposal, assuming catch levels close to 10 individuals per year is assessed as posing only a negligible risk to the population. **Tiger sharks** The total number of tiger sharks estimated to be captured per season is close to 300. This equates to 25 to 40 tonne per year depending upon the level of release mortality (0-100%). It is determined that the Proposal may generate a minor consequence, and therefore represent a low risk to the western Australian tiger shark population. This acceptable level of risk requires a higher level of monitoring and a specific assessment for tiger sharks to be completed at the end of the three year period. **Bull sharks** With an expected capture rate of none to only a few individuals each year (most of which will be less than 300 cm TL), there is a high likelihood that the Proposal will have no impact on the population numbers in Western Australia. This represents a negligible risk to the Western Australian bull shark population.	The Proposal has been deliberately conservatively designed to minimise environmental impacts. Environmental impacts will be minimised by the following measures: • Regular monitoring and surveillance of drum lines (between 0600 and 1800, seven days a week). • No deployment of nets. • The use of a large (no smaller than an approximate 25/0 circle) design hook. • Restricted geographic and temporal footprint (two small MMAs representing <0.1% of Western Australian waters and <5% of the West Coast Bioregion) with deployment between 15 November and 30 April each year. • Drum lines will be removed before 1 May each year to reduce the potential for interactions with annual whale migrations along the Western Australian coast which occur between May and October each year. • The use of shark as bait where possible to reduce the potential for interaction with non-shark species. • Appropriate specifications for vessel and equipment and experienced staff through a rigorous tender process. • Provision of pre-operational training in areas of animal handling. • Regular provision of observers on each vessel each season to observe operations and compliance with legislative and permit requirements. If the rates of capture of one or more listed species or groups begins to materially exceed the predicted levels, a within season review of the risks would be appropriate.	In considering: • a negligible risk to white sharks; • a low risk to tiger sharks; and • either no or negligible, or negligible risks to all other species the Proposal is not considered to represent a significant impact to Marine Fauna and is expected to meet the EPA's objective for marine fauna by maintaining the diversity, geographic distribution and viability of fauna at the species and population levels.

			Broader ecosystem effects The Proposal is expected to generate negligible impacts on each of the species which is also consistent with no trophic impacts being generated. Based on the capture of ~40 tonne of tiger shark, a negligible catch of non-shark species, and up to an additional 5 tonne of other shark species, the cumulative total for all captures of all species is very small (approximately 45 tonne per year) when compared to the total combined levels of commercial capture of sharks that previously occurred within this bioregion (> 500 tonne per year). The level of commercial shark capture in the West Coast Bioregion has been reduced from 500 tonne to less than 250 tonne annually, and is expected to operate at this lower level into the future. Consequently, the additional ~45 tonne per year of sharks to be captured under the Proposal poses a negligible risk to the community structure of the Leeuwin-Naturaliste ecosystem.		

TABLE OF CONTENTS

List of Acronyms

CMS	*Convention on the Conservation of Migratory Species of Wild Animals*
DoE	The Commonwealth Department of the Environment
DoF	The Department of Fisheries, Western Australia
DPaW	The Department of Parks and Wildlife, Western Australia
DPC	The Department of the Premier and Cabinet, Western Australia
EP Act	*Environmental Protection Act 1986* (WA)
EPA	The Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
ESD	Environmental Scoping Document
FHPA	Fish Habitat Protection Area
FRMA	*Fish Resources Management Act 1994* (WA)
MMA	Marine Monitored Area
MNES	Matters of national environmental significance
PER	Public Environmental Review
SMN	Shark Monitoring Network
TL	Total length
VR2	Sea floor mounted data recording acoustic receivers
VR4G	Sea-surface satellite-linked acoustic receivers
WC Act	*Wildlife Conservation Act 1950* (WA)
WC Regs	*Wildlife Conservation Regulations1970* (WA)

List of Figures

List of Tables

1 INTRODUCTION

1.1 Purpose and scope

Since 2008, the Western Australian Government (the Government) has been working to address the issue of human-shark interactions. More than $22million has been committed to 2015-16 for a broad range of shark hazard mitigation measures including aerial and beach surveillance, beach enclosure trials, community awareness and education programs and a range of research initiatives (Figure 1). However, the latest fatality by shark attack in Western Australia occurred on 23 November 2013, taking the total for the State to 10 in 10 years, compared to 10 in the previous 90 years. The latest fatality prompted the Government to take further action towards providing increased safety measures for water users.

A trial drum line program was implemented to provide select areas with enhanced mitigation measures aimed at capturing potentially dangerous sharks which came into close proximity of popular swimming beaches and surf breaks during the high use summer months. Response capabilities were also enhanced for responding to a shark threat or incident within Marine Monitored Areas (MMAs) during the time of the drum line deployment. The trial program provided the public with a further option on which to make informed risk assessments and decisions on their own water use. A total of 60 static baited drum lines were set off popular swimming beaches and surf breaks in the metropolitan and south west MMAs between 25 January and 30 April 2014. A review of the trial program is currently underway.

Following the trial program, the Government is now proposing to set drum lines for a further three years (the Proposal). The Proposal is designed to offer a measure of protection at popular swimming beaches and surf breaks during periods of peak usage, which is in addition to the shark hazard mitigation measures already enacted by the Government. The Proposal also contains a provision for responding to identified shark threats and incidents within all Western Australian waters at any time, including the temporary deployment of drum lines. It is fundamentally addressing an identified need for public safety.

The Proposal has been designed following a close examination of shark control programs in other jurisdictions, and a review of the catch data from the trial program. The result is a very conservative program, explicitly designed to minimise environmental impacts A detailed description of the Proposal is in Section 2.

The Proposal has been referred to the Environmental Protection Authority (EPA) for assessment under s 38(1) of the *Environmental Protection Act 1986* (EP Act) and to DoE for assessment under Part 3 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The EPA has indicated that the Proposal is suitable for a level of assessment in the form of a Public Environmental Review (PER) (EPA 2014b). The EPA has identified Marine Fauna as the preliminary key environmental factor requiring assessment. The Commonwealth Minister for the Environment has considered the Proposal to be a ‘controlled action’ due to the likely significant impacts on the following matters of national environmental significance (MNES) protected by the EPBC Act:

- listed threatened species and communities (ss 18 and 18A); and
- listed migratory species (ss 20 and 20A).

The Commonwealth consider the proposed action is likely to have a significant impact on the white shark (*Carcharodon carcharias*) which is listed as vulnerable under s 178, as migratory under s 209 of the EPBC Act and in Appendix I of the *Convention on the Conservation of Migratory Species of Wild Animals* (CMS).

This PER document is written in accordance with the EPA's 2012 gazetted Environmental Impact Assessment Administrative Procedures and the EPA-prepared scoping document (EPA 2014a) (Appendix 1). The document has been prepared to inform decision-makers and stakeholders about the Proposal and facilitate its assessment under the EP Act. The assessment will be undertaken by the EPA under the provisions of Part IV of the EP Act and under bilateral agreement with the Commonwealth.

The Proposal contains two drum lining elements; static drum lines which are to be set within two MMAs between 15 November and 30 April for three consecutive years; and temporary drum lines which may be set anywhere in Western Australian waters at any time in response to identified shark threats or incidents until 30 April 2017.

The PER contains a detailed description of the Proposal, the existing environment in which the action is proposed to take place and details on Marine Fauna and MNES. The PER provides an assessment of the potential environmental impacts resulting from the Proposal and alternatives to taking the action which have been considered. The assessment methodology and the measures proposed to avoid, mitigate, manage and monitor those impacts are considered in detail. The risk assessment examining the element of deploying static drum lines is used as a basis for assessing the potential environmental impacts of the setting of temporary drum lines anywhere in Western Australian waters at any time until 30 April 2017. A draft Management Plan, which will be developed and refined through the assessment process, should be read in conjunction with the PER (Appendix 2).

The PER has considered and incorporated information from a variety of sources including peer reviewed articles, published governmental and non-governmental documents, input from a broad range of stakeholders and other published and available information where appropriate, all of which are fully referenced at Section 7.

For the Proposal to receive approval, the assessment must establish that the environmental objectives of the EPA can be met and that the Proposal is not expected to result in unacceptable or unsustainable impacts on MNES.

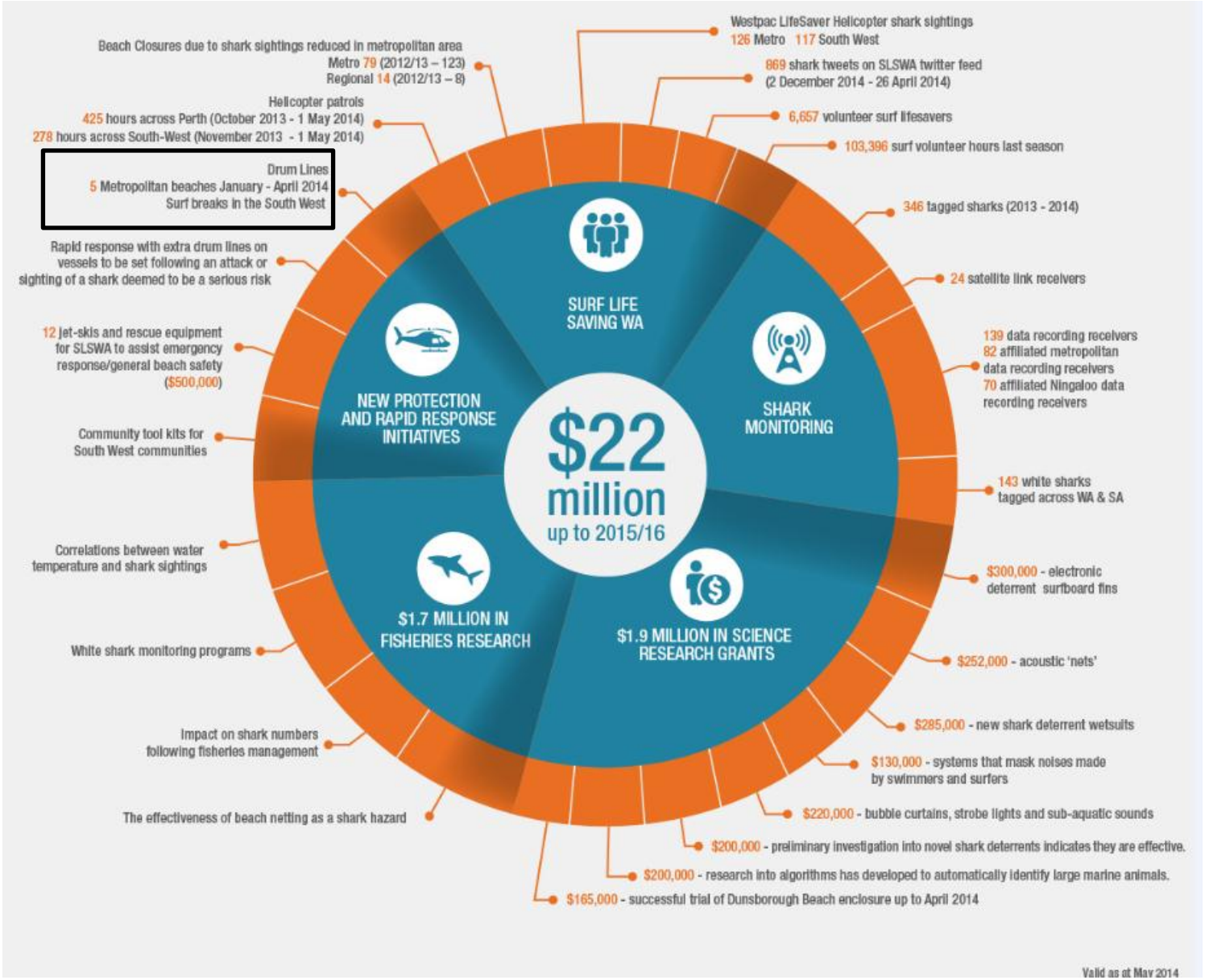

Figure 1. Graphic showing the investments made into shark hazard mitigation by the Western Australian Government, of which drum lines are one component (as per the trial drum line program) (graphic taken from **www.sharksmart.com.au**)

1.2 Assessment pathway

The PER will be released for public comment for a period of four weeks. Following the close of the public comment period the assessment pathway under the EP Act and indicative timing is as follows:

- EPA develops a summary of submissions received and will provide the summary to the Government (July 2014).
- The Government responds to the summary of submissions (July/August 2014).
- EPA reviews response to public submissions (August 2014).
- EPA assesses the Proposal and prepares an assessment report for consideration by the EPA (August 2014).
- EPA consults with the Government and key government agencies on any draft recommended implementation conditions (August 2014).
- EPA submits the report to both the Western Australian and Commonwealth Ministers for Environment and publishes the report (September 2014).
- Members of the public can appeal the findings and recommendations of the EPA report. If any appeals are received under the EP Act assessment, they are considered by the Office of the Appeals Convenor and a recommendation is made to the Western Australian Minister for Environment (September 2014).
- Western Australian Minister for Environment makes a final determination on appeals and consults with decision-making authorities as to whether the Proposal should be approved for implementation (October 2014).
- Western Australian Minister for Environment issues an implementation statement, or notifies the Government that the project is unacceptable (October 2014).

Under the EPBC Act, the Commonwealth Minister for the Environment will consider the EPA's report and decide whether to approve, approve with conditions, or not approve the proposed action.

1.3 Environmental record of proponent

The Department of the Premier and Cabinet (DPC) has a satisfactory record of responsible environmental management, being fully compliant with all applicable Commonwealth and State legislation. DPC has never been subject to any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources.

2 PROPOSAL DESCRIPTION

2.1 Proposal summary

The Government is proposing to set up to 60 static baited drum lines at approximately 1km offshore of selected high use beaches and surf breaks within designated MMAs in the metropolitan and south west coastal regions of Western Australia. Twelve drum lines will be kept in reserve for temporary deployment in response to a shark threat or incident anywhere in Western Australian waters at any time throughout the year.

The static drum lines are to be deployed between 15 November and 30 April for a period of three years, commencing 15 November 2014 and ceasing 30 April 2017, after which the program will be subject to review. Temporary drum lines may be deployed anywhere in Western Australian waters at any time throughout the year until 30 April 2017.

The drum line configuration to be used for both the static and temporary drum lines will be similar to that shown in Figure 2 below. Further information on the specifications of the drum line configuration is detailed in the draft Management Plan (Appendix 2).

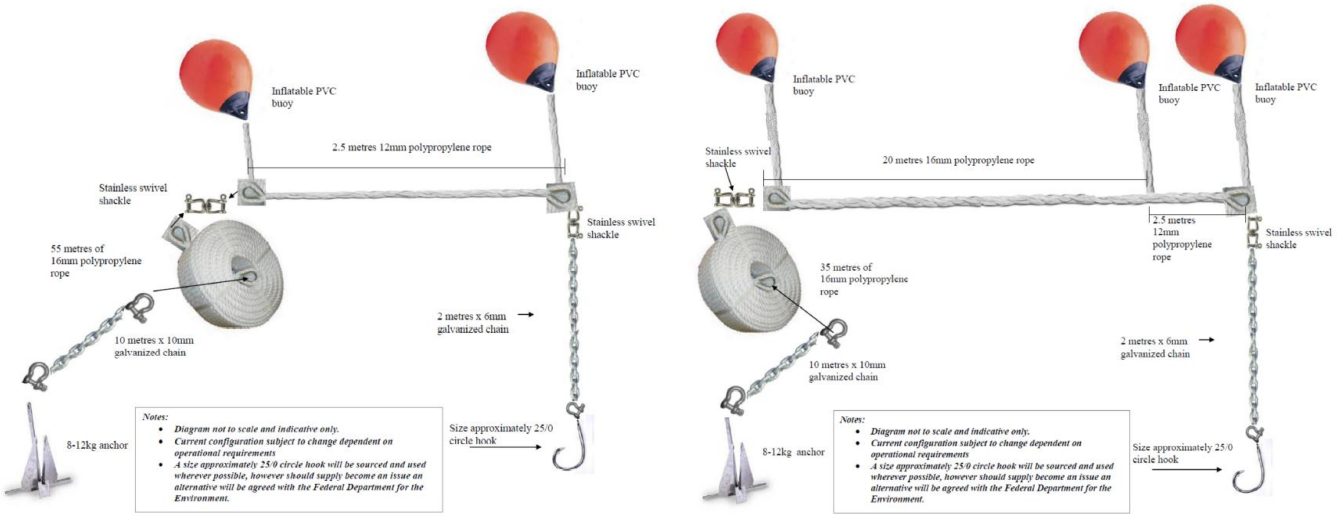

Figure 2. Example of the drum line configuration to be used for both the static drum lines and temporary drum lines.
A third float can be added to the rig for more effective handling of an animal, particularly in rough sea conditions (refer to the draft Management Plan for additional images)

Species targeted in the deployment of static drum lines are any white shark (*Carcharodon carcharias*), tiger shark (*Galeocerdo cuvier*) or bull shark (*Carcharhinus leucas*) with a total length of three metres or greater. In responding to a shark threat or incident anywhere in Western Australian waters, the shark posing a threat, or the shark understood to be responsible for an incident, may be targeted.[1]

Full details, including all operational aspects of the Proposal, are detailed in the draft Management Plan at Appendix 2.

[1] See Section 2.7 for legal framework.

2.2 Key characteristics

The Key Characteristics of the Proposal are provided in Table 1.

Table 1. Summary of the key characteristics of the Proposal

Proposal title	Western Australian Shark Hazard Mitigation Drum Line Program 2014-17	
Proponent name	The State of Western Australia (Department of the Premier and Cabinet)	
Project duration	**Static drum lines**: set between 15 November and 30 April each year for a period of three years, commencing 15 November 2014 and ceasing 30 April 2017. **Temporary drum lines**: may be set at any time throughout the year in response to identified shark threats or incidents until 30 April 2017.	
Short description	**Static drum lines**: Up to 60 static baited drum lines approximately 1km offshore of popular swimming beaches and surf breaks within MMAs in the metropolitan and south west coastal regions of Western Australia. Static drum lines will not be deployed in any marine recreational or sanctuary zones or Fish Habitat Protection Areas.[2] **Temporary drum lines**: may be set anywhere in Western Australian waters at any time in response to identified shark threats or incidents.	
Element	Location/Description	Authorised Extent
The placement of up to 60 static drum lines	Located within the MMAs as shown in Figure 3. Figure 4 - Metropolitan MMA: from Ocean Reef to Port Beach. Figure 5 - South west MMA: from Quindalup to Prevelly. The area of the metropolitan MMA is 34km² (3 400ha) and is 35km long. The total area of the south west MMA is 81km² (8 100ha) and covers 85km of the coastline. Drum lines will be set within a minimum of 28km² (2 800ha) of state waters and along 29km of the coastline, and within a maximum of 48km² (4 800ha) of state waters and along 52km of the coastline during the south west deployment.[3]	Metropolitan MMA: from Ocean Reef (-31° 44.6038', 115° 43.3727') to Port Beach (-32° 2.4354', 115° 44.4630'). South west MMA: from Quindalup (-33° 37.8569', 115° 8.9470') to Prevelly (-33° 58.9200', 114° 59.3834'). The two MMAs account for approximately 0.05-0.07% of all Western Australian waters and approximately 0.5-0.7% of the Western Australian coastline.
The deployment of temporary drum lines	Figure 6. Anywhere in Western Australian waters at any time in response to an identified shark threat or incident.	To 30 April 2017. Temporary lines would be monitored for up to one hour (per response) in response to a sighting and for up to one week (per incident) in response to an attack.
Target species	Static drum lines: Any white shark (*Carcharodon carcharias*), tiger shark (*Galeocerdo cuvier*) or bull shark (*Carcharhinus leucas*) with a total length of three metres or greater. Temporary drum lines: any shark posing a threat or understood to be responsible for an incident.	

[2] Static drum lines will not be deployed within any gazetted or proposed marine sanctuary zone or gazetted or proposed recreation zone in any Western Australian marine park as designated under the *Conservation and Land Management Act 1984.* Static drum lines will not be placed within any Fish Habitat Protection Area as designated under the *Fish Resources Management Act 1994.* Further details are contained in Section 2.5 and within the draft Management Plan.

[3] Details on the timings and extent of the south west deployment are contained within the draft Management Plan.

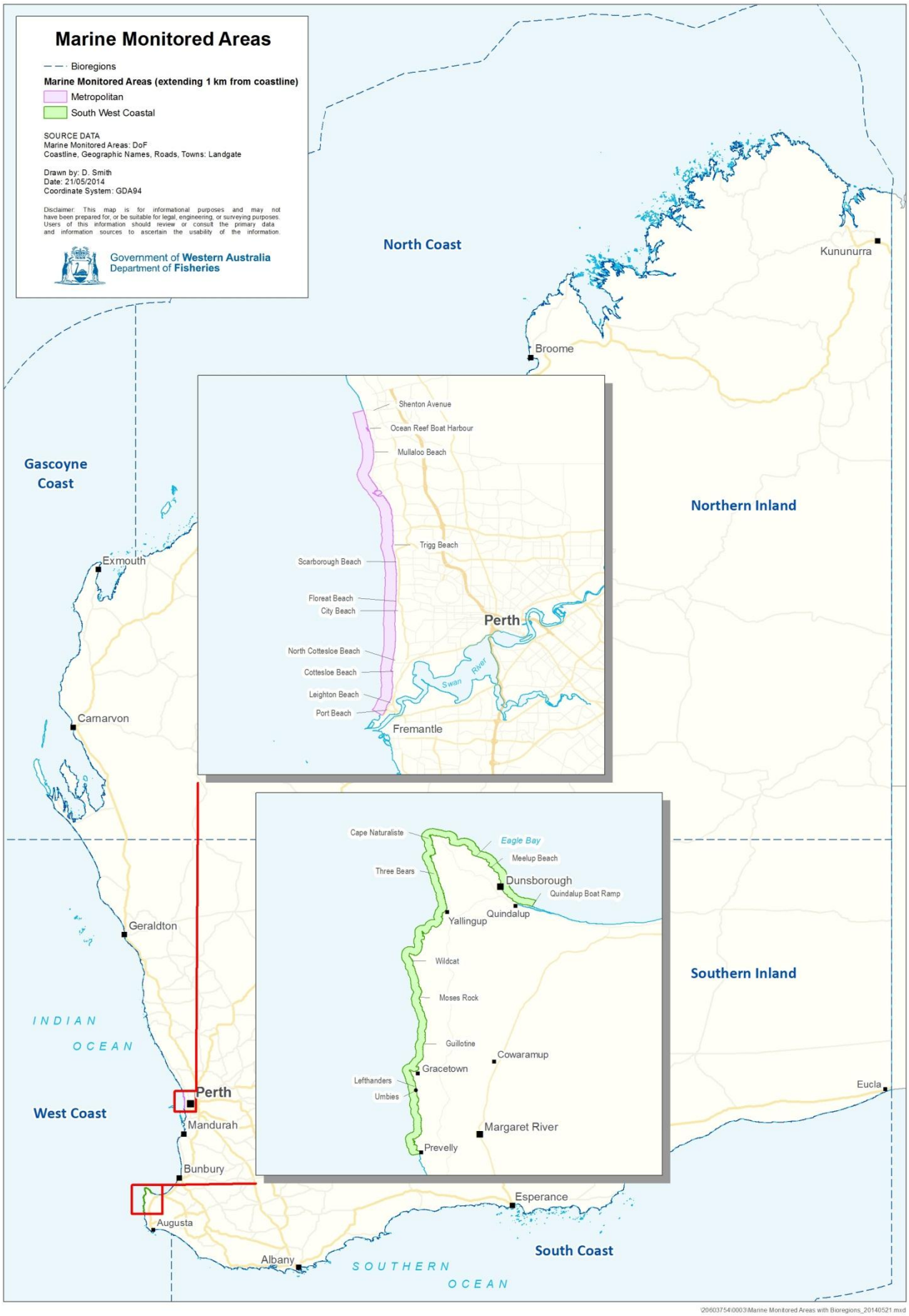

Figure 3. The metropolitan and south west region MMAs in relation to the State of Western Australia and fisheries management bioregions.

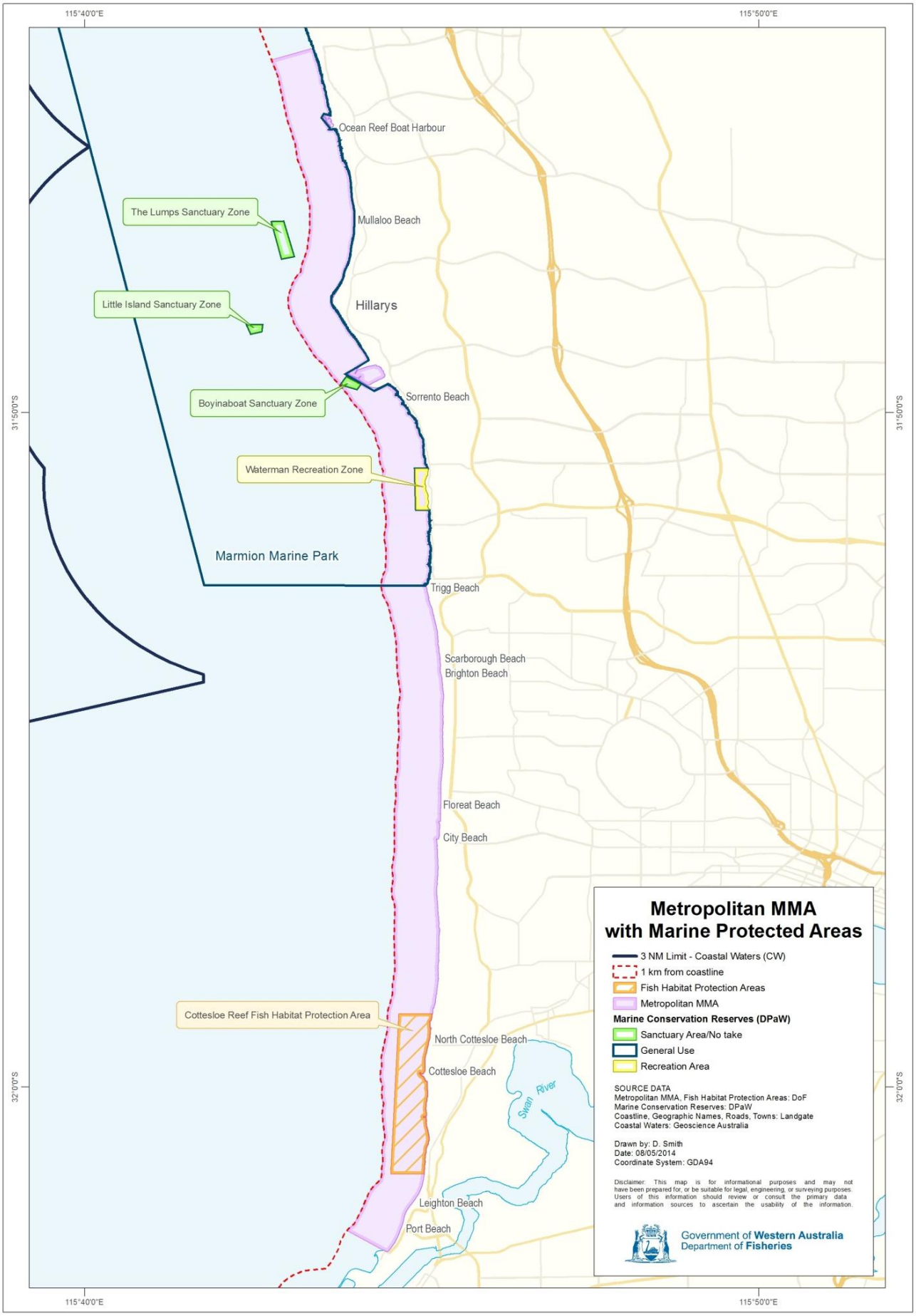

Figure 4. The metropolitan MMA showing the Marmion Marine Park sanctuary and recreation zones and the Cottesloe Fish Habitat Protection Area.

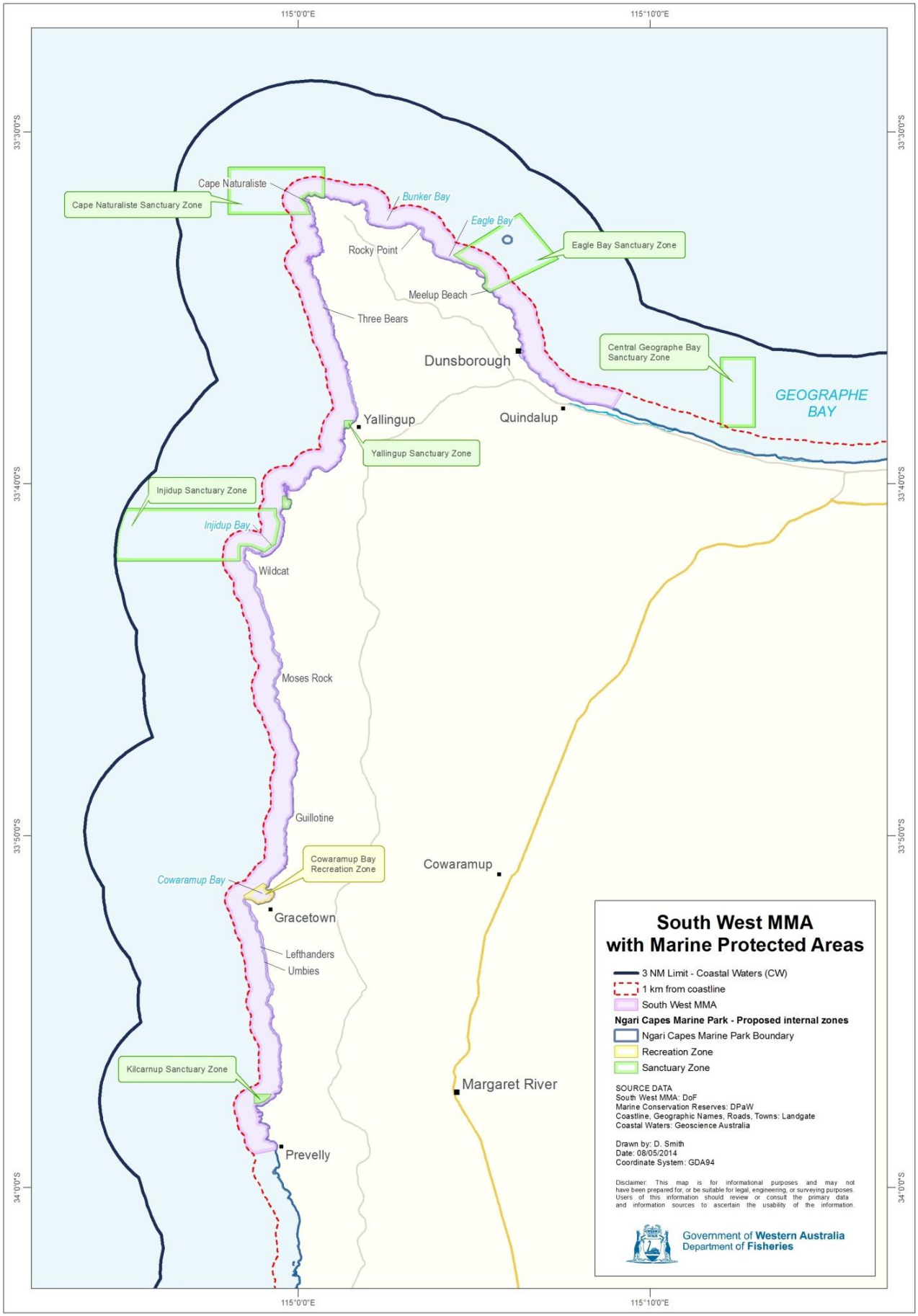

Figure 5. The south west MMA showing the Ngari Capes Marine Park gazetted and proposed sanctuary and recreation zones.

Figure 6. Western Australian state waters.
Western Australian waters are defined by Geoscience Australia as coastal waters between the territorial sea baseline, usually the low water line along the coast, and a line three nautical miles seaward from the baseline.

2.3 Potential environmental impacts from the deployment of temporary drum lines in response to an identified shark threat or incident.

The Proposal includes a provision for the deployment of temporary drum lines at any time throughout the year, anywhere in Western Australian waters in response to identified shark threats or incidents until 30 April 2017. Under these circumstances, and as determined by specific criteria (refer to the draft Management Plan at Appendix 2 and the "Guidelines for Fishing for Sharks Posing an Imminent Threat to Public Safety" at Appendix 3) either the contract vessel or a Department of Fisheries (DoF) vessel, dependent upon the location and time of the identified threat or incident, may attend the scene and deploy up to five baited drum lines. Drum lines would be set for a maximum of one hour (per response) in response to an identified threat, or for a maximum of one week (per incident) in response to an attack. In all cases, the small number of drum lines would be monitored closely for the restricted duration of their deployment.

Consideration has been given to the potential environmental impacts resulting from the temporary deployment of drum lines anywhere in Western Australian waters in response to a shark attack or a shark considered to be posing a threat to public safety at any time. The frequency with which a response is likely to be enacted is considered to be rare. Orders to deploy capture gear were issued by DoF on just three occasions between January 2013 and November 2013. In addition, during the 2013-14 summer trial drum line deployment program a direction to deploy temporary drum lines in response to a shark considered to be posing a threat to public safety was given five times. Of these, four were enacted in one day in response to the same shark moving southwards through near shore metropolitan waters. This constitutes eight deployments in more than 480 days, or roughly less than 2% of the time.

In the event that lines are deployed to target a specific shark, while the capture of a target shark cannot be guaranteed, lines would be closely monitored for the duration of their deployment to minimise any environmental impacts to non-target species. Drum lines deployed in response to a sighting would be monitored continuously for up to a maximum of one hour per response. Drum lines which are set in response to an attack would be closely monitored for up to a maximum of one week per incident.

The risk assessment examining the potential environmental impacts of deploying static drum lines between November and April for three years, as outlined in detail in Section 4.2.3 is used as a basis for assessing the potential environmental impacts of the setting of temporary drum lines anywhere in Western Australian waters at any time until 30 April 2017.

2.4 Alternatives considered

Prior to implementing the drum line program the Government considered a number of alternative options to offer enhanced protection from the risk of shark attack at popular swimming beaches and surf breaks during the peak usage summer months, while minimising impacts on environmental values.

2.4.1 Take no further action

The Government has committed more than $22million to 2015-16 for a broad range of shark hazard mitigation measures in direct response to the number of recent shark related fatalities. As shown in Figure 1, these measures include:

- aerial surveillance contracted through Surf Life Saving WA (2012-17);
- jet skis for enhanced beach patrols;
- construction of a watch tower at Cottesloe beach (metropolitan region);
- a Shark Response Unit to develop initiatives including:
  - legislative amendments to prohibit activities that may change the behaviour of sharks and attract sharks to major tourist or population areas;
  - a four year community engagement strategy to explore the use of community-based programs to contribute to public safety along the Western Australian coast;
  - the recently launched SharkSmart website www.sharksmart.com.au; and
  - the BeachSafe mobile app. with Surf Life Saving.
- research undertaken through DoF, including:
  - expansion of the Government's shark monitoring network;
  - a correlation study exploring possible links between shark sightings, interactions or attacks and locations, weather conditions, water temperatures and the activity of other marine mammals that might attract sharks (DoF 2012);
  - an examination of white shark population numbers; and
  - a beach netting study to look at the effectiveness of shark meshing, and shark exclusion barriers. This study formed the basis for the trial of a beach enclosure at Old Dunsborough.
- applied research programs to focus on non-lethal shark hazard detection and deterrent technologies; and
- an imminent threat policy to allow fishing for sharks for the purpose of public safety.

These measures represent a comprehensive set of shark hazard mitigation strategies. However, the death of a male surfer in November 2013 represented the seventh fatality in Western Australia in just over three years by shark attack, and consequently the option of simply maintaining the measures already in place and doing nothing more was considered unviable from a public safety perspective.

While taking no further action in addition to the measures already in place would not pose any risks to Marine Fauna or MNES, the requirement to address the issue of public safety could not be met.

2.4.2 The use of netting in addition to, or in place of, drum lines

In New South Wales, a total of 51 ocean beaches from Wollongong to Newcastle are currently netted between September and April each year using bottom-set mesh nets. This program has proven effective at reducing fatalities from shark attack, with only one death at a protected beach since the introduction of the Shark Meshing Program in 1937. The Shark Control Program operating in Queensland utilises a combination of approximately 366 drum lines and 6.5 km of nets along 85 beaches. In the 44 year history of the program there has been only one fatal shark attack at a protected beach. The province of KwaZulu-Natal in South Africa has a shark control program offering protection to 80 bathing areas over 320 km of coastline. The program uses a combination of nets and drum lines. The control program in KwaZulu-Natal has been effective in reducing the number of shark attacks in the province by 90% per annum (Curtis *et al.* 2012). Queensland and South Africa have both taken steps to replace a number of nets with drum lines as a means to reduce the capture of non-target species.

Evidence from these programs suggests that catch rates of non-target species are much lower on drum lines than in nets (Dudley *et al.,* 1998; Gribble *et al.* 1998; Cliff & Dudley 2011). The Government, in its consideration of the environmental impacts of its shark hazard mitigation measures, concluded that nets would not form part of the Proposal and that the exclusive use of a limited number of drum lines would offer the most effective protection for water users with the least environmental impact.

In considering the environmental impact of nets used in other jurisdictions, it is likely that implementation of this option would pose significantly greater impacts to Marine Fauna and MNES than the risks posed under the current Proposal. It is for this reason that nets were not included in the Proposal.

2.4.3 Shark proof beach enclosures

Following a study on the feasibility of beach enclosures the Government provided $165,370 to the City of Busselton and in January 2014 a trial enclosure was constructed at Old Dunsborough. The enclosure extended about 100 m from the shore, ran parallel with the beach for 300 m, and was constructed from heavy gauge netting. The specifications for the enclosure were similar to the barriers used successfully on the Gold Coast in Queensland and are designed to prevent sharks from entering the area.

A review of the trial enclosure is being conducted and a report will be provided to the Government in June 2014. Pending the outcome of the review, additional suitable areas for enclosures along the Western Australian coastline may be identified. However, it should be noted that beach enclosures are most effective at low energy beaches and are therefore not suited to all coastal environments. While the environmental impact of beach enclosures on Marine Fauna and MNES may be less than the risks posed under the Proposal, beach enclosures alone cannot provide an effective shark hazard mitigation measure at the majority of the popular swimming and surfing areas in the metropolitan and south west regions of Western Australia.

2.4.4 Shark deterrent technologies

The Government considered the promotion and subsidy of the SharkShield as a means to offering additional protection to water users. While the SharkShield device may provide protection for surfers and divers, and the impacts on Marine Fauna and MNES through the use of shark deterrent technologies may be less than the risks posed under the Proposal, the devices are unsuitable for use by swimmers in crowded areas, children, pregnant women and people fitted with pacemakers. The promotion of the device as a means to offering increased safety measures to water users at popular beaches, during peak usage months, was therefore not considered a viable option.

2.4.5 Expansion of the Shark Monitoring Network

The Government's Shark Monitoring Network (SMN) comprises 250 data recording and 24 satellite-linked real-time reporting devices. The program commenced in 2009 and more than 140 white sharks, 200 whaler sharks and 20 tiger sharks have been tagged with compatible acoustic transmitters. Since 2009, the satellite linked receivers have generated almost 700 detection alerts from which numerous beach closures have been instigated, contributing to beach user safety. The receiver network has benefited from additional government funding ($2.5million) and infrastructure roll outs which have significantly improved the number and geographic scale of both data logging and real-time receivers. This has not only provided an increase in real time detections, but also a unique dataset for white shark (and other shark species) movements around the south, south west and lower west coasts. Additional roll outs have taken place during the summer of 2013-14, supporting the importance the Government places on the receiver network. While the level of impact to Marine Fauna and MNES through the SMN may be lower than the risks posed under the Proposal, at the current level of coverage, and number of sharks tagged, it was considered the SMN could not be solely relied upon to provide sufficient protection from the risk of shark attack.

2.4.6 Catch and release program

Some jurisdictions, including New South Wales, have undertaken to release sharks captured as part of their shark control programs, including potentially dangerous species. The Government considered this approach as part of the Proposal, and considered the relative impact on Marine Fauna and MNES in employing a catch and release program. However, in considering public safety, determining acceptable release locations for potentially dangerous sharks would be challenging and present additional public liability risks. Moreover, transporting large sharks offshore is logistically difficult, with the additional stress placed on the animals from extended transport likely to lead to either mortality of sharks in transit, or decreased chance of post-release survival.

2.4.7 Beach closures

Beach closures are currently enacted in accordance with Surf Life Saving WA and Government guidelines and protocols. While beach closures are effective at reducing the level of risk to water users, anecdotal evidence provided by Surf Life Saving WA suggests that the more frequently beaches are closed, the less responsive and compliant beach users become. It has also been suggested that beach closures are considered an annoyance and frustration by water users, particularly on hot days, and are considered an impediment to public amenity. While the impacts to Marine Fauna and MNES may be lower by enacting beach closures than the risks posed under the Proposal, enhancing the criteria further for triggering beach closures in response to shark sightings was not considered a stand-alone viable alternative.

2.4.8 Target sharks smaller than three metres

In determining the size of shark to be targeted the Government looked to other shark control programs and available scientific literature for guidance. The Queensland Shark Control Program targets sharks greater than two metres. The shark control program in Recife, Brazil does not specify a size of shark, but targets Potentially Aggressive Sharks (PAS), defined by the International Shark Attack File as large sharks which have previously been implicated in unprovoked attacks on humans. South Africa does not stipulate a size of shark that is targeted in its shark control program.

The Government therefore considered the option of targeting sharks two metres or greater in total length. However, research also suggests that, white sharks in particular, experience a switch in diet from predominantly fish to a diet of mammals at approximately three metres in size (Estrada *et al*. 2006) and that these sharks are more likely to be associated with human interactions. In addition, when looking at the history of shark incidents in Western Australia, a significant number are believed to have involved sharks of approximately three metres in length or greater. In considering the research, and in an effort to address any potential impacts on shark populations and MNES, the Government therefore committed to targeting only white, tiger and bull sharks three metres or greater in total length on the static drum lines.

2.4.9 Extending period of deployment of drum lines beyond 30 April

The Government considered increasing the period of deployment of the drum lines into the winter months to coincide with increased prevalence of white sharks at a time when many surfers remain active users of the ocean. However, the Government is cognisant of the environmental factors to be considered in setting static drum lines through Western Australian waters during winter months. The Proposal has therefore been specifically developed to avoid entanglement with humpback and southern right whales which migrate annually along the Western Australian coast between May and October and minimise the impacts on Marine Fauna and MNES.

2.4.10 Extending period of Proposal beyond three years

The Government considered applying for approval to deploy static drum lines for a period longer than three years, and also considered an *ad infinitum* Proposal to align with the operations and legislative authority in other jurisdictions. The drum line element of the Government's overall shark hazard mitigation strategy is however not considered to be a permanent solution. With continued investment into research into shark ecology and biology and non-lethal deterrent and detection

technologies, it is hoped that at some time in the future drum lines may be able to be replaced with alternative mitigation measures.

2.4.11 Reduced monitoring of drum lines

The Proposal states drum lines are to be monitored between 6am and 6pm, seven days a week for the duration of the deployment. This represents a significant surveillance commitment compared to that employed in other jurisdictions. Reducing the level of servicing of drum lines, to either fewer hours each day, or fewer days each week, was an option for reducing the cost of the program. However, regular monitoring of drum lines increases the chance of successful release of bycatch and reduced stress on captured animals, and as such the Government committed to the monitoring of drum lines between 6am and 6pm seven days a week to minimise impacts on Marine Fauna and MNES.

2.5 Existing environment

2.5.1 Metropolitan region

The metropolitan MMA extends from Ocean Reef (-31° 44.6038', 115° 43.3727'), approximately 30 km north of Perth, to Port Beach (-32° 2.4354', 115° 44.4630'), approximately 20 km south of Perth (Figure 3). The metropolitan MMA incorporates the local government areas of the City of Fremantle, the Town of East Fremantle, the Town of Mosman Park, the Town of Cottesloe, the City of Nedlands, the Town of Cambridge, the City of Stirling and the City of Joondalup and adjoins one of the most densely populated coastal areas of south west Western Australia (DEWHA 2008).

Perth has a mediterranean climate, with warm to hot, dry summers and mild winters making it an ideal destination for outdoor activities (Table 2) (Tourism WA 2014). The strong "Fremantle Doctor" onshore breeze in the summer provides world class conditions for kite-surfing, windsurfing and sailing (LookatWA 2014).

The ecology of the metropolitan marine environment is heavily influenced by the Leeuwin current which carries sub-tropical and tropical species southward where they mix with temperate species brought northwards from the cool temperate waters of the south (Figure 7) (DEC 2007, DEWHA 2008, SEWPaC 2012b).

Marine habitats in the region include intertidal reef platforms, coastal sandy beaches, limestone reefs and complex assemblages of sea floor communities including seagrass meadows (CALM 1992). Offshore lagoons, protected by outer reefs also provide for a range of recreational opportunities for visitors including swimming, diving and fishing (CALM 1992). The marine environment also plays a critical role to a number of industries including commercial fishing (particularly for western rock lobster) (DEWHA 2008).

Table 2. Monthly climate summary statistics for the Perth region (BOM 2014a).

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years	
Temperature															
Mean maximum temperature (°C)	31.1	31.6	29.6	25.9	22.4	19.3	18.4	18.9	20.2	23.2	26.4	29.0	24.7	19	1994 -2013
Mean minimum temperature (°C)	18.1	18.3	16.5	13.8	10.5	8.6	7.6	8.0	9.4	11.4	14.2	16.4	12.7	19	1994 - 2013
Rainfall															
Mean rainfall (mm)	15.3	8.2	20.7	36.2	87.6	129.5	146.4	123.5	90.2	39.6	23.8	10.4	728.0	21	1993 - 2014
Decile 5 (median) rainfall (mm)	1.8	3.2	8.3	25.4	88.6	140.8	142.0	124.8	90.8	38.3	23.6	5.0	741.2	21	1993 - 2014
Mean number of days of rain ≥ 1 mm	1.5	1.0	2.3	4.5	8.6	12.3	14.3	13.0	11.5	5.1	3.9	2.1	80.1	21	1993 - 2014

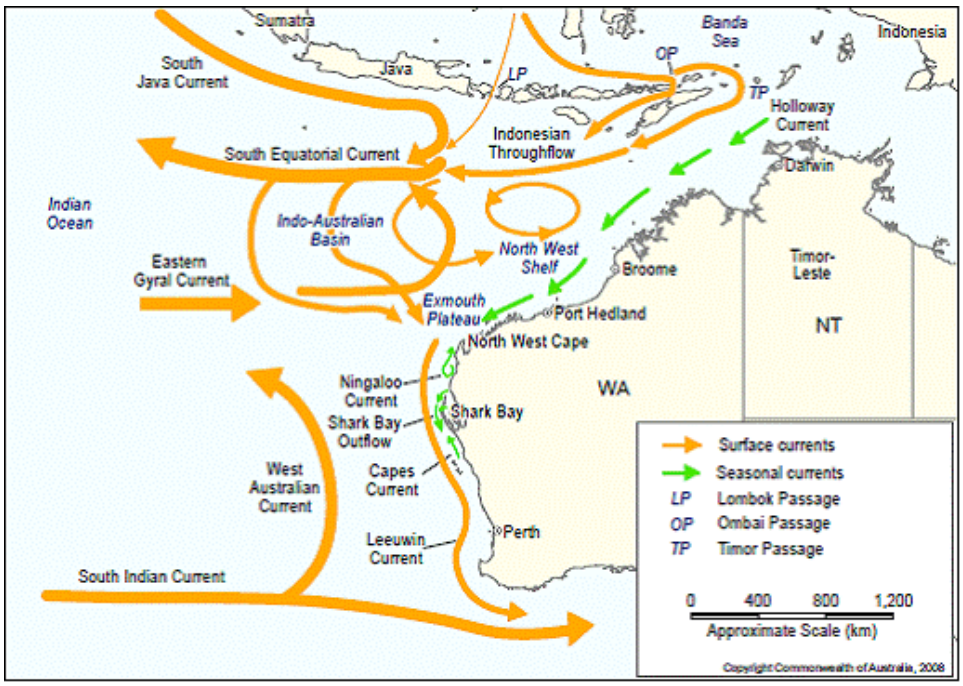

Figure 7. The influence of the Leeuwin current on the ecosystems and biodiversity of the Western Australian coastline.

(http://imos.org.au/httpimosorgauwasci1html.html)

2.5.2 Geographe Bay and the south west capes region

The south west MMA extends from Quindalup (-33° 37.8569', 115° 8.9470'), approximately 240 km south of Perth, to Prevelly (-33° 58.9200', 114° 59.3834'), approximately 280 km south of Perth (Figure 4). The south west MMA incorporates the shires of Busselton and Augusta-Margaret River.

The south west capes area has one of the fastest growing populations in Australia and is frequently visited by tourists (DEC 2013). The climate of the south west region is similar to that of the metropolitan region, with warm and sunny summers and cold and rainy but relatively mild winters (Table 3). The unique geographical location of this region exposes it to large, uninterrupted ocean swells and results in the south west capes being recognised as one of the world's premier surfing regions (SEWPaC 2012b, DEC 2013).

Marine life in the south west region is very diverse and is also influenced by the warm waters of the Leeuwin Current with the relatively sheltered Geographe Bay considered a marine biodiversity hotspot (DEWHA 2008). Tourism is a major growth industry in the area, with many recreational activities occurring in the region being marine based, including swimming, diving, surfing and snorkelling (DEC 2013). The region is also important for shipping, marine tourism and recreational and commercial fishing (DEWHA 2008).

Table 3. Monthly climate summary statistics for Busselton Shire (BOM 2014b).

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years	
Temperature															
Mean maximum temperature (°C)	28.5	28.4	26.1	22.8	19.3	17.3	16.3	16.7	18.1	20.1	23.6	26.5	22.0	76	1900 - 1975
Mean minimum temperature (°C)	13.8	14.0	12.7	10.7	9.2	8.3	7.5	7.5	8.4	9.3	10.9	12.5	10.4	75	1900 - 1975
Rainfall															
Mean rainfall (mm)	9.8	10.3	20.1	41.2	115.9	169.3	163.8	115.6	75.3	50.0	24.9	12.9	806.3	132	1877 - 2014
Decile 5 (median) rainfall (mm)	3.3	4.2	9.9	33.0	112.9	160.9	153.9	113.0	70.2	44.5	20.8	7.4	795.9	107	1877 - 2014
Mean number of days of rain ≥ 1 mm	1.1	1.3	2.1	4.2	8.4	11.3	12.7	11.2	8.8	6.4	3.5	1.7	72.7	104	1877 - 2014

2.5.3 Marine Protected Areas

Marmion Marine Park

The Marmion Marine Park was gazetted on 13 March 1987 and covers approximately 9,500 ha of State waters out to approximately 5.5 km between Trigg Island and Burns Beach in the metropolitan region (Figure 8) (CALM 1992). The marine park consists of general use zones, recreation zones and sanctuary zones. The Marmion Marine Park is declared under the *Conservation and Land Management Act 1984* and is managed by the Department of Parks and Wildlife (DPaW). Fishing activities in the marine park are regulated under the *Fish Resources Management Act 1994* (FRMA) and managed in collaboration with DoF.

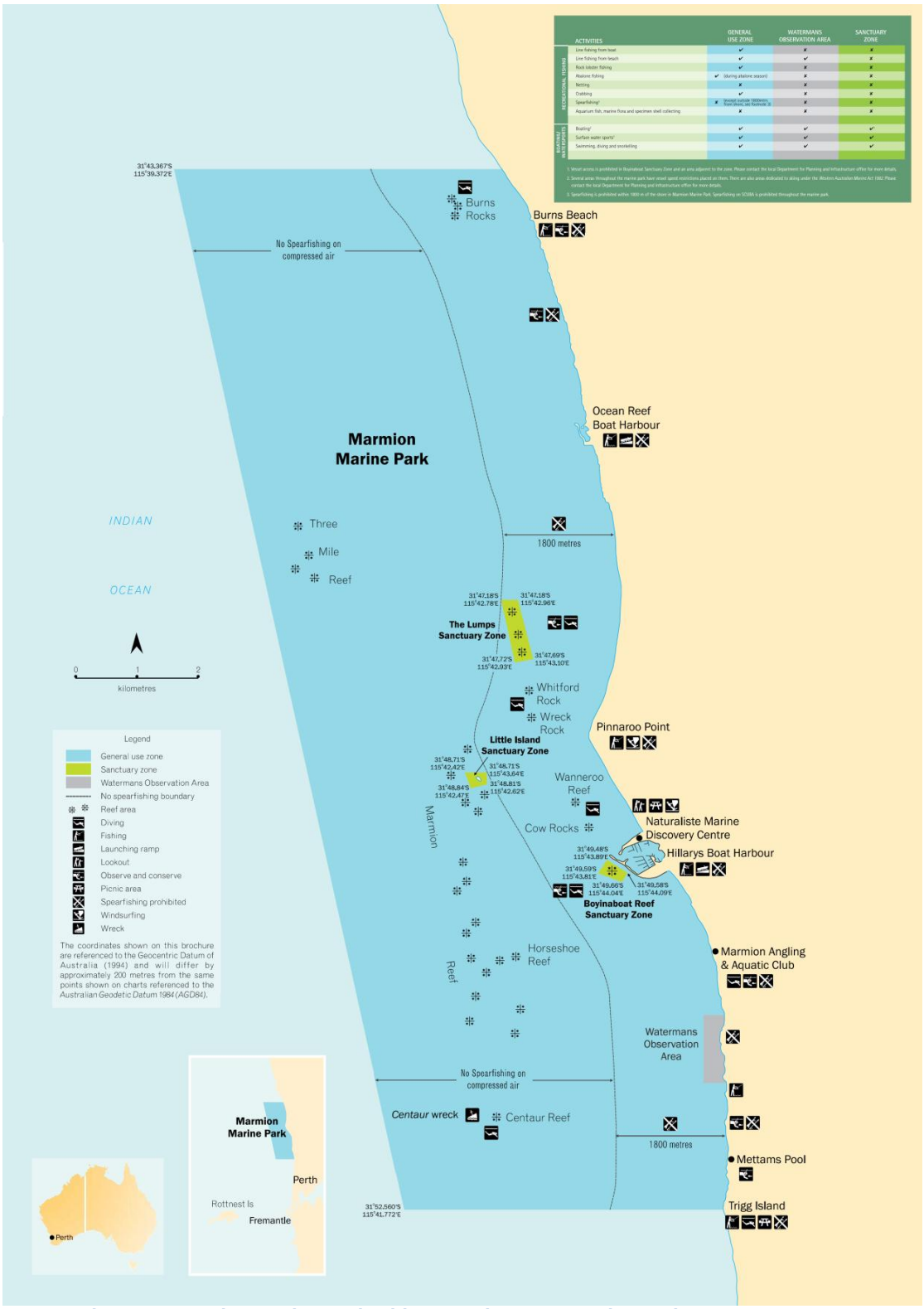

Figure 8. Marmion Marine Park with general use, recreation and sanctuary zones.

Cottesloe Fish Habitat Protection Area

The Cottesloe Fish Habitat Protection Area (FHPA), managed by DoF was ratified in 2001 and is designated under the FRMA. The FHPA stretches for approximately 4.4 km along Cottesloe beach and out 800 m westwards from the high watermark (Figure 9). The aim of the FHPA is to conserve the fish and habitats within the fringing reef system (DoF 2010).

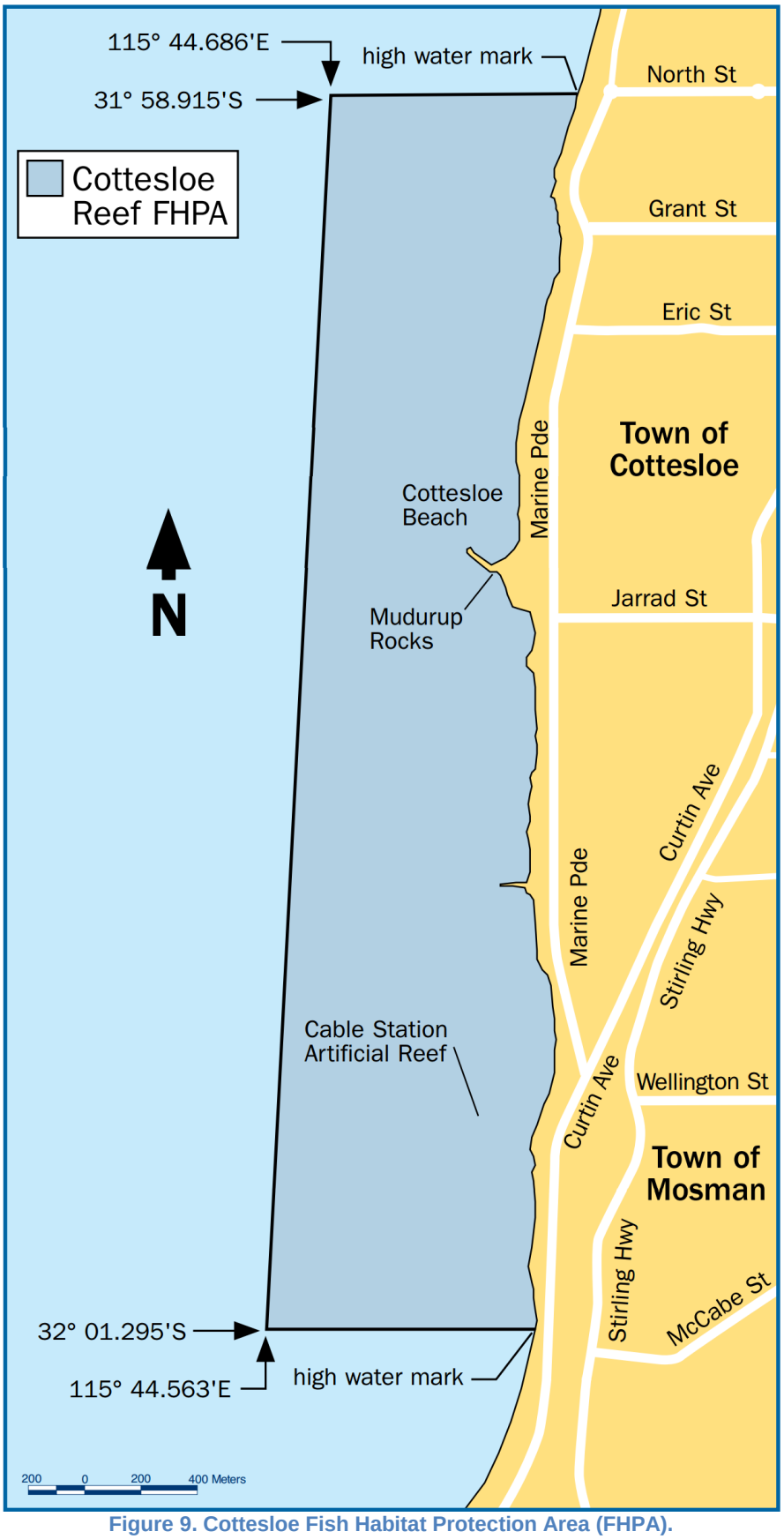

Figure 9. Cottesloe Fish Habitat Protection Area (FHPA).

Ngari Capes Marine Park

The Ngari Capes Marine Park is located in the south west of Western Australia, approximately 250 km south of Perth, and covers an area of approximately 123,790 ha. The marine park was gazetted in June 2012 and is zoned using one, or a combination of sanctuary, special purpose, recreation and general use zones (Figure 10). The Ngari Capes Marine Park is managed by DPaW.

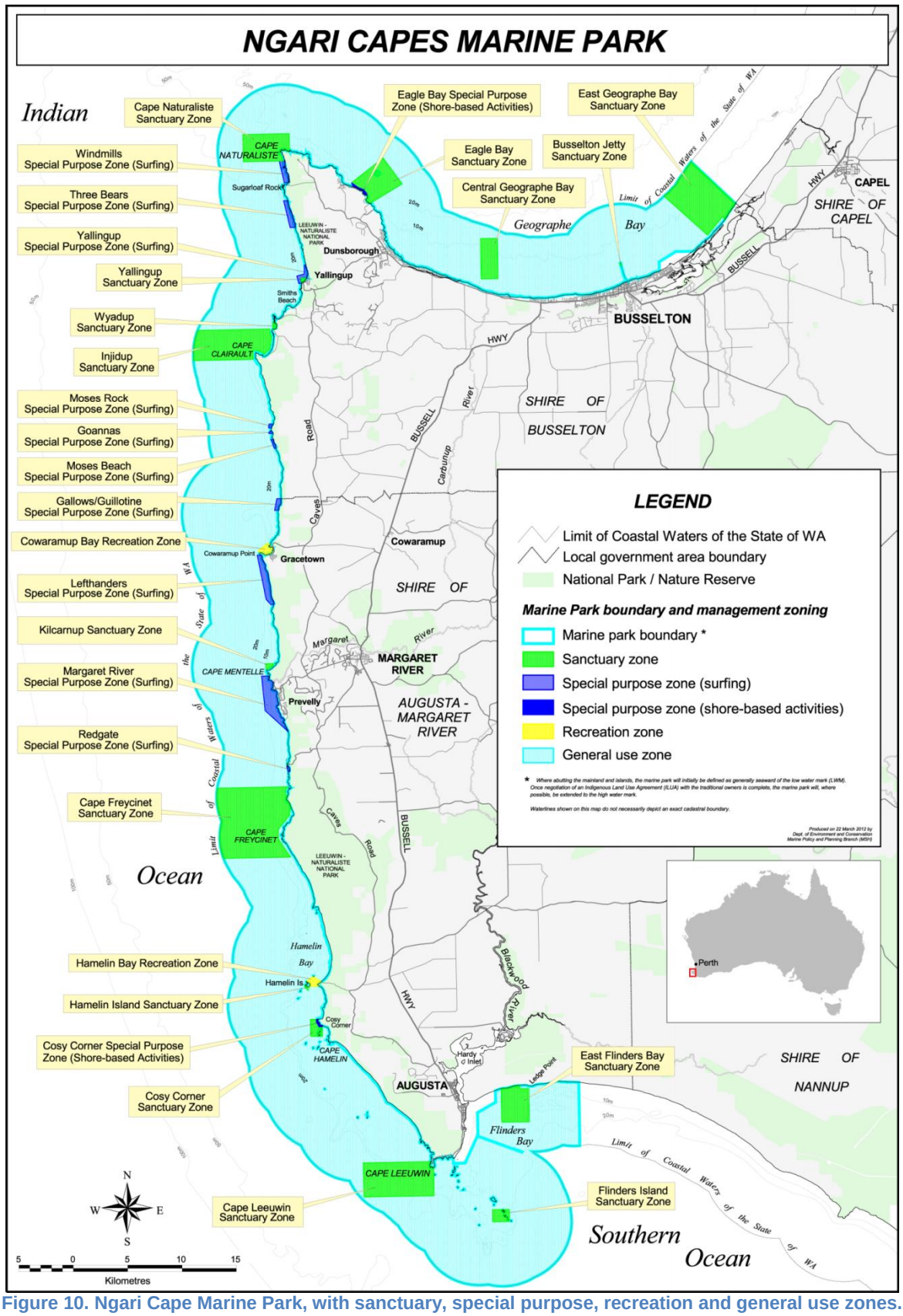

Figure 10. Ngari Cape Marine Park, with sanctuary, special purpose, recreation and general use zones.

The MMAs overlap with the Marmion Marine Park and Cottesloe Fish Habitat Protection Area (FHPA) in the metropolitan region (see Figure 8 and Figure 9) and with the Ngari Capes Marine Park in the south west region (see Figure 10).

Static drum lines will not be deployed within any gazetted or proposed marine sanctuary zone or gazetted or proposed marine recreation zone in any Western Australian marine parks as designated under the *Conservation and Land Management Act 1984*. Static drum lines will not be placed within any FHPA as designated under the FRMA.

Temporary drum lines may be set anywhere in Western Australian waters at any time, including within marine protected areas in response to an identified shark threat or incident.

As detailed in Section 5.1 of the draft Management Plan (see Appendix 2), if an identified shark threat or incident requires a response within a marine protected area, appropriate consultation will be held between the DoF Operations Manager and the Department of Parks and Wildlife (DPaW) prior to giving an order to deploy.

The frequency with which a response is likely to be enacted is anticipated to be rare. Orders to deploy capture gear in response to a shark considered to be posing a threat to public safety, or following an incident, were issued only eight times over more than 480 days between January 2013 and 30 April 2014.

In the event that temporary drum lines are deployed to target a specific shark, while the capture of a target shark cannot be guaranteed, lines would be closely monitored for the duration of their deployment to minimise any environmental impacts to non-target species. Drum lines deployed in response to a sighting would be monitored continuously up to a maximum of one hour per response. Drum lines which are set in response to an attack would be closely monitored for up to a maximum of one week per incident.

In considering the low frequency of when temporary drum lines may be deployed, the small number of lines that may be deployed (a maximum of five per response) and the high level of monitoring that will occur if they are deployed, it is considered that the setting of temporary drum lines in response to a shark attack or shark sighting considered to be posing a threat to public safety poses no risk to the ecological values associated with marine protected areas, and in particular sanctuary or recreation zones.

2.6 Relevant studies

Through the development of the shark hazard mitigation policy, the Government has commissioned a number of studies, including the examination of the social and community aspects of shark risk and ecological studies of white sharks. The studies completed either by the Government, or commissioned by the Government are listed below:

- DoF (2012). A correlation study of the potential risk factors associated with white shark attacks in Western Australian waters. Department of Fisheries, Fisheries Occasional Publication No 109 2012 (Appendix 4).

- McPhee, D.P. (2012). Likely effectiveness of netting or other capture programs as a shark hazard mitigation strategy in Western Australia. A report prepared for Department of Fisheries, Western Australia. Fisheries Occasional Publication No. 108, August 2012 (Appendix 5).

- DoF (2014a). Research advice on the Proposed Shark Mitigation Strategy using drum lines for January to April 2014. Department of Fisheries Research Division (2475/13) (Appendix 6).

- DoF (2014b). Review of the outcomes from the drum line component of the Shark Mitigation Strategy for the trial period January - April 2014. Report submitted to the Department of Premier and Cabinet, May 2014. Department of Fisheries, Western Australia (Appendix 7).

- DoF (2014c). Ecological Risk Assessment for the Proposed Western Australian Shark Hazard Mitigation Drum Line Program (2014-17). Department of Fisheries, Western Australia (Appendix 8).

- DoF (2014d). A risk-based, weight of evidence approach to determine the range of plausible estimates for the southwestern Australian population of white sharks. *Fisheries Research Report*, Department of Fisheries, Western Australia (Appendix 9)

Other studies that have been used to inform the Government on aspects of the shark hazard mitigation policy and assess potential environmental impacts from the Proposal are listed below:

- Cliff, G. and Dudley, S.F.J. (2011). Reducing the environmental impact of shark-control programs: a case study from KwaZulu-Natal, South Africa. *Marine and Freshwater Research*, **62**, 700-709 (Appendix 10).

- Dudley, S.F.J. and Gribble, N.A. (1999). Management of Shark Control Programs. In 'Case studies of the management of elasmobranch fisheries'. FAO Fisheries Technical Paper No 378 (Appendix 11).

- Godin, A.C., Carlson, J.K. and Burgener, V. (2012). The effect of circle hooks on shark catchability and at-vessel mortality rates in longline fisheries. *Bulletin of Marine Science,* **88 (3)**: 469-483 (Appendix 12).

- Green, M., Ganassin, C. and Reid, D.D. (2009). Report into the NSW Shark Meshing (Bather Protection) Program, New South Wales Department of Primary Industries, Sydney (Appendix 13).

- Queensland DPI (2006). Queensland Department of Primary Industries and Fisheries, A report on the Queensland Shark Safety Program (Appendix 14).

- SEWPaC (2013). Recovery plan for the white shark (*Carcharodon carcharias*) (2013). Commonwealth of Australia, Department of Sustainability, Environment, Water, Population and Communities (Appendix 15).

2.7 Legal framework

2.7.1 Environmental Protection Act 1986 (WA)

The EP Act governs environmental protection and impact assessment in Western Australia. In March 2014 the EPA provided a response to a third party referral of the 2013-14 Western Australian Shark Drum Line Deployment, Management and Associated Services. The EPA concluded that the EPAs objectives for Marine Fauna could be met with a high level of confidence due to the limited extent of the 2013-14 program in both duration and geographic footprint. The EPA considered the program was unlikely to have a significant effect on the environment and therefore did not warrant formal environmental impact assessment under the EP Act.

Subsequently, in April 2014 the Government referred the Proposal for a three year program to the EPA for assessment under Part IV of the EP Act. The EPA determined that the Proposal should be assessed at the level of PER with a four week public review period (see Section 1.2 for a full assessment pathway). The Environmental Scoping Document (ESD) provided to the Government by the EPA considered the preliminary key environmental factor to be considered in the PER to be Marine Fauna (EPA 2014a) (Appendix 1) and the ESD was further developed to incorporate the requirements of the bilateral assessment to include MNES.

2.7.2 Environment Protection and Biodiversity Conservation Act 1999 (Cth)

The EPBC Act is a Commonwealth Government Act administered by DoE. In January 2014 the Commonwealth Minister for the Environment granted an exemption to the State of Western Australia and those acting on behalf of the State of Western Australia from the application of all of the provisions of Part 3 of the EPBC Act to undertake drum lining operations to 30 April 2014. In granting the exemption the Commonwealth Minister for the Environment acknowledged the imminent threat to public safety and significant economic concerns associated with shark attacks.

Subsequently the Government referred a proposed action to DoE in April 2014 for assessment of a further three year program. The Commonwealth Minister for the Environment announced the proposed action to be considered a 'controlled action' in respect of the white shark being listed as vulnerable under s 178 and migratory under s 209, and the following MNES protected under the EPBC Act:

- listed threatened species and communities (ss 18 and 18A); and
- listed migratory species (ss 20 and 20A).

In May 2014, under s 75 of the EPBC Act, the Commonwealth Minister for the Environment announced the assessment approach to be under bilateral agreement with the EPA. This allows matters considered under the EPBC Act to be addressed within the PER and assessed by the EPA. In deciding whether or not to approve the Proposal consideration must be given to s 139 and s 140 of the EPBC Act, which address requirements about decisions relating to threatened species and endangered communities and decisions relating to migratory species respectively. If the Proposal is approved, the Commonwealth Minister for the Environment may choose to set conditions under which the Proposal must be implemented.

2.7.3 Fish Resources Management Act 1994 (WA)

Under the FRMA white sharks are prescribed as 'totally protected fish' and cannot be taken, held in possession, sold or purchased or consigned. Similarly, all whaler sharks with an interdorsal fin measurement greater than 70 cm are 'totally protected fish' (tiger sharks and bull sharks are members of the whaler family). Section 7 of the FRMA provides that the Western Australian Minister for Fisheries may, by instrument in writing, exempt a specified person or class of persons from all or any provisions of that Act.

An exemption from all provisions of the FRMA was granted by the then Minister for Fisheries in November 2012 to allow for the take and possession and landing of white sharks (*Carcharodon carcharias*) in the waters of Western Australia and whaler sharks (Family Carcharhinidae) with an interdorsal fin measurement of 70 cm or greater in the waters of the West Coast and South Coast

regions. The exemption allows for the capture of sharks deployed on temporary drum lines in response to a shark identified as posing a threat to public safety or following an attack.

A further exemption from the FRMA was granted by the Western Australian Minister for Fisheries in January 2014 to allow for the drum lining operations to 30 April 2014 for the purpose of public safety. A further exemption from the provisions of the FRMA will be sought to allow for the deployment of drum lines between 15 November and 30 April for three years, commencing 15 November 2014 and ceasing 30 April 2017.

Appropriate exemptions under the FRMA to deploy temporary drum lines in response to a shark posing an imminent threat or in response to an incident between 1 May and 14 November each year to 2017, will also be sought at a State level.

2.7.4 Wildlife Conservation Act 1950 (WA)

Under the Western Australian *Wildlife Conservation Act 1950* (WC Act), the white shark is fauna which is wholly protected throughout the state of Western Australia under s 14(1) and is declared to be in need of special protection under s 14(4). Without proper authority, a person capturing and killing a white shark commits an offence under ss 16(1) and 17(2) of the WC Act.

In January 2014, under regulation 15 of the *Wildlife Conservation Regulations 1970* (WC Regs) the Director General of DPaW issued a Licence to Take Fauna for Public Purposes to the contractor engaged to undertake the 2013-14 drum lining activities in the south west region. The licence expired on 1 May 2014. Contractors engaged to undertake the drum lining activities as part of the Proposal will be required to apply for relevant licences to take fauna under the WC Regs.

As agents acting for the Crown, Fisheries Officers and other agency officers are not required to apply for a licence to take fauna under the *Wildlife Conservation Act 1950* (WC Act) and *Wildlife Conservation Regulations 1970* (WC Regulations).

3 STAKEHOLDER CONSULTATION

3.1 Overview

The Government has consulted with a range of stakeholders and interest groups, both during the development of the policy in December 2013, and following the trial drum line program in May 2014. Consultation was undertaken in the form of face-to-face meetings, telephone conversations and emails.

The purpose of the consultation was to inform and involve interested parties and stakeholders and to address and listen to their concerns. The Government is committed to providing factual and objective information on the Proposal and to seeking constructive feedback and listening to concerns relating to the drum line operations. The Government has committed to being accessible and responding to stakeholder concerns as far as has been practicable throughout the program.

A summary of the stakeholders consulted in December 2013 and May 2014 is at Table 4 and a summary of the key matters raised during consultation and responses to each concern is at Table 5.

The Conservation Council of Western Australia and Sea Shepherd Australia were not directly consulted, having made their position clear through information offered on their websites and legal action brought against the State.

With respect to the Conservation Council of Western Australia the following was extracted from their website on 14 May 2014:

> *'The WA Government has announced a brutal policy to kill endangered White sharks in the hope this will reduce the incidence of shark attack on WA beaches.*
>
> *There is no scientific evidence that culling endangered sharks using baited drum lines would reduce the already very low risk of shark attack.*
>
> *Baited hooks used to kill sharks will also kill other marine life including turtles, dolphins and other non-target sharks. These animals will inevitably die after prolonged suffering.*
>
> *Non-lethal methods such as early detection, alarm systems, community education and increased scientific research should be much higher priorities than the indiscriminate killing of sharks and other marine animals'*

Sea Shepherd Australia's website offers 11 separate news items between 26 January 2014 and 8 May 2014, with the general proposition that there should be a stop to the Western Australian Government's drum line component of its overall shark hazard mitigation strategy.

Table 4. Stakeholders consulted by the Western Australian Government to June 2014

Category	Stakeholder
Local government agencies	Shire of Augusta-Margaret River
	Shire of Busselton
	City of Bunbury
	Shire of Capel
	Shire of Harvey
State government agencies	Department of Fisheries (DoF)
	Department of Parks and Wildlife (DPaW)
	Department of Transport (DoT)
	Department of Fire and Emergency Services (DFES)
	WA Police (WAPol)
	EventsCorp WA
	Queensland Department of Primary Industries (QDPI)
Interested groups and organisations	Bouvard Fisheries
	The West Australian Fishing Industry Council (WAFIC)
	RecFishWest
	University of Western Australia (Oceans Institute) (UWA)
	Surf Life Saving WA
	Surfing WA
	Western Australian Marine Science Institution (WAMSI)
	WA Sports Federation
	Open ocean swimmers
	Wildlife Marine
	Private consultant
	Margaret River Board Riders Club
	Yallingup Board Riders Club
	Margaret River Recreational Surfers
	Margaret River recreational surfers (3)
	WA Undersea Club
	Bond University
	University of Sydney
	WA Abalone Industry
	Mullaloo Surf Club
	James Cook University, Queensland (JCU)
	Marine Conservation Science Institute
	West Australians for Shark Conservation (WASC)
	Fisheries Research and Development Corporation (FRDC)
	Commercial fishers
	Recreational water users
	PADI Aware
	Environmental consultant
	Curtin University (Marine Science and Technology Centre)

Table 5. Major matters raised during stakeholder consultation and responses to each concern.

Matters raised	Raised by	Response by the Western Australian Government
Effectiveness of program		
Program has not been effective as it has not caught a white shark/Program cannot reduce the risk of shark attack, even if white sharks are caught.	UWA, Wildlife Marine, WAMSI, JCU	The drum line program is designed to offer an additional shark hazard mitigation measure at select high use swimming beaches and surf spots at peak times of the year. The Government did not necessarily expect to catch a white shark between January and April, however 50 tiger sharks ≥3m in total length were removed from the vicinity of popular swimming beaches, with the largest being a 4.5m tiger shark in the metropolitan region and a 4.2m shark in Geographe Bay. The Proposal requests future deployments to begin on 15 November, thereby increasing the potential for capturing a white shark and providing extended coverage into the early summer months.
Drum lines have been effective in restoring confidence to water users, including the visual aspect of seeing the gear and/or vessel on the water.	Open ocean swimmers, Margaret River Recreational Surfers, Surfing WA, Bouvard Fisheries, Surf Life Saving WA, WA Sports Federation	Noted.
Access to animals for research		
Would be a benefit of the program if carcasses could be used or samples/specimen taken.	UWA, Curtin University, WA Undersea Club, Open ocean swimmers, Wildlife Marine, Bouvard Fisheries, WA Sports Federation	There were restrictions on access to animals during the trial program due to legislative conditions. Access to animals for research has been requested as part of the Proposal and will be facilitated wherever possible. The Government is committed to making the best use of animals caught as part of the Proposal. The Government is appreciative of proactive advice provided on potential measures to quickly preserve tissues following capture. Logistical issues including, but not limited to, transport and storage still need to be addressed.
Activism and personal safety		
Supporters of the program had no choice but to stay quiet due to the level of abuse and vilification received. Level of personal attack and social media postings were unacceptable	Open ocean swimmers, Margaret River recreational surfers, WA Sports Federation, private consultant, DoF	The Government is now more acutely aware of the level of abuse that was directed towards supporters of the program and the reasons for so many staying silent. It is proposed to better utilise the media and other outlets to provide information and facts on the program to facilitate better informed public discussion on the issue of human-shark interactions.

Period of deployment of drum lines		
Belief that drum lines should be deployed throughout the winter months, particularly in the south west.	WA Undersea Club, Open ocean swimmers, Margaret River Recreational Surfers, Margaret River recreational surfers, Surfing WA, private consultant	The Government is cognisant of the environmental impacts of setting drum lines through the winter months and potential for interactions with migrating whales along the Western Australian coastline. It is hoped that in time, other options including shark deterrent and detection measures, may become available to offer water users additional protection through the winter months.
Research		
Research into white shark behaviour, detection and deterrent technologies and general shark ecology should continue.	UWA, Curtin, WA Undersea Club, Margaret River recreational surfers	The Government is hopeful that applied research programs will offer effective alternative deterrent and detection options to the drum lines. Research in Western Australia into white shark populations and aggregation areas is continuing, with a joint Commonwealth funded program (CSIRO and DoF) continuing into 2014-15. In the absence of effective alternatives, drum lines offer an additional protective measure to the measures already implemented in the overall shark hazard mitigation strategy.
Should be employing a tag, tow and release program, rather than a destructive program for target species.	UWA	Three tiger sharks were fitted with acoustic tags during the trial program, one of which died shortly after. Further acoustic tagging may be incorporated into future deployments. Consideration needs to be given to the condition of the animal and an assessment of its ability to withstand the stress of surgery. The Government considered a tag and release program, however this raises additional public liability risks of releasing a potentially dangerous shark.
Target species		
Some concern at tiger sharks being targeted due to no recent incidents involving tiger sharks in metropolitan and south west waters.	WA Undersea Club, UWA, Wildlife Marine	Tiger sharks are confirmed as responsible for eight fatalities in Australia since 1925, with the most recent in New South Wales in late 2013. Tiger sharks are also considered most likely to be responsible for a further 54 fatalities in Australian waters since 1916. They are listed as one of the top three most dangerous sharks in the world.
Believe tiger sharks are possibly responsible for more attacks in Western Australian waters than is reported. Level of evidence to attribute responsibility to white shark is insufficient to discount the possibility of tiger shark involvement.	Margaret River Recreational Surfers, Environmental consultant, private consultant	Tiger sharks are listed as one of the top three most dangerous sharks in the world. The Government cannot ignore them as a potentially dangerous species, especially given their increasing presence in southwestern Western Australian waters.

Gear modifications		
Need to find a way to reduce interactions with tiger sharks and increase interactions with white sharks (i.e. modifications to bait/gear).	WA Undersea Club	The Government has listened to suggestions for gear modifications and bait and will implement where appropriate and/or legislatively permissible.
Should be using better bait i.e. mammals (marine and terrestrial)	Curtin, Margaret River recreational surfers, Open ocean swimmers	Not permitted under State and Federal legislation. Restrictions on the type of baits that are permitted.
Options for making slight gear modifications to reduce stress to animals (i.e. longer tethers on hook line and use of slings).	Bouvard Fisheries, DoF, UWA,	The Government has listened to suggestions for gear modifications and is looking to lengthen the tether on hook lines wherever appropriate.
Public information and media		
Community awareness information needs to be improved (Sharksmart website could be better/possible info for fishers).	Surf Life Saving WA, RecFishWest,	The Government has taken this on board and is taking steps to improve public communications.
Community organisations could be used to disseminate information about the drum lining program and shark safety in general.	Surfing WA, WA Sports Federation, Surf Life Saving WA	The Government will look to work more closely with community organisations to better disseminate accurate information relating to the Government's overall shark hazard mitigation strategy.
Media messages need to be more proactive and better structured (significant amount of mis-information in the public domain) and better pre-operational briefings for interested/affected parties.	Bouvard Fisheries, DoF, WAFIC, Surf Life Saving WA, EventsCorp WA, WA Sports Federation, Surfing WA, Environmental consultant, Open ocean swimmers, private consultant	With greater lead in time to a November deployment the Government anticipates more proactive briefings and pre-deployment meetings to be possible.
Impacts on local business/communities		
Local businesses are suffering from recent spate of shark attacks/ Concern that level of public engagement can negatively impact on tourism.	Margaret River Boardriders, Margaret River recreational surfers	The Government did not have the option of waiting for empirical statistical data before taking steps to counter potential negative impacts on businesses and industries. The Government hopes that the drum line program will go some way to restore confidence in water users and tourists to the regions.
Training		
Need to provide better pre-operational training (animal handling/data recording/photographic records etc.)	DoF, WAFIC	With a greater lead in time to a November deployment the Government is committed to providing comprehensive pre-deployment training for the appointed contractors.
Placement of drum lines		
Concerns from some surfers that drum lines were too close to surf breaks	Margaret River Recreational Surfers	The Government responded to concerns during the trial program and re-deployed drum lines to more suitable areas around surf breaks, however no further than 1km offshore as per the Commonwealth exemption requirements. The Government has worked to allow for some flexibility in the placement of drum lines, particularly near surf breaks, in the Proposal design.

3.2 Findings of stakeholder consultation

Feedback from consultations held in May 2014 focused on operational matters and program considerations in both reviewing the trial drum line program and in considering the three year program proposal. The following is a synopsis of the feedback received.

3.2.1 Operational matters

- Significant media and public interest should have been dealt with more effectively. More publically available information in a variety of formats should be made available for inclusion in industry and association newsletters, public announcements in newspapers and appropriate websites, literature (sticker and/ pamphlet) for boat users, and literature (pamphlet) for distribution through dive, surf, and tackle shops. The suggestion of pamphlets was not unanimously supported as it may give a perception of a problem which conversely could impact on businesses.
- Specific improvements/suggestions to gear, bait and operations including:
    - shortening of anchor rope;
    - use of a wire trace instead of chain;
    - more swivels to prevent twisting of ropes;
    - black rope to be replaced because it is harder to see and encourages growth on lines;
    - use of bonito and southern blue fin tuna which were found to be successful;
    - longer hook lines to enable animals to swim more freely and reduce stress;
    - ramps on vessels to reduce stress on animals;
    - pumping of sea water over the gills of captured animals; and
    - greater flexibility in hours of operation.
- More intensive training to be provided to contractors at the commencement of the program to agree on standard descriptions, terminology and protocols for measurements, photographs and other logistical requirements.
- Surfing organisations generally support the Government's shark hazard mitigation policy. Some surfers expressed concerns at the distance of drum lines from surf breaks.
- Mammals or fatty meat should be used as bait (it was noted to advocates of this idea that the use of mammal as bait is prohibited).

3.2.2 Program

- The rationale for the program is understood but the program had not been effective in reducing the risk of shark attack as no white sharks had been caught. A catch and release policy similar to that employed in Brazil was advocated.
- Interest expressed in obtaining specimens for research from the program, however acknowledged logistical issues of obtaining fresh samples. Assistance offered in providing information on animal handling techniques to reduce stress in captured animals.
- Collection of additional information including status of bait (e.g. time on the hook), hook location on animal, additional animal measurements and more detailed description of shark status on release would prove beneficial to long term data analyses.
- The program was well considered and effective in minimising environmental impacts, including demonstrated low levels of bycatch.
- Number of sharks likely to increase as the potential for sick and injured whales also increases.
- It is hoped that current research programs will lead to effective alternative measures to the drum lining program.
- A briefing directly to commercial fishers could have assisted in gaining support for, and providing a better understanding of, the drum lining program.
- Water users felt safer because of visual references - contractor and DoF vessel on the water, aerial patrols overhead and jet skis in use. Conversely, the sight of drum lines and the contractor and the DoF vessels made some water users nervous.
- Organisers of water based events, especially those with interstate and international participants, were concerned about the perceived shark problem in Western Australia as reported in mainstream and social media, and not specifically the drum line policy.

- There is anecdotal evidence of an increase in confidence of water users over the summer period.
- Drum lines are not a solution in themselves, but are useful as part of a multi-faceted strategy and there should be greater promotion of the various elements of the Government's overall strategy.
- Drum lines should go in earlier (during winter months) and the need for a fast response boat to deal with shark threats more quickly, especially in the south west.
- Tiger sharks should not be targeted because they are essentially scavengers and not shown to be responsible for recent attacks. Conversely some commenters singled out tiger sharks as highly dangerous and potentially attributable to more fatalities than is currently recorded.
- A 14 week trial is insufficient to determine the success or otherwise of the program, and a lengthier implementation over a number of years is more appropriate from a science and research perspective.

3.2.3 Other

- Misinformation, offensive allegations, abuse and baseless attacks on contractors through social media were difficult to address.
- People supporting the drum lining program have stayed silent due to the high level of abuse and vilification received.
- There were difficulties in sourcing bait, and salmon appeared to attract rays. Demersal heads and frames seemed most effective in the metropolitan region. Sharks caught on the lines that are not commercially or totally protected should be considered for use as bait.
- The SharkSmart website could be better promoted to more effectively provide community awareness information.
- Debate on the issue has been clouded by emotional responses and disproportionate media coverage.

The main themes emerging from the consultation were that there is a need for more research, the trial program was effective at minimising environmental impacts, the level of misinformation needs to be addressed, media coverage and tone were disproportionate to the issue, water user groups generally supported the program and researchers generally did not. It should be noted that facts and data were not always agreed upon and at times contradicted. There was also a lack of understanding or knowledge of the Government's overall shark hazard mitigation strategy and shark control programs in other jurisdictions.

3.2.4 Regional consultation

Officers from DPC and DoF met with representatives of local government councils in the south west on 10 March 2014 to discuss support for regional centres as part of an overall shark hazard mitigation strategy. Concern was expressed by some at not having a clear set of guidelines to enact beach enclosures, whereas others were satisfied with the processes they had in place. There were also issues raised about the text messaging system for shark sightings, support from Surf Life Saving WA in the south west and need for standardisation of signage.

In response to the issues raised in the meeting the following occurred:

- Information was provided to the south west councils on the text messaging system for shark sightings - it was clarified how the system works, who gets the messages and how they are accepted and disseminated.
- Information was provided on factors to consider in taking precautionary actions with respect to shark sightings, emphasising however in the absence of patrolled beaches, local factors such as time of day, water usage, water conditions, and other priorities would also provide the context for such decisions.
- Information was provided on Surf Life Saving WA's prescribed protocols for securing beaches for councils to use should they wish to adapt their processes.

- Contact was made between the Shire of Augusta and Margaret River and Surf Life Saving WA to explore the possibility of Surf Life Saving WA's twitter feeds being incorporated into a phone application being developed by the Shire.
- DPC has raised the issue of extended coverage in the south west by Surf Life Saving WA and it is understood that opportunities exist for aerial patrols to be extended in 2014-15, and then again in 2015-16. However, a Surf Life Saving WA patrolled beach option is more difficult to implement because essentially this relies on a significant volunteer base.
- Another meeting with local councils, DPC, DoF, Surf Life Saving WA and others is being organised by the Shire of Augusta-Margaret River for later in 2014 to further explore issues and responses.

4 ENVIRONMENTAL IMPACT ASSESSMENT

4.1 Identification of Preliminary Key Environmental Factors

In the ESD, the EPA identified Marine Fauna as the preliminary key environmental factor requiring assessment under the PER (EPA 2014a) (Appendix 1).

In May 2014, the Commonwealth Minister for the Environment announced his decision that the project was considered a 'controlled action' in respect of the white shark being listed as vulnerable under s 178 and migratory under s 209, and the following MNES protected by the EPBC Act:

- listed threatened species and communities (ss 18 and 18A); and
- listed migratory species (ss 20 and 20A).

The threatened species which may be present in the two MMAs include:

- birds, including various species of albatross and petrel;
- mammals, including whales and sea lions;
- turtles; and
- sharks including the grey nurse shark and the white shark.

The migratory species which may be present in the two MMAs include:

- birds, including various species of albatross and tern;
- whales and dolphins;
- turtles and rays; and
- sharks including the white shark and the porbeagle mackerel shark.

For full reports from the EPBC Act Protected Matters database please refer to Appendix 16 (metropolitan MMA) and Appendix 17 (south west MMA).

Following the Commonwealth announcement to enter into a bilateral assessment process (see Section 2.7.2) the ESD was developed to incorporate the above listed MNES. Impacts to MNES are included in the risk assessment provided at Section 4.2.3 and a summary is provided at Section 5.

The definition of 'environment' under s 528 of the EPBC Act includes 'ecosystems and their constituent parts, including people and communities' and allows for consideration of 'social, economic and cultural aspects' (SEWPaC 2012a). The socio-economic element of the drum lining program; the potential impacts relating to humans, Western Australian culture and its economy through human-shark interactions and the potential consequences of not proceeding with the action, are therefore also considered in the context of the environmental impact assessment at Section 4.4.

4.2 Marine Fauna

The EPA's objective for Marine Fauna is 'to maintain the diversity, geographic distribution and viability of fauna at the species and population levels' (EPA 2013).

Catch data from the 2013-14 drum line program, a risk assessment of the potential impacts of a three year program together with an examination of the cumulative impacts of the program and a determination of the acceptable range of catch of target sharks are examined to address the ability of the Proposal to meet the EPA and Commonwealth objectives for Marine Fauna and MNES.

4.2.1 Catch data from 25 January to 30 April 2014

The following is an analysis of the catch data undertaken by DoF (see Appendix 7 for the full report) for the 14 weeks over which the trial program operated. It is largely descriptive as the program was in place for a short period of time and definitive conclusions are therefore difficult to form.

All catch data and photographic records submitted by the metropolitan and south west operators from 25 January to 30 April 2014 were used to validate species identifications. The catch data for each region were then tabulated and further validation was completed prior to undertaking analyses and reporting of all captures in each region. The level of analysis that could be undertaken for individual species was determined by the relative number caught. For those species rarely caught, only the catch numbers are assessed. As tiger sharks were caught on a more frequent basis, more detailed analyses such as examination of catch rates and size frequencies are performed. Species lengths are recorded as total length (TL) which is defined as the distance from the snout to the point on the horizontal axis intersecting a perpendicular line extending downward from the tip of the upper caudal lobe.

Given the significant difference in the oceanographic and habitat characteristics of the northward-facing, relatively protected waters of Geographe Bay (Forrest Beach to Cape Naturaliste) compared to those of the more exposed waters off the westward-facing Capes coast (Cape Naturaliste to Prevelly) these two sub-areas of the southern MMA (see Figure 5) have been assessed separately.

Results

Catch on the drum lines during the period 25 January – 30 April 2014 mostly comprised tiger sharks (91% of the total numerical catch; Table 6). These captures are therefore considered in detail. The very small number of individuals of other species caught by the drum lines (0-7 individuals per species) did not allow for more detailed analyses to be completed.

Table 6. Number of animals caught on the drum lines.

The 'dead' category includes target species that were destroyed based on their size (≥300 cm TL) and all shark species that were dead upon hook retrieval or destroyed due to a very low likelihood of survival.

	Total		Metropolitan		Geographe Bay		Capes	
Common name	**Dead**	**Released alive**	Dead	Released alive	Dead	Released alive	Dead	Released alive
Tiger shark	**64**	**99**	34	75	15	5	15	19
Shortfin mako	**4**	**1**	0	0	2	0	2	1
Dusky shark	**0**	**1**	0	1	0	0	0	0
Spinner shark	**0**	**1**	0	0	0	1	0	0
Bull shark	**0**	**1**	0	1	0	0	0	0
Unidentified shark	**0**	**1**	0	0	0	0	0	1
Ray	**0**	**7**	0	7	0	0	0	0
North-west blowfish	**0**	**1**	0	1	0	0	0	0

Non-target species

In total, nine individuals of non-target shark species were caught (Table 6). Five shortfin mako sharks (*Isurus oxyrinchus*) were caught in the south west (ranging from 170 – 264 cm TL); one was released, three were dead upon gear retrieval and one was destroyed as it was considered unlikely to survive if released. A single dusky shark (290 cm TL) and a single spinner shark (180 cm TL) were caught and each was released. One unidentified shark removed itself from the hook and swam off before it could be identified.

Seven rays (species unknown) were caught in the metropolitan region, all of which were released. Two of the rays were identified as sting rays (Family Dasyatidae). A single north-west blowfish (*Lagocephalus sceleratus*) was caught and released.

Target species

White sharks
No white sharks were caught during the trial drum line program.

Bull sharks
A single bull shark (197 cm TL) was caught in the metropolitan region and was released.

Tiger sharks
In total, 163 tiger sharks were caught (67% in the metropolitan; 12% in Geographe Bay and 21% in the Capes). Ninety-nine (61%) were released with a greater proportion released in the metropolitan region (Table 6; Figure 11).

A total of 17 (10%) were found dead upon gear retrieval. These were distributed across all regions and throughout the duration of the program. The remainder (29%) of captured tiger sharks were destroyed either because they were 300 cm TL or greater or in three instances because the sharks were considered not in a condition to survive.

The tiger sharks captured ranged in size from 153 – 450cm TL (mean size = 270 cm TL, SD = 63 cm, n = 155) (Figure 12) with a larger range of sizes captured in the metropolitan region (Figure 13). The overall sex ratio significantly differed from parity ($\chi^2 = 34.1$, $p < 0.0001$) with more females being caught at all three locations (Figure 13). Released sharks ranged in size from 153 – 299 cm TL while those that died (either because they were dead upon gear retrieval or due to their size) were from 182 – 450 cm TL (Figure 14).

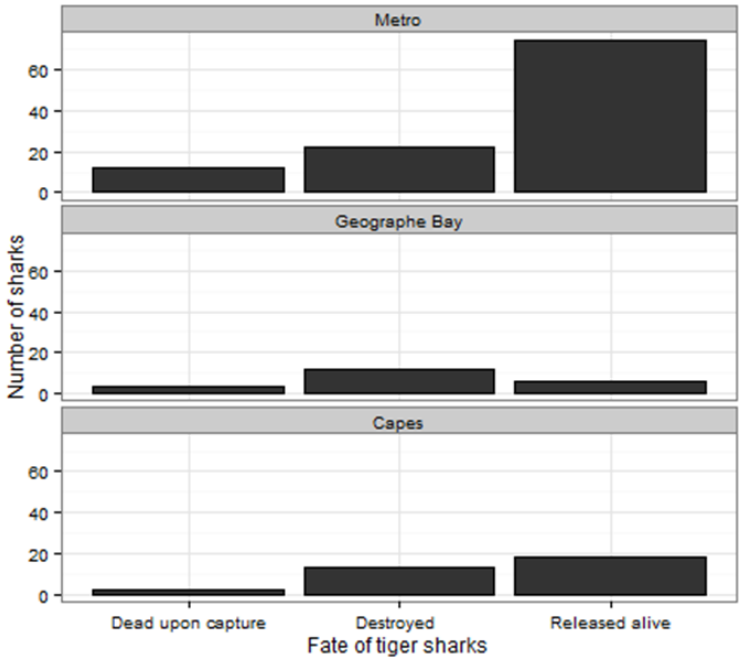

Figure 11. Fate of tiger sharks caught on drum lines by region. Destroyed sharks were generally those 300 cm TL or greater.

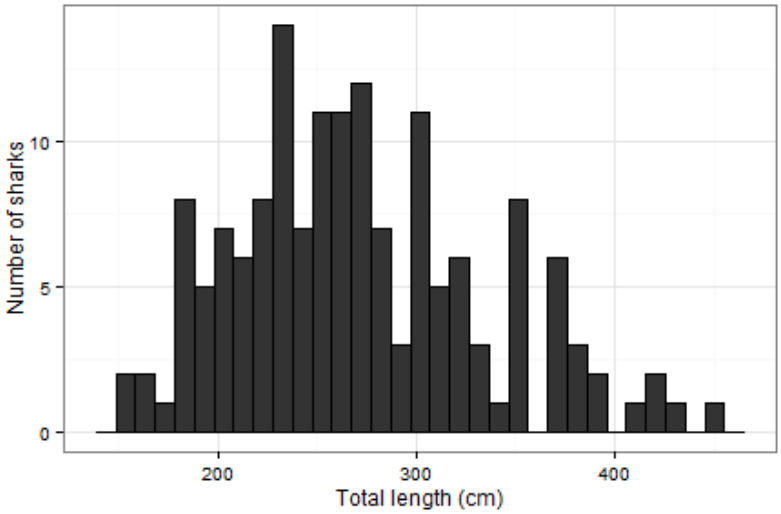

Figure 12. Size frequency of tiger sharks caught in all regions.

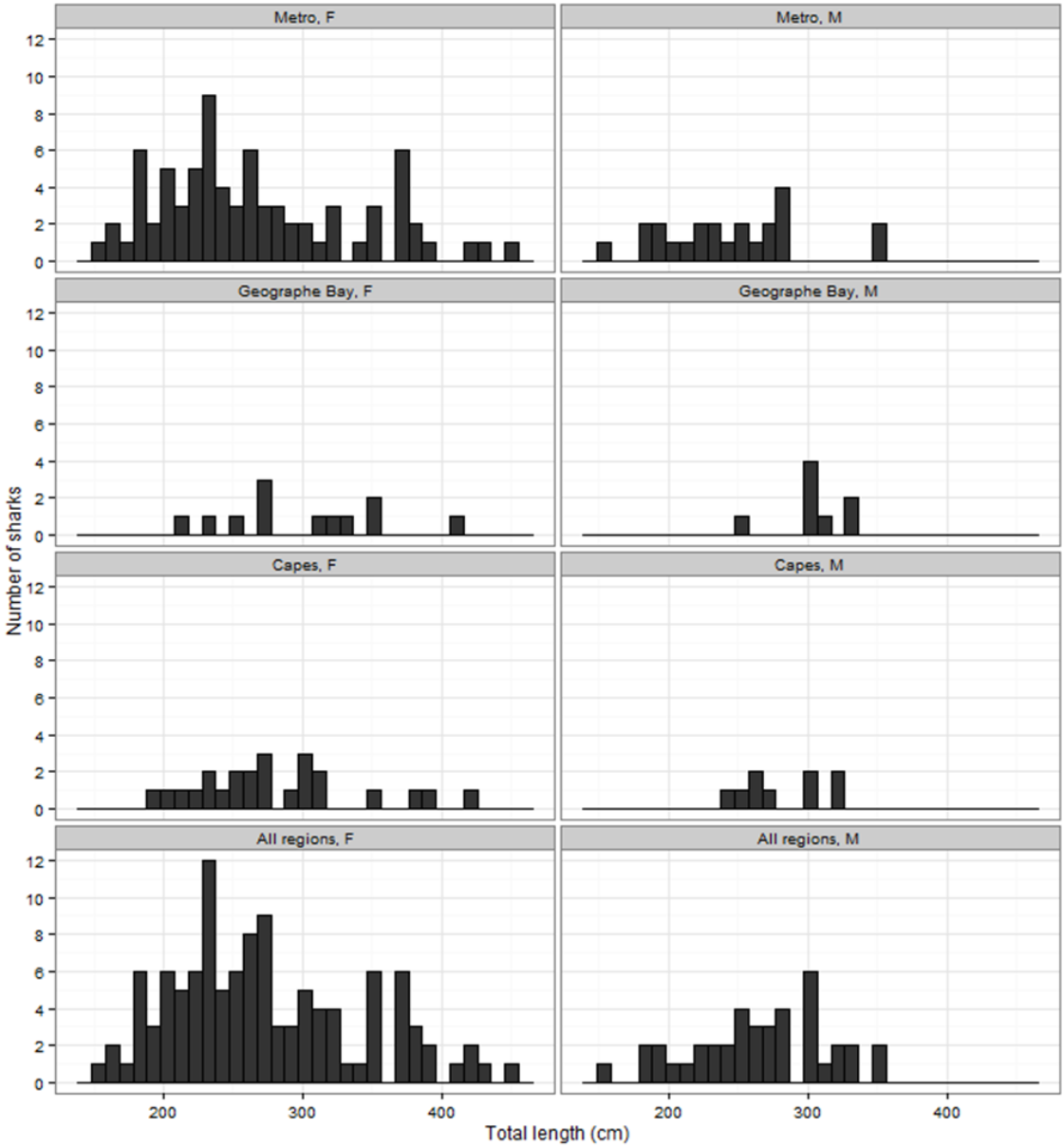

Figure 13. Size frequency and sex (F = females, M = males) of tiger sharks caught by region.

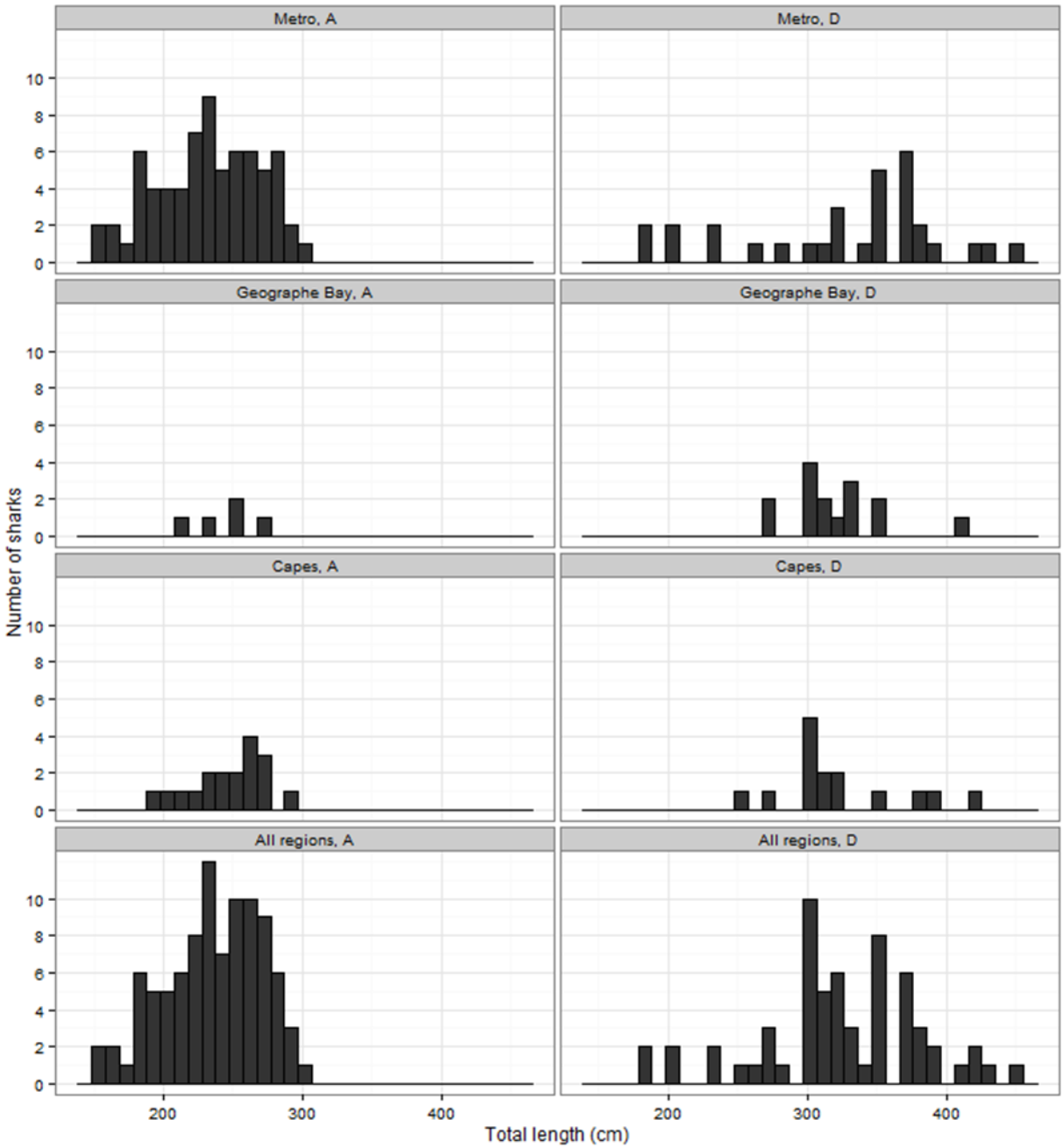

Figure 14. Size frequency and fate (A = alive/released, D = dead) of tiger sharks caught by region. The dead category includes sharks that were dead upon gear retrieval and those destroyed due to their size.

Of the 99 tiger sharks that were released, 90% were tagged with a conventional dorsal fin tag. To date, none of these tagged sharks have been recaptured. Of the three tiger sharks that were fitted with internal acoustic tags, one (230 cm TL female) is confirmed to have died immediately after release; one (251 cm TL female) was detected by a VR4G receiver approximately two km from its release site 30 minutes after release and the third (173 cm TL female) has not been detected following her release (noting no data from the more widely spread VR2 receivers are available for this time period).

Based on length-weight conversions from northern Australia (Stevens & McLoughlin 1991), the estimated weight of tiger sharks destroyed during this program (assuming 100% survival of released sharks) would be approximately 17 tonne. More than half of this was taken in the metropolitan region.

Given the potential for at least some released sharks to have died, total mortality is likely to be higher than this estimate. The maximum weight, assuming no survival of released sharks, is approximately 25 tonne (Table 7).

Table 7. Estimated total weight of tiger sharks destroyed.
The lower limit and upper limit assume 100% and 0% survival of released sharks respectively.

Region	Lower limit (tonne)	Upper limit (tonne)
Metropolitan	9.5	15.3
Geographe Bay	3.5	4.0
Capes	3.9	5.5
Total	16.9	24.8

Catch rates (Tiger sharks only)

The catch per day at all three sites was highly variable with many of the days having no captures, particularly in the Capes region (Figure 15). The overall rate of capture (sharks captured per day) in the metropolitan region was very similar to that in Geographe Bay (1.2 tiger sharks per day) with catch rates for both of these regions being higher than for the Capes (0.4 tiger sharks per day). The lower average catch rates in the Capes region may reflect either distributional differences (lower abundance in the southern region) and/or differences in susceptibility in this region. Furthermore the different geography of each of these two south west sub-regions (e.g. sheltered waters at Geographe Bay versus more exposed waters off the Capes) may also have influenced the relative catch rates of this species.

The catch rates for tiger sharks in the metropolitan region were highest in early-mid February (e.g. nine captured on 14 February). This was followed by lower, more stable daily catches of tiger sharks for the remainder of the trial program. The daily catch data for both locations in the south west shows no trends across time (Figure 15).

The decline in catch levels observed after February may reflect some level of depletion of tiger sharks in this region but their continued capture up to the last day of the program indicated tiger sharks were still present within the region. There was no evidence of any depletion within the two south west areas with the catch level remaining at consistent levels for the duration of drum line deployment at both Geographe Bay and the Capes (Figure 15).

The catch rate of tiger sharks 300 cm TL or greater showed no pattern at any sites (Figure 16). This may be an indication of different distribution and residency patterns for small compared to larger tiger sharks but the data are too few to be conclusive.

More detailed analyses may subsequently be able to explore the extent to which the observed spatial and daily differences in catch may have been influenced by differences in local oceanographic and benthic conditions and hook density (i.e. gear competition/saturation effects) or bait type. In addition, 14 weeks of catch data is insufficient to quantitatively assess the impacts to a local population of catching more female tiger sharks than males. However, catch data generated through the Proposal will be assessed on an ongoing, and annual, basis to further inform any impacts associated with the biological characteristics of the species.

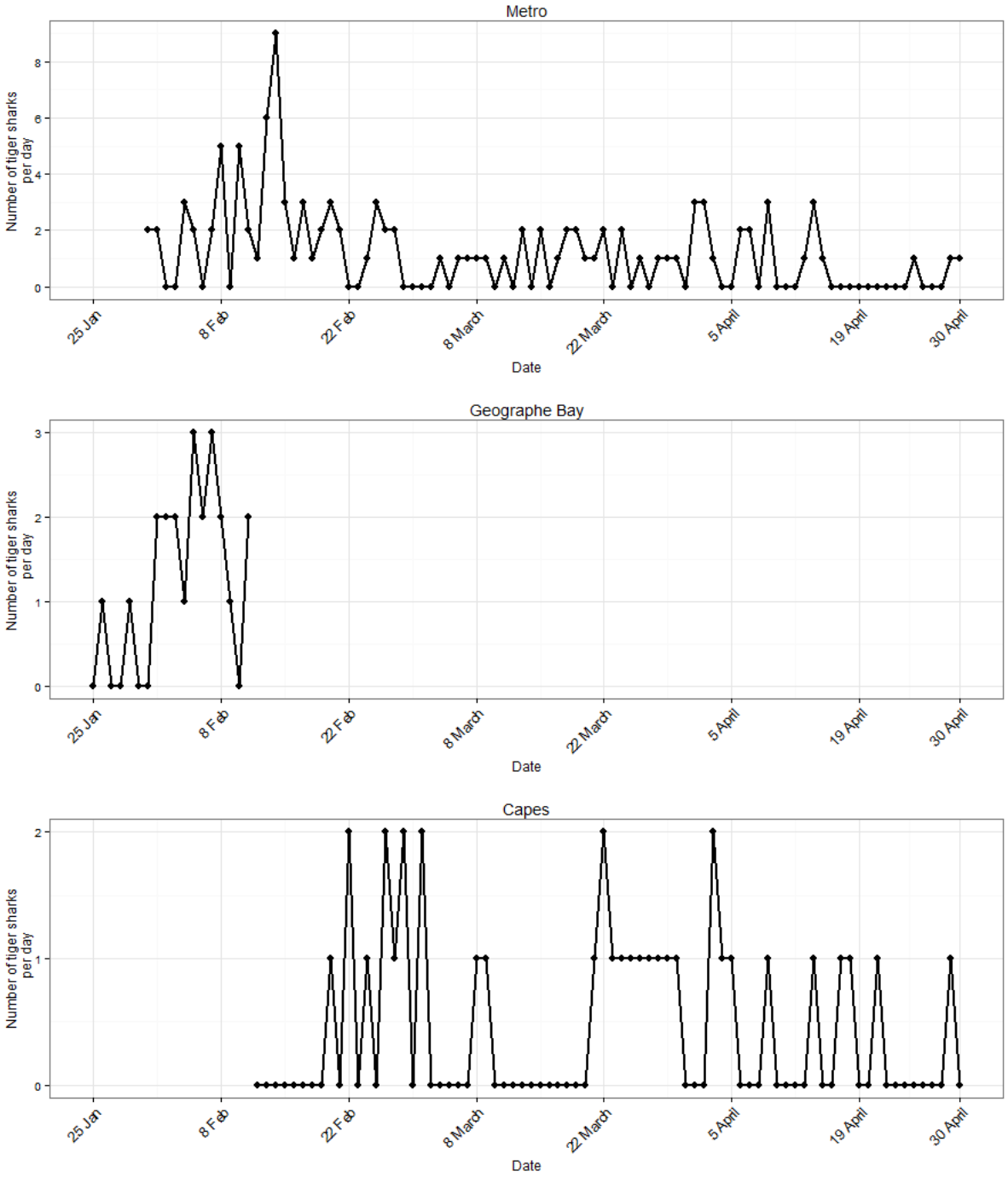

Figure 15. Daily catch of all tiger sharks captured in the metropolitan, Geographe Bay and Capes regions. Note the different scales of the y-axis for each region.

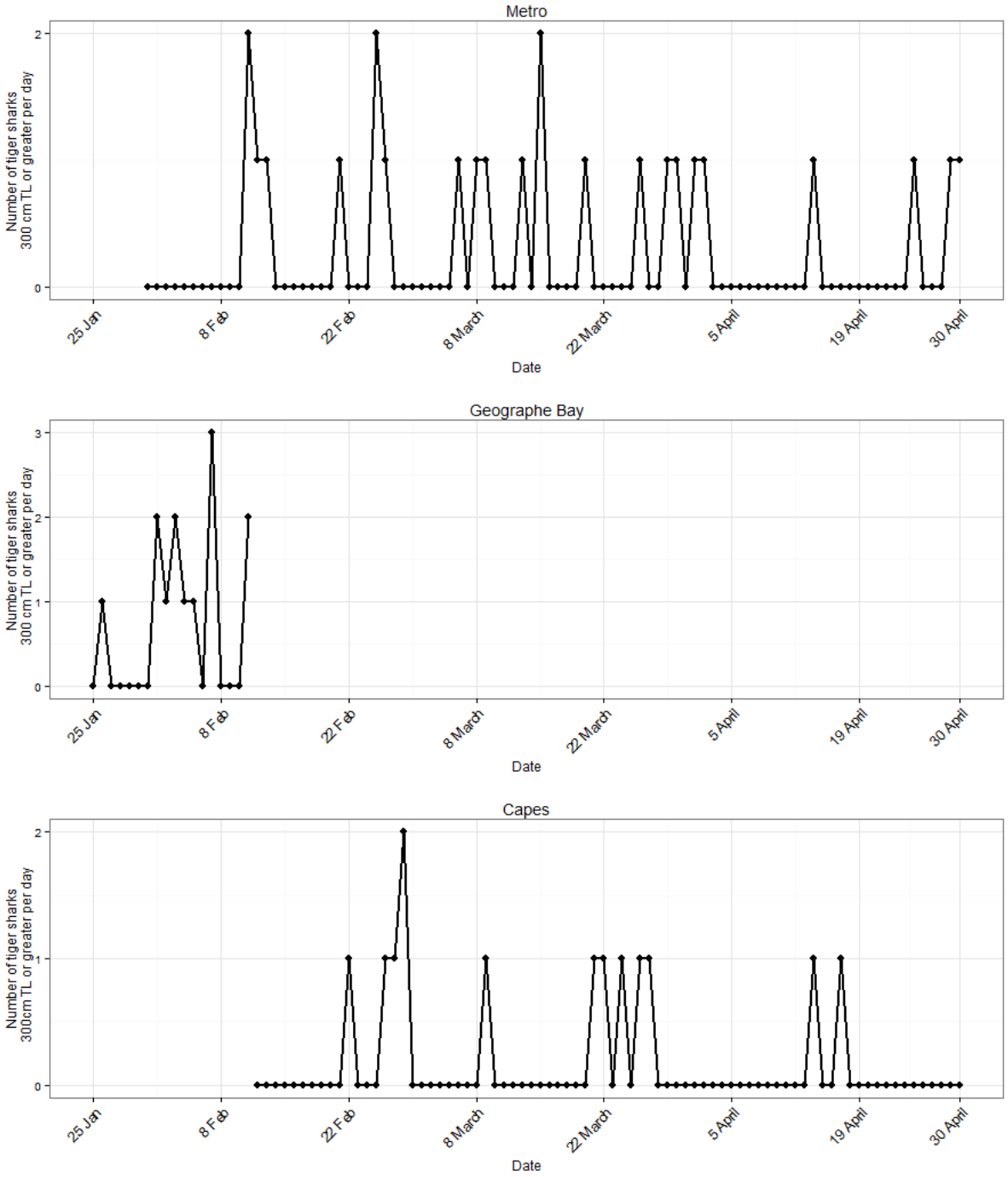

Figure 16. Daily catch of tiger sharks ≥300 cm TL captured in the metropolitan, Geographe Bay and Capes regions.
Note the different scales of the y-axis for each region.

Observed versus predicted catches

For most species or species groups the observed levels of catch by the drum line program were consistent with the predictions (low for most species) that were presented in the initial risk assessment (DoF 2014a) (Table 8) (Appendix 6). For one species the actual level of capture was lower than predicted (dusky sharks) and only the actual catch of tiger sharks was higher than expected. Comparisons of the actual versus predicted capture levels of each of the main species or groups are considered below.

Table 8. Summary comparison of actual catch levels versus predictions presented in the initial risk assessment (DoF 2014a).

Species/Group	Level of capture consistent with predictions?	Comments
White shark	Yes	-
Bull shark	Yes	-
Tiger shark	No (higher than predicted)	Increased water temperatures in recent years
Dusky shark	No (lower than predicted)	Drum lines inshore of migration route
Grey nurse shark	Yes	-
Demersal scalefish	Yes	-
Dolphins	Yes	-
Seals/Sea lions	Yes	-
Whales	Yes	-
Turtles	Yes	-

Tiger sharks

Tiger sharks are a relatively abundant, tropical and subtropical shark species with a geographic distribution that extends from the west coast of Western Australia over the northern half of Australia to southern New South Wales. Drum lines deployed for the trial program were located in small areas at the southern end of the tiger shark range on the west coast of Australia (compare Figure 17 with Figure 3). This species is currently subjected to only minor levels of exploitation elsewhere along the Western Australian coast.

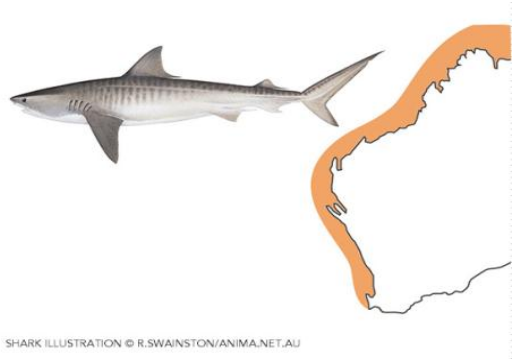

Figure 17. Distribution of the tiger shark in Western Australia.

The predictions were that most of the captures of this species were expected to be released, with the number expected to be destroyed in the order of 10-20 individuals. The level of catch of tiger sharks in the program was higher than expected. Thus, while the proportion that was released alive was consistent with predictions (being over 60%), the actual number destroyed was 64.

Having a higher than expected number of tiger sharks off the west coast of Western Australia is, however, consistent with the observed trend in warming water temperatures occurring off this part of the coast. Moreover, in the past four to five years this region has experienced marine heat wave events (Pearce *et al*., 2011). These have been associated with major effects on a number of species including affecting their distributions (Caputi *et al*., 2014), which could have also led to increased numbers of this mainly tropical species being located towards the southern extent of their distribution off Western Australia. Additional monitoring of this species would be required to determine whether the catch rates experienced in 2014 are now typical or not.

Despite higher numbers encountered in the trial program than were anticipated, the initial risk assessment indicated that the number of tiger sharks that would need to be removed before even a measurable change in their total population would occur was likely to be in the order of 100s. The number known to have died during the trial, while higher than expected, was still less than the levels considered necessary to potentially make a material effect on total stock size.

The levels of mortality generated from the trial program are not considered to have exceeded those outlined within the initial risk assessment which would generate more than a negligible risk. However, the higher than expected level of captures obtained in the trial period and the possibility of high levels of post-release mortality have prompted a more detailed examination of the risks associated with this level of capture should this same level be maintained for a number of years (see Section 4.2.3).

Bull sharks

All available data obtained by the DoF shark research program over the last two decades suggested that this species' distribution, within the region of the MMAs, would be largely confined to the Swan/Canning estuary system[4]. Consequently, given their apparent scarcity in near-shore marine waters off south-western Western Australia, the expected number of bull sharks caught in this program was considered to be negligible. Consistent with this prediction, only one bull shark was caught in the trial period.

White sharks

Based on the low rates of capture of white sharks during the targeted tagging fishing operations completed off Western Australia in the past few years, especially between January and April, it was expected that the capture of white sharks would be small (< 10). The lack of any white shark captures in the trial period within the metropolitan and south west regions is therefore consistent with this prediction, and with the view that white sharks are more common in winter and spring when water temperatures are lower (DoF 2012).

Dusky shark

One of the most important and economically valuable species that was considered to be potential bycatch of the program was the dusky shark (*Carcharhinus obscurus*). There were initial concerns that the level of capture of this species may be relatively high and if it were to exceed 30 this would represent a moderate risk to the stock. Only one was caught in the trial period, which was much less than predicted. It is likely this lower than predicted catch rate is due to the drum line gear being set well inshore of what emerging data suggests is this species' offshore migratory pathway.

Shortfin mako shark

Due to concerns for populations of shortfin mako (*Isurus oxyrinchus*) elsewhere in the world the species has been included in Appendix II of the CMS. Therefore it has been listed as a migratory species under the EPBC Act and is considered separately in Section 4.2.3 of the Proposal.

There are no particular concerns about anthropogenic impacts on shortfin mako in Australian waters with continued recreational and commercial catches still permitted following its listing under the EPBC Act. Moreover the very small number caught in the trial program (five) would have negligible impacts on this species' Australian population.

Grey nurse shark

The number of captures of this species was expected to be very low. If caught, their survival prior to release is also expected to be high given their ability to buccally ventilate and maintain neutral buoyancy. Consistent with the predictions, no individuals of this species of shark were caught in the trial program, supporting the initial assessment that the risk to this population is negligible.

Demersal scalefish

The design of the gear (e.g. size and design of hooks) made it highly unlikely that any demersal scalefish species would be caught in the drum line program. As predicted, no demersal scalefish were caught on drum lines in the trial program.

[4] See http://www.environment.gov.au/topics/water/water-quality/water-quality-improvement-plans/water-quality-hotspots/western-australi-1 for more details on the Swan/Canning estuary system.

Seals and sea lions

The size and design of the hooks on the drum lines made it a remote likelihood that any individual pinniped (seal or seal lion) would be captured in the program. Consistent with the predictions, none of these species were caught during the program.

Turtles

Turtles are not common in the more temperate regions where the MMAs are located. Individuals of most turtle species are therefore highly unlikely to be in the vicinity of the MMAs, and therefore to interact with the drum lines. The size and design of the hooks make it a remote likelihood that any turtle would be captured on the drum lines. Consistent with the predictions, none were captured in the trial period.

Whales

The trial period (January–April) occurred outside the typical migration seasons for the whale species that migrate along the Western Australian coast, reducing the likelihood of encountering drum line ropes. In addition, the positioning of these lines well inshore of where the majority of whale movements occur also reduced the likelihood of entanglements. Drum line surface ropes were shortened as soon as the early presence of a few whales along the coast became apparent. Consistent with the predictions, no interactions with whales occurred during the trial period.

Dolphins

Given the size and shape of the hooks used, it was highly unlikely that dolphins would be captured by the drum line gear. Consistent with the predictions, no dolphins were captured during the trial period.

Broader ecosystem effects

The footprint of the operation is extremely small compared to the distribution of the species most likely to be directly affected, with only very small numbers of species other than tiger sharks captured and/or destroyed. As outlined, the trial program has therefore generated only negligible impacts on each of the affected species.

There was nothing captured in the drum line program that would significantly affect the initial assessment that the program would have negligible impacts on the ecosystem. Consistent with this prediction, no effects on other species have been identified.

The removal of up to 25 tonne of a common species of shark (i.e. tiger shark) in one year effectively distributed across three small areas of the west coast by this program is unlikely to have any measurable effect on the functioning of the broader mesoscale, Leeuwin-Naturaliste ecosystem. Nonetheless the potential effects of this level of capture extending over a number of years is addressed in Section 4.2.3.

4.2.2 Mitigation measures

The Proposal is designed to reduce the risk of human-shark interactions within the MMAs through the use of a limited number of drum lines. The Proposal is therefore designed to only have a localised impact on the abundance of large individuals of target species within these MMAs, and not to significantly affect the total population size of these species. Based on the experiences in other locations, it is recognised that the use of drum lines can capture species other than the target sharks. A number of measures have been incorporated into the Proposal to minimise the risks associated with the potential capture of non-target species, specifically dolphins, whales, sea lions, turtles and non-target sharks. These measures have been considered as an integral part of the overall risk assessment.

The likelihood of capture and/or mortality of non-target species is reduced by:

- a significantly larger hook (no smaller than an approximate 25/0 circle) than is used elsewhere in the world for this purpose. Moreover, the hook design is circle like with a closed gape. These two features should substantially limit the types and sizes of non-target species likely to be captured. This gear configuration has already proven to be highly effective in limiting the bycatch captured in the trial drum line program (see Section 4.2.1). Importantly, only one non-chondricthyan (shark or ray) individual was captured;
- limited number of drum lines (a maximum of 72 drum lines to be deployed at any one time);
- daily monitoring and maintenance of drum lines to occur between 0600 and 1800 hours to ensure any non-target species that may be unintentionally caught are freed and released as soon as possible;
- aerial and land patrols which operate at most of the beaches where the drum lines will be deployed, so that the drum line contractor can be notified of any captures;
- the limited area in which static drum lines are to be deployed (<0.1% of Western Australian waters and <1% of the Western Australian coastline);
- the limited time in which static drum lines are to be deployed (5.5 months per year); and
- the removal of static drum lines between 1 May and 14 November each year to avoid annual whale migrations along the Western Australian coastline.

The risk levels associated with the potential impacts of the capture and/or mortality of non-target species will also be minimised through close monitoring of catch data. Close monitoring of catch data will ensure that the rates and composition of capture are consistent with those expected and used in determining the risk evaluations. The monitoring and review requirements include:

- maintenance of detailed records of all catches (including digital photographs) and provision of this information to relevant authorities for assessment purposes (see Appendix 2 for details);
- assessment throughout and following the end of the program by relevant technical experts from DoF and, where necessary, DPaW;
- development of range or levels of acceptable catch for each of the target species and other potential bycatch species (see Section 4.2.3). The actual numbers captured will be examined against these acceptable ranges each year to ensure that the risk levels have not materially altered;
- provision for an additional review to be undertaken prior to the standard annual review should a major increase in the rate of captures for any species occur within a season;
- a requirement for observers to be aboard each vessel on the first day of deployment and on subsequent trips thereafter (see Appendix 2 for details); and
- the restriction of the program to operate for only three years, after which a further review of the program will be undertaken.

4.2.3 Risk assessment and predicted catch rates of a three year program (2014-17)

A formal assessment of the ecological (environmental) risks that may result from the Proposal has been completed by DoF to assist in determining whether the Proposal meets the EPA's objective for Marine Fauna and whether these risks are considered acceptable under the EPBC Act (see Appendix 8 for the full report).

The issues that are subject to individual risk analyses include each of the three target species, the potential suite of non-target species (including all relevant listed threatened and migratory species) and potential cumulative impacts on community structure that may be generated by interactions with drum line gear. The scope of the assessment does not include an examination of the degree to which the Proposal affects risks associated with human-shark interactions.

The definition of risk contained in international standards is "*the effect of uncertainty on objectives*" (ISO 2009). This definition of risk makes it clear that examining risk will inherently include the level of uncertainty generated from having incomplete information (SA 2012). In the context of assessing the risks of the Proposal, the objectives that are to be achieved are the longer term sustainability of the species at the whole of population level, and the maintenance of the ecosystem structure at the regional level. This is consistent with meeting the EPA objective of "*to maintain the diversity, geographic distribution and viability of fauna at the species and population levels.*" (see Section 4.1).

Consequently a "significant impact" that would result in a high risk would be one for which there was a reasonable likelihood that the number of individuals of a species that are captured and ultimately die would materially affect the longer term sustainability and population dynamics of the species at the whole of population level, or that the cumulative level of captures would materially affect the ecosystem structure at a regional level.

The risk analyses assume that the static drum line activities will occur between 15 November and 30 April each year for a three year term within the two MMAs and only with the specified number of drum lines (30 static drum lines routinely deployed and 12 for temporary deployment in response to a shark threat or incident) (see Section 2 and Appendix 2 for a description of the Proposal).

Risk assessment methodology

The assessment of risks that may be generated by the Proposal was completed using methods that are consistent with the international standards for risk management and assessment (IEC/ISO, 31010 2009; ISO 2009; SA-HB89 2012). The process for risk assessment includes three components; (1) risk identification, (2) risk analysis, and (3) risk evaluation (see Figure 18).

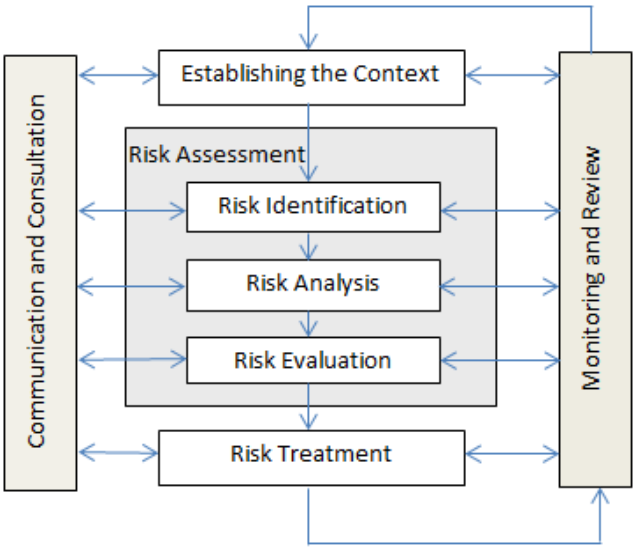

Figure 18. Description of risk assessment within the risk management process (SA 2012).

The protocols to complete each of these steps have been specifically tailored and extensively applied across a number of different aquatic management situations in Australia (e.g. Fletcher *et al.*, 2002; Fletcher 2005; Jones & Fletcher 2012). Moreover this methodology has now been widely applied in many other locations in the world (e.g. Cochrane *et al.,* 2008; Fletcher 2008; FAO 2012; Fletcher & Bianchi 2014) and are considered one of the 'must be read' methods supporting the implementation of the ecosystem approach (Cochrane 2013).

Risk identification

The identification of risks utilised a component tree approach. This approach assists with the orderly identification of issues (components) for an assessment by providing a standardised starting point and framework to structure components in a consistent and hierarchical manner (FAO 2012). The generic component tree structure was used to assist with the identification of the ecological components that require assessment as a result of undertaking a fishing activity. There are three main branches to the component tree for the Proposal: target species, non-retained/bycatch species and ecosystem impacts (see Fletcher *et al.,* 2005; FAO 2012 for more details). These three categories are consistent with the set of potential impacts defined in the ESD. The components within each of these branches were then tailored to suit the particular circumstances for the potential impacts that may occur through the Proposal.

The risk identification process utilised extensive knowledge of the species or categories of species (e.g. life history and biological characteristics) that reside in the West Coast Bioregion (see Figure 3) of Western Australia that may be directly affected through capture, or entanglement in, the drum line gear. In addition, the components identified included the potential for indirect effects on the broader ecosystem impacts to be generated by the cumulative removal of all target and non-target species.

The final component tree structure included all the species or species groups that were captured in the initial trial program. In addition, components identified for specific examination also included all species listed in the ESD and those that are relevant as MNES. As there are no key ecological features located within the two MMAs, the IMCRA based Leeuwin-Naturaliste meso-scale ecosystem was used to assess the potential for ecosystem effects in the West Coast Bioregion (CoA 2006) (Figure 19). This is considered the appropriate scale at which to assess the potential effects of the cumulative removal of all individuals captured by the drum line program.

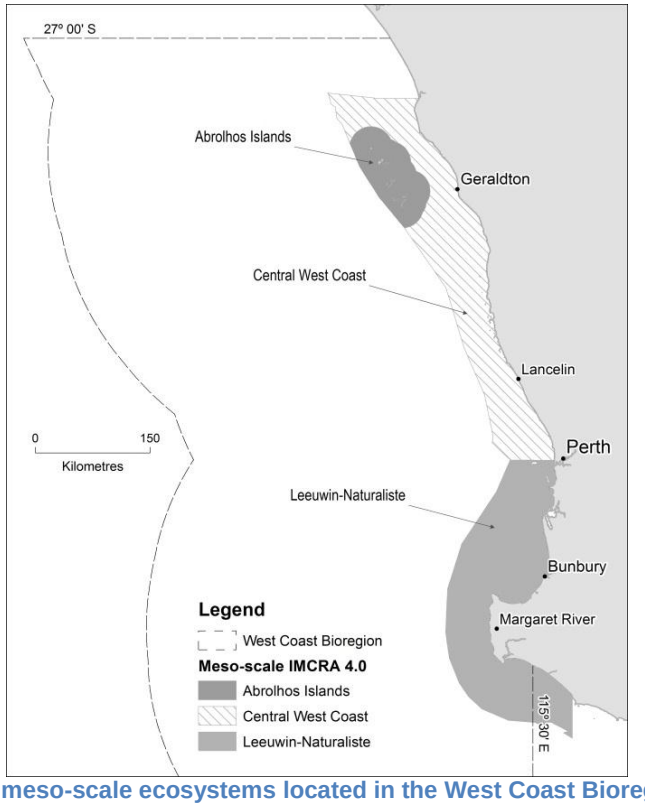

Figure 19. The IMCRA v4.0 meso-scale ecosystems located in the West Coast Bioregion of Western Australia.

Risk analysis

The 'Consequence–Likelihood' (CxL) method was used to assess the level of risk for each of the identified species, groups of species and potential broader ecosystem effects resulting from cumulative removals in the program. This method is widely used (SA 2012) and is applied by many Western Australian government agencies through WA Risk Cover.

Undertaking risk analysis using CxL methodology involves selecting the most appropriate combination of consequence (levels of impact) and the likelihood (levels of probability) of this consequence actually occurring (see Figure 20). The combination of these scores is then used to determine the risk rating (IEC/ISO 31010 2009; SA 2012).

		Likelihood Level				
Consequence level		Remote	Unlikely	Possible	Likely	Highly Likely
		1	2	3	4	5
Negligible	0	0	0	0	0	0
Minor	1	1	2	3	4	5
Moderate	2	2	4	6	8	10
High	3	3	6	9	12	15
Severe	4	4	8	12	16	20
Extreme	5	5	10	15	20	25

Figure 20. Risk analysis matrix.
The number in each cell indicates the Risk Score and the colour indicates the Risk Ranking (see Table 9).

The potential consequences, likelihoods and resultant levels of risk are all dependent upon the effectiveness of the risk mitigation controls that are in place (SA 2012). Determining the most appropriate combinations of consequence and likelihood scores therefore involves the collation and analysis of all information available on an issue. The best practice technique for applying this method now makes use of all available lines of evidence for an issue and is effectively a risk-based variation of the 'weight of evidence' approach that has been adopted for many assessments (e.g. Wise *et al.,* 2007; Linkov *et al*., 2009).

Different consequence tables are used for the different categories of effects. For this assessment tables were required to examine the potential impacts on Stocks, Habitats and the Ecosystem Structure. These three tables and the likelihood table are each presented in Appendix 18 and outline the types of issues, risk factors or threats that need to be considered in these analyses. Importantly, the different consequence levels used to assess the risks to stocks are directly analogous, and incorporate all the elements, needed to assess the potential impacts of an activity to effective population viability.

Risk evaluation

The risk evaluation step uses the outcomes of the risk analysis to help make decisions about which risks need treatment, the level of treatment and the priority for action. The different levels of management action can be determined by having the risk scores separated into different categories of risk (Table 9).

The key information used to generate the risk scores included:

- The composition of the species captured during the Western Australian trial drum line program January- April 2014 (see Section 4.2.1).
- The rates of capture of these species recorded in drum line programs in other shark control programs outside of Western Australia.
- The rates of capture using similar equipment in Western Australia for tagging purposes.
- Research survey information for the west coast region.
- Commercial catch and catch rate information for relevant Western Australian fisheries.
- Relevant stock assessment information as presented within the annual Status Reports on the Fisheries Aquatic Resources of Western Australia and in various Fisheries Research Reports.
- Relevant biological and behavioural information on these species.
- Other relevant information on species and methods including the 2012 review by McPhee.
- A correlation study completed by DoF (DoF 2012).
- Other relevant scientific studies and publications.

Table 9. Risk Evaluation, Risk Rankings and Outcomes (modified from Fletcher *et al*., 2002; Fletcher 2005).

Risk Category (Score)	Description	Likely Reporting Requirements	Likely Management Response
Negligible (0-2)	Not an issue – no actions necessary	Minimal	Nil
Low (3-6)	Acceptable; no specific control measures needed	Periodic	None specific
Medium (7-10)	Acceptable; with current risk control measures in place (no new management required)	Full annual report	Specific management and/or monitoring required
High (11-15)	Not desirable; continue strong management actions OR new and/or further risk control measures to be introduced in near future	Full annual report	Increases to management activities needed
Severe (16-25)	Unacceptable; major changes required to management in immediate future	Full annual report plus interim reports	Increases to management activities needed urgently

Results

Identification of issues requiring assessment

Most of the issues identified in this risk assessment were previously identified during the initial risk assessment for the trial program (DoF 2014a). The only additional (or refined) issues that required separate assessment were: (1) the potential impacts on seabirds (many of which are listed in the EPBC Act); (2) a separate assessment of shortfin mako sharks (listed as a migratory species); (3) other listed sharks and rays (e.g. whale sharks and manta rays); and (4) an explicit assessment of habitat impacts (Figure 21).

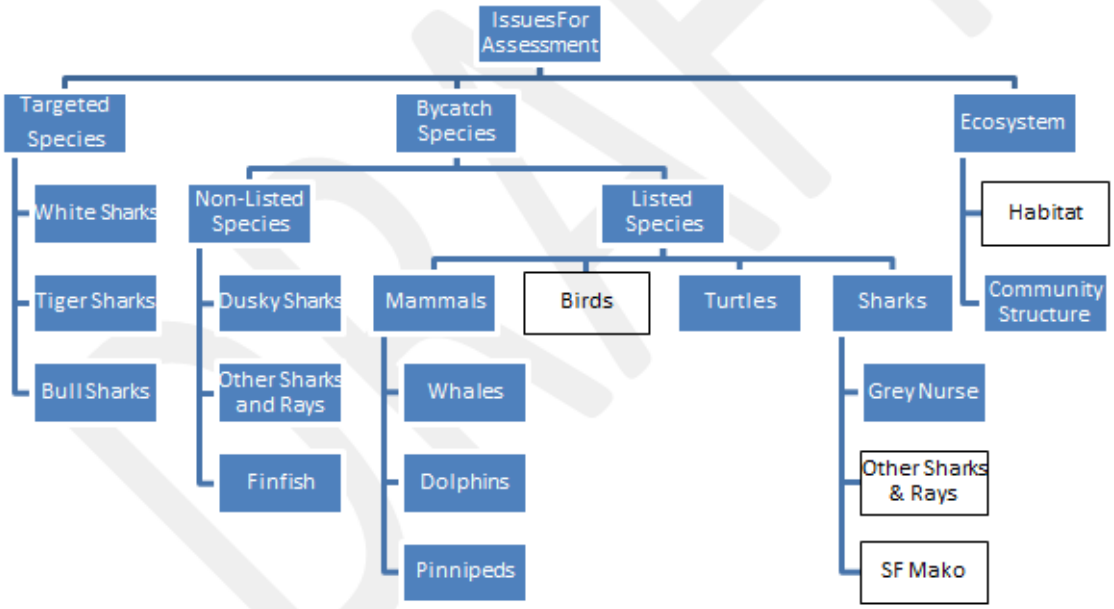

Figure 21. Issues identified for completion of a risk analysis.
Those in white boxes were not separately examined during the initial risk assessment (DoF 2014a)

Analysis of risks to target species

White shark

Background

The white shark (*Carcharodon carcharias,* Linnaeus 1758) is a very large (up to 600 cm TL) and relatively rare shark species in all locations where it is found in the world (Last & Stevens, 2009). Each of the different populations of this species covers a large spatial distribution, often including both coastal and oceanic waters. Individual white sharks can be wide-ranging and may undertake significant migrations (Bruce *et al*., 2006). Their diet appears to change with size, with smaller individuals consuming mainly teleosts (bony fish) and elasmobranchs (sharks), with mammals becoming a more important part of the diet for larger individuals (Malcolm *et al*., 2001).

In Australian waters it has recently been determined that there are effectively two subpopulations of white sharks. Tracking data and genetic studies (Blower *et al*. 2012; Bruce & Bradford 2012) indicate that these two subpopulations of white sharks are separated at Bass Strait with a southwestern population that extends across the southern ocean in South Australia and Western Australia and up the west coast of Western Australia to approximately North West Cape (Last & Stevens 2009). White sharks are widely, but not evenly, distributed in Australian waters with some areas appearing to have more frequent sightings. These are especially around pinniped (seal and sea lion) colonies off South Australia, areas of the Great Australian Bight as well as the Recherche Archipelago of Western Australia (Malcolm *et al.* 2001).

Within the geographical distribution of this southwestern population white sharks have not been directly targeted by commercial activities and have now been officially protected for nearly 20 years. The majority of white shark captures have been as incidental bycatch by temperate demersal gillnet and longline fisheries that operate in both Western Australian and South Australian waters.

Anticipated annual catch levels

The use of drum lines to capture sharks under the Proposal is intended to have a localised impact on the relative number of individuals of white sharks and other targeted species within the MMAs. It is not designed to generate a significant reduction in their overall population numbers. During the trial program no white sharks were captured. This result was not surprising as it was predicted few would be captured between January and April given the relatively high water temperatures during this period in this region off the Western Australian coast (DoF 2012).

The Proposal will operate between November and April for a three year period. Based on the relative catch rates of white sharks in the region adjacent to the MMAs by local west coast fisheries, research tagging programs and the drum line trial program, it is expected that fewer than 10 white sharks, and even fewer in the target range (≥300 cm TL) will be caught each year. This would lead to a likely cumulative catch of less than 25 white sharks over the three year program and even fewer that are ≥300cm TL.

Comparative catch levels
The low expected level of annual catch in Western Australia is consistent with the low annual catches of white sharks that have been sustained for decades through the drum line and netting programs off Queensland and New South Wales (see Reid *et al.,* 2011). The expected level of annual catch in Western Australia is also substantially lower than the numbers that were estimated to have previously been caught each year as bycatch in commercial fishing operations in Western Australia, South Australia and Victoria. Prior to the major reductions in effort of the commercial fisheries that occurred in the mid-1990s (due to issues with targeted stocks) up to 260 individuals per year were estimated to be captured across the Western Australia/Victorian region (DoF 2014d).

The estimated annual level of capture under the Proposal (fewer than 10) is still much lower than the current estimate of the annual bycatch of white sharks by all fisheries across the southwestern population which is estimated to still be in the order of 50-100 individuals per year. Based on these estimates, the expected catch levels generated as a result of the Proposal would only be increasing annual catch by less than 10%.

Current population assessment
Estimating the size of the southwestern white shark population (west of Bass Strait) has been difficult due to the lack of long term quantitative monitoring information. Recent research has focused on reconstructing likely historical catch levels generated from all sources, including commercial, game and recreational fishing and captures associated with whaling. In combination with these, different life history scenarios and initial population sizes have been used to generate potential fishing mortalities and stock trajectories for the southwestern white shark population (DoF 2014d). Each of the alternative scenarios is then compared against the available lines of evidence for this population using an innovative risk based, weight of evidence approach. The basis of this approach is that the more each of the independent lines of evidence are considered consistent with a specific scenario, the greater the level of likelihood that the scenario is a plausible reflection of the real situation.

The lines of evidence that are being examined include the catch rates of white sharks by commercial fishers across periods before, during and after the highest levels of white shark captures occurred, trends in the rate of attacks per head of the Western Australian population for the past 20 years, observed sighting rates by Western Australian abalone divers for the past decade and sightings at South Australian cage diving sites for the last 20 years. Additional lines of evidence include comparisons with estimates of sizes of other populations of white sharks and comparisons of relative catch rates and stock estimates for co-occurring sharks in this region.

All the available lines of evidence strongly suggest that over the past decade the southwestern white shark population has remained stable or been increasing (DoF 2014d). No lines of evidence were consistent with this population decreasing during the most recent decade. Using the most plausible population scenarios for starting population size and life history characteristics suggests that the southwestern Australian white shark population either did not decline significantly or if it did, it has at least now achieved stable or increasing levels since the major reductions in fishing effort and mortality. An increasing trend is considered more likely if there were some benefits from their listing as a protected species nearly two decades ago through the survival of some of the individuals that are released after capture. The results of these analyses suggest that the current size of this southwestern population is most likely to be in the order of at least a few thousand to several thousand individuals with the most likely estimates between 3 400 – 5 400 (DoF 2014d).

Further, the population is estimated to be at least 70% of the unexploited level with the highest likelihood scenarios suggesting the population is currently above 85% of unexploited levels (DoF 2014d).

Risk analysis of the impacts of the program
All lines of evidence indicate the size of the southwestern population is either stable or has increased over the past decade. With anticipated captures less than 10 white sharks per year, the Proposal would add less than 10% to the current annual levels of capture. Therefore, even using the most conservative plausible estimates of current population size (>3 100), with the expected very low levels of additional annual mortality the modelling identified this to general minimal effects on the population size (DoF 2014d).

Over the next three years, if catch levels remain at the bottom of the anticipated level (a few per year) the cumulative effects of the Proposal would have a negligible impact (Consequence Level 0). If the catch levels are at the top of the anticipated range (i.e. closer to 10 each year) there is still only a **remote likelihood** (Likelihood Level 1) that this would have a **minor level of consequence** (Consequence Level 1) on the total size, and therefore the population viability, sustainability and migratory patterns, of the southwestern Australian population of white sharks. This combination generates a **Risk Score of 1.**

Risk evaluation
If the mortality rates of white sharks generated under the Proposal remain within the expected levels (< 10 year), this would represent only a **negligible risk** to this population.

This is an acceptable level of risk with no actions necessary.

Tiger shark

Background
The tiger shark *(Galeocerdo cuvier,* Peron & Lesuer 1822), is a very large species of whaler shark which can attain approximately 600 cm TL (Last & Stevens 2009). This species is a relatively common and wide-ranging coastal-pelagic species, found in tropical and warm-temperate oceans around the world. Tiger sharks are mostly located from close inshore to shelf habitats with depths of around 150 m, and have also been found considerable distances off the continental shelf and around oceanic seamounts and islands (Compagno 1984).

Within Australian waters tiger sharks have a geographic distribution that extends from the west coast of Western Australia over the northern half of Australia to southern New South Wales (see Figure 17). The species is known to make seasonal excursions into temperate waters (Last & Stevens 2009) with their range in Western Australia possibly becoming more extensive in the last few decades. Thus, Last and Stevens (1994) suggested the range extended to south of Perth, however their more recent update extended this range to Windy Harbour (Last & Stevens 2009) with some records even further east, presumably in response to years of stronger Leeuwin Current (DoF 2006). The location of the drum lines that are to deployed under the Proposal will therefore be located at the southern end of the tiger sharks' range on the west coast of Australia.

Anticipated annual catch levels
Within the trial program a total of 163 tiger sharks were caught with 64 dead or destroyed and 99 released (see Table 6). As discussed in Section 4.2.1, it is possible that the level of capture was higher during the trial program than was anticipated due to warmer water temperatures than historical levels. It is, however, also likely that these warmer water conditions will persist. Consequently, to assess the risks to this population it has been assumed that the average catch per day at each of the sites observed during the trial program will be maintained across the entire season (15 November – 30 April). This would generate a total number of tiger sharks captured per season of close to 300. Accounting for the expected level of release (60%), this would equate to an annual mortality in the order of 25 – 40 tonne depending upon the level of release mortality (0-100%).

Comparative catch levels

Tiger sharks are currently subjected to only minor levels of exploitation by other fisheries along the Western Australian coast. This species has only ever been commercially fished for relatively short and irregular intervals within Western Australia. Generally their capture has occurred in different parts of their distribution at different times with most of these captures having occurred in the northern more tropical part of their Western Australian range. These captures have been as a byproduct of fishing for other shark species and not as a target species as their flesh is not marketable. The current level of commercial capture of tiger sharks as bycatch is also now very low in Western Australia because of a series of management actions and other events that have affected the overall level of effort and areas remaining open for commercial shark fishing (Figure 22).

There has been a prohibition on the use of commercial shark fishing gear which covers large areas of the distribution of tiger sharks off the north-west coast of Western Australia (see Figure 22). This prohibition was introduced in 1993 along with statewide restrictions on the retention of shark catches for commercial purposes by other fishing methods (e.g. trawl). There was a further dramatic decrease in commercial shark fishing effort within the northern bioregion that began in 2005 and in 2008-09 there was a complete cessation of the northern shark fishery due to economic issues unrelated to tiger sharks (Figure 23). For the decade prior to this cessation, this fishery alone had been capturing tiger sharks as a byproduct with up to 80 tonne caught during the 2004-05 season (Figure 24).

Smaller amounts of tiger shark landings have been recorded in the West Coast Demersal Gillnet and Demersal Longline Fishery (WCDGDLF) which also reached eight tonne in 2005–06 and small numbers of tiger sharks were also caught in Eighty Mile Beach, the Kimberley Gillnet and Barramundi Fishery and the Pilbara Fish Trawl Fishery (Heupel & McAuley 2007). A further reduction in shark fishing off the west coast occurred in 2008, when as part of an allocation decision directed towards recreational fishers for demersal scalefish, the metropolitan region was closed to all commercial wetline and shark fishing. Consequently the total capture of tiger sharks by commercial fishers has declined substantially over the past decade from an annual total close to 90 tonne, down to the current levels of less than five tonne (Figure 25).

For the recreational sector, the annual level of catch has also been reduced from the relatively high estimates obtained in the late 1990s (Henry *et al.* 2001) to now be in the order of 330 per year (>80% released) with the majority caught in the Gascoyne Bioregion which includes Shark Bay (see Figure 3) (Ryan *et al.* 2013).

The historical catch levels far exceed the expected level of annual catch that would occur from the drum line deployment under the Proposal. Collectively all the management actions and events over the past decade have reduced the total catch levels of tiger sharks across Western Australia to relatively low levels (Figure 23). Consequently the combined annual mortality for tiger sharks that would now occur through the drum line and current commercial fishing catches are still substantially below historic levels.

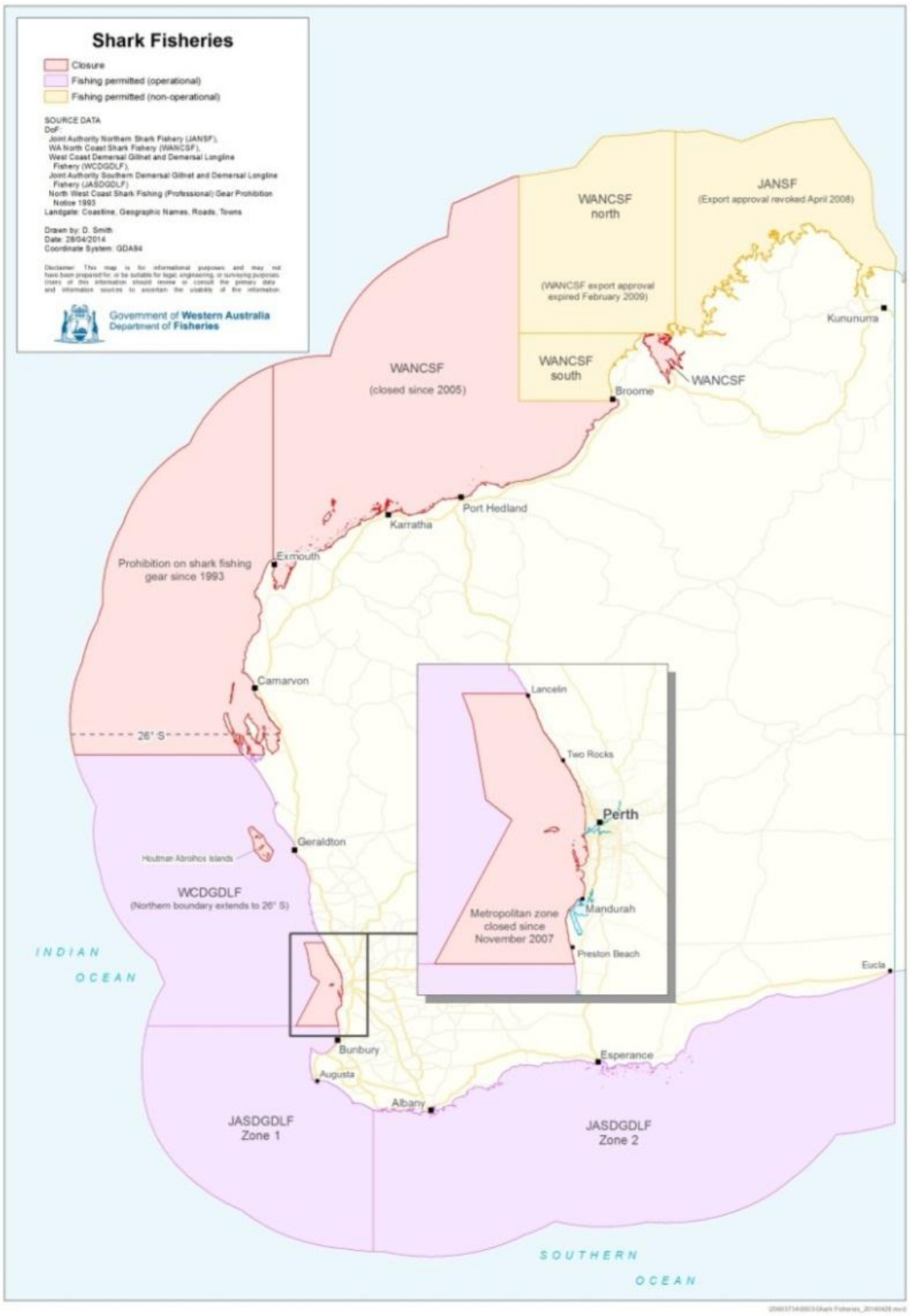

Figure 22. Map of the significant areas of the coastline where commercial shark fishing is no longer occurring.

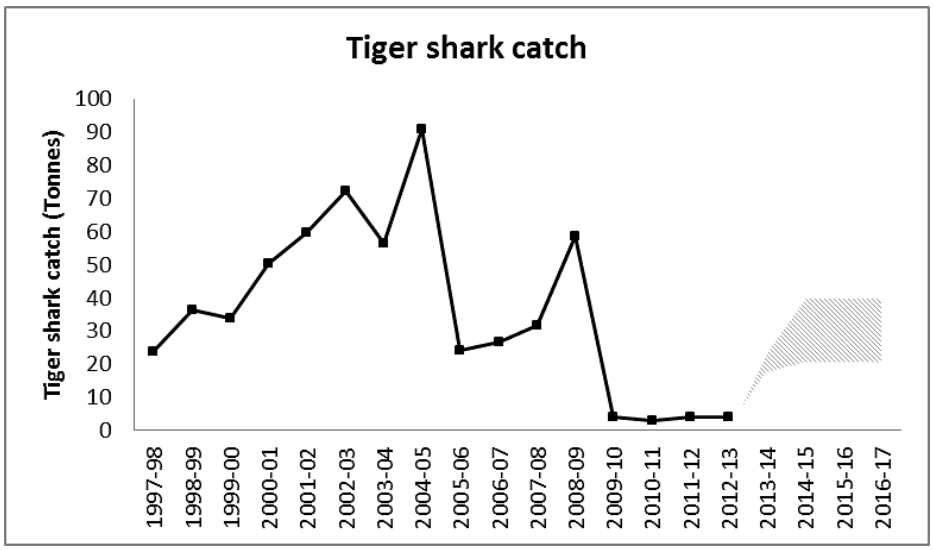

Figure 23. Total Western Australian commercial catch of tiger sharks since 1997-98. This graph illustrates the reductions in catch level since 2004 due to management and industry changes. The shaded area is the potential range of annual mortality from the Proposal depending upon the level of release mortality (0-100%).

Population assessment

Being considered a relatively minor bycatch species, the stock status of tiger sharks in Western Australia has not been formally assessed within the various assessments completed for export approvals for the West Coast and North Coast shark fisheries under the EPBC Act. The limited quantitative information from the northern shark fisheries indicates that the catch rate for the northern shark fisheries declined from 0.20 kg hook^{-1} in 1998-99 to 0.06 kg hook^{-1} in 2001-02 during a period when catches were relatively low. Importantly, the catch rate for this fishery remained at relatively stable levels from 2001-02 until the end of the time series (2004-05) which equates to the time period when the highest tiger shark catch levels were occurring (Figure 24, Heupel & McAuley 2007).

More recent catch rate data from a long term time series of annual fisheries-independent longline surveys (2001–13) shows a steady increase in the catch rate for this species in the Western Australia region north of 29^{o}S latitude (Figure 25). This survey is ongoing and will therefore continue to provide data on tiger sharks within this northern region.

The daily catch rate data for tiger sharks obtained from the trial drum line program are presented in Section 4.2.1 (see Figure 15). The only evidence of a decline in daily catch levels which could reflect some level of depletion of tiger sharks was observed in the metropolitan region. Their continued capture in the metropolitan region up to the end of the program indicated tiger sharks were still present within the region. There was no evidence of any local depletion having been generated by the levels of capture within the two south west areas, with the catch remaining at consistent levels for the duration of drum line deployment at both the Geographe Bay and Capes areas. If the levels of capture recorded during the trial program were sufficient to generate a significant population wide level of impact, it would be anticipated that the levels of local depletion in the MMAs would be more noticeable than was observed.

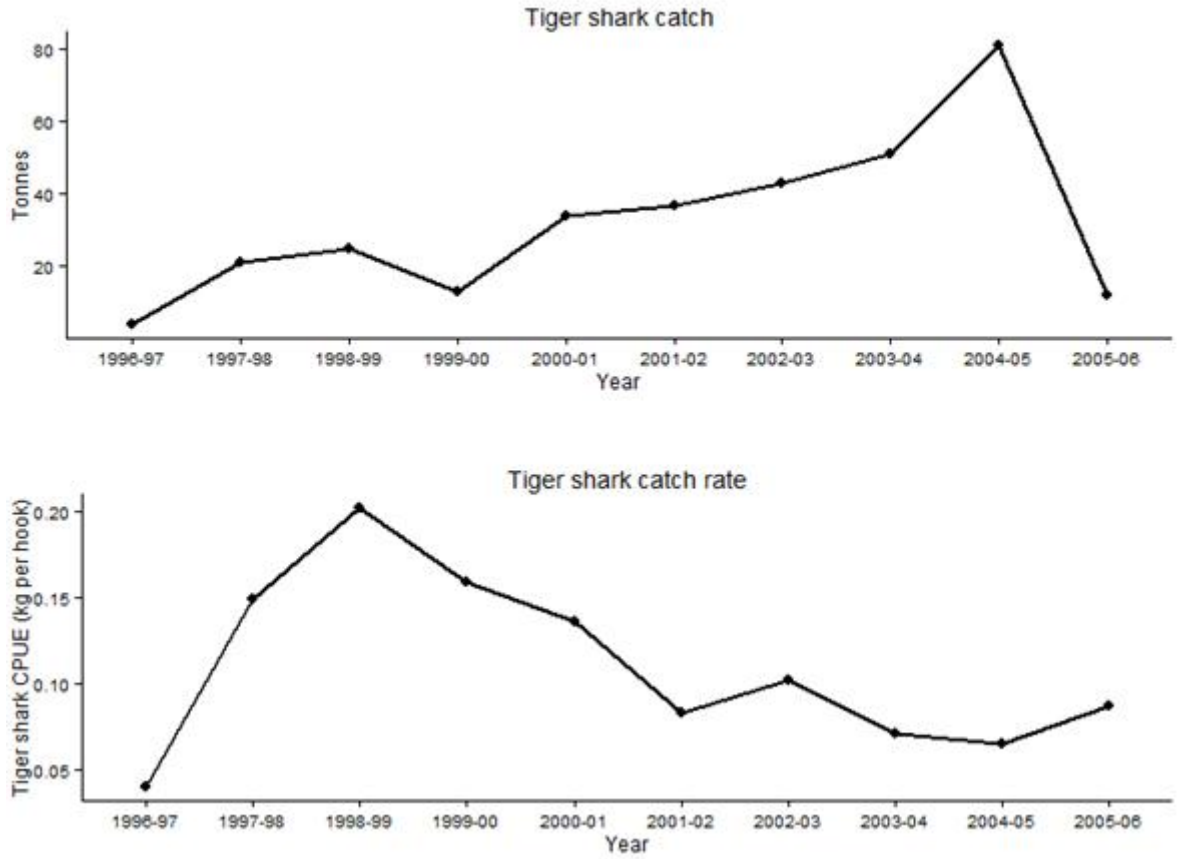

Figure 24. Tiger shark catch, and catch rate in the northern shark fisheries (from Heupel & McAuley 2007)

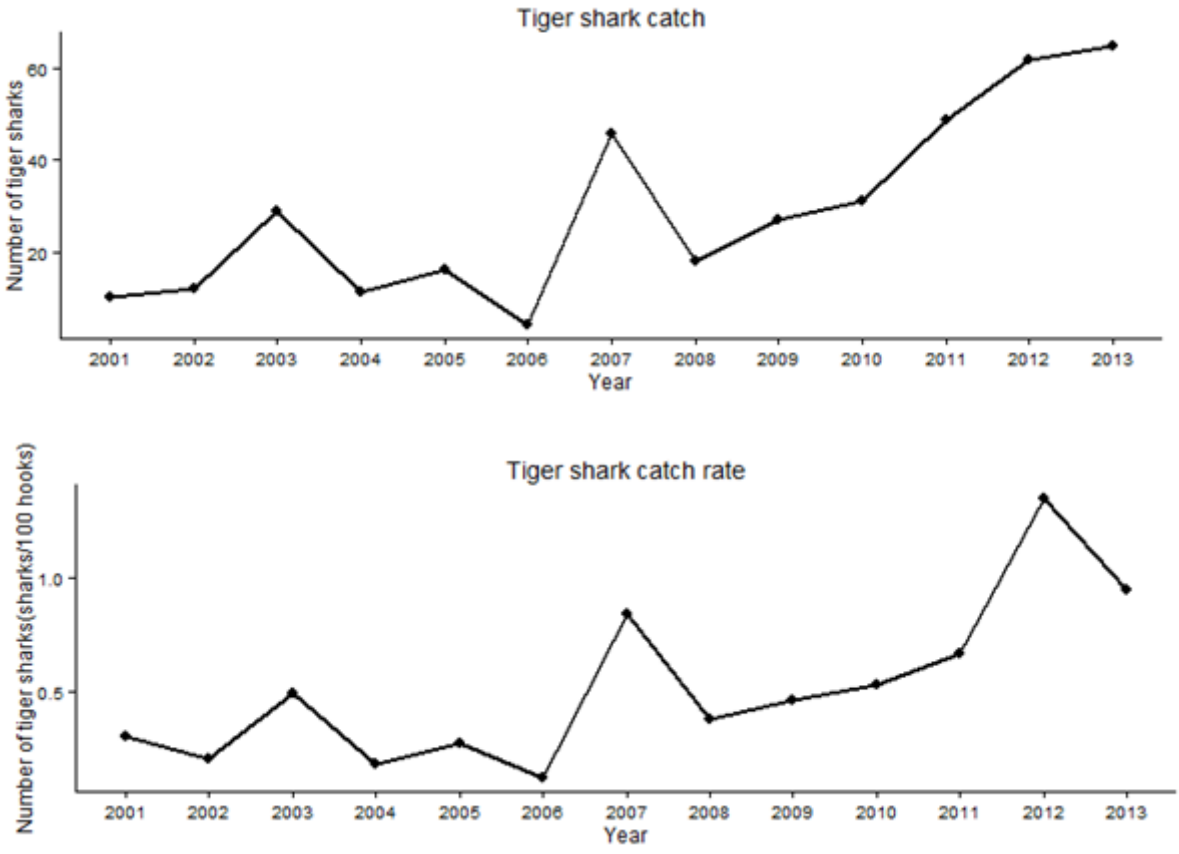

Figure 25. Tiger shark catch, and catch rate in a fisheries-independent survey of sharks north of 29°S latitude between 2001 and 2013.

Risk analysis

The various lines of evidence for tiger sharks are consistent with the Proposal having either a negligible or, at most, a minor impact on the total stock level of tiger sharks across their distribution in Western Australia. These include:

i. the extremely small footprint of the program;
ii. the location of the program being at the southern edge of their distribution, not in the area where the main distribution of this species is considered to be located in Western Australia;
iii. the likely annual rate of captures (with the majority being released) being significantly less than was previously reported from longer term historical commercial fishing activities (up to 90 tonne per year);
iv. the estimated levels of capture being only at similar levels to those now estimated to be captured by recreational fishers (mostly in the Gascoyne Bioregion and most of which are also released);
v. the anticipated level of capture of tiger sharks in Western Australia being similar to the average annual catch of tiger sharks that has been taken by the Queensland Shark Control Program for at least the last decade;
vi. only some evidence of local depletion of tiger sharks during the trial program in the metropolitan region and not at Geographe Bay or the Capes;
vii. the relatively low levels of mortality of this species now being generated from commercial fishing in other areas of Western Australia; and
viii. the relatively short term nature of the proposed program (c.f. with most fisheries activities) only 5.5 months of the year and only for three years.

Risk Evaluation

If the levels of capture of tiger sharks generated by the Proposal remain within the anticipated levels (approximately 300 animals per year), combined with assuming high levels of release mortality rates, and maintaining this level of annual mortality (approximately 40 tonne) for three years, it would be **possible** (Likelihood Level 3) for the program to generate a **minor consequence** (Consequence Level 1). (The conversion from 300 animals to approximately 40 tonne is based on length-weight conversions from northern Australia (Stevens & McLoughlin, 1991)). This would represent a potentially measureable but relatively small decrease in their total abundance. This level of decline would not, however, have a material effect on their longer term population dynamics and therefore no effect on the effective viability and sustainability of the Western Australian population of tiger sharks.

The calculated **Risk Score of 3** represents a **low risk** to the Western Australian population of tiger sharks. This is an acceptable level of risk with no specific management controls necessary.

A periodic report is required and it is recommended that if the Proposal is implemented, a full assessment is completed at the end of the three year program to reassess the risk level. The assessment would be assisted by a suitable level of sampling of the tiger sharks that are captured within the MMAs, plus those found more broadly in the West Coast Bioregion. The assessment would also benefit from comparative work completed on tiger sharks in more northern areas of their distribution in Western Australia. This would include the data from the long term fishery-independent monitoring program.

Bull shark

Background

The Bull Shark (*Carcharhinus leucas*, Miller & Henle, 1839) is a large, stout body shark with a tropical to warm temperate distribution across northern Australia from northern New South Wales to Perth, Western Australia (Last & Stevens, 2009). It is commonly found in estuaries and even freshwater systems and is more rarely found in open marine waters.

Anticipated annual catch levels

As discussed in Section 4.2.1, all available data from more than 20 years of dedicated DoF shark research suggest that this species' distribution within the MMAs is largely confined to the Swan/Canning estuary system. Given the apparent scarcity/absence of bull sharks in near-shore

marine waters off southwestern Western Australia, the expected number of bull sharks that will be caught by the program will be minimal.
Consistent with this prediction only one bull shark was caught in the metropolitan region during the trial program and was released alive. It is therefore anticipated that this low level of capture will be maintained under the current Proposal.

Risk analysis and evaluation
With an anticipated capture rate of none to only a few individuals each year (most of which will be less than 300 cm TL), there is a **high likelihood** that the Proposal will have **no impact** (Consequence Level 0) on the population numbers in Western Australia. This generates a **Risk Score of 0** and represents a **negligible risk** to the Western Australian bull shark population.

This is an acceptable level of risk with no actions necessary.

Assessment of risks to non-target species

Dusky shark

Background
The dusky shark (*Carcharhinus obscurus*, Lesueur, 1818) is one of the program's most important and economically valuable shark species that occurs in the region where the drum lines will be deployed. The Western Australian dusky shark stock supports significant commercial fisheries and is the subject of a well-designed and successful recovery plan (see McAuley *et al.,* 2005; Braccini *et al*., 2013).

For dusky sharks, the recovery program which has been successful in generating significant recovery over the past decade (see Braccini *et al*., 2013) assumes minimal capture of larger individuals (> 200 cm TL). Therefore, if a significant number of large dusky sharks was removed (e.g. more than 30 individuals per year) through the drum line program, these activities could affect the rate of the recovery of the species. If the numbers removed under the Proposal begin to exceed 30 per year, a reassessment of management arrangements for the commercial fishery would need to be undertaken.

Anticipated catch levels
During the trial program, only one dusky shark was captured and this was released alive. Data currently being collected on movement along the west coast using acoustic tags and an extensive acoustic monitoring network has identified that the main routes for migration of this species may be much further offshore (e.g. behind Rottnest Island, west of Perth) than where the drum lines are located (which are only approximately 1km from the mainland shore). Consequently, the numbers of larger dusky sharks that are now anticipated to be caught under the Proposal is likely to be less than 10 per year.

Risk analysis
Given the very low capture rate experienced in the trial program (only one), combined with the increased understanding of their patterns of movement, it is now considered unlikely that the Proposal will generate a level of mortality of larger dusky sharks over the three year time period that will affect the recovery of the Western Australian stock of dusky sharks.

Risk evaluation
If the annual level of capture and mortality of large dusky sharks remains in the anticipated range (< 10), it is now only a **remote likelihood** (Likelihood Level 1) that the Proposal will generate even **a minor level of impact** (Consequence Level 1) on this stock generating a **Risk Score of 1**. The Proposal therefore now represents a **negligible risk** to the Western Australian dusky shark stock.

This is an acceptable level of risk with no actions necessary.

Other non-listed elasmobranchs (sharks and rays)

Background

A number of other elasmobranch species have distributions within the West Coast Bioregion and the MMAs and therefore have the potential to interact with the drum lines. Shark control programs undertaken elsewhere in the world often capture a variety of non-target species of sharks and rays (see Section 4.3).

Anticipated catch levels

The design of the gear (e.g. large hook size and circle like design) makes it highly unlikely that many other species of sharks or rays will be caught under the Proposal. Only one spinner shark and seven individual rays of a number of species were caught during the trial program and these were all released alive (see Table 6).

This low level of capture and even lower level of mortality is expected to continue with numbers within a possible range of between five and 20 individuals per year. These will probably comprise a number of different species.

Risk analysis and evaluation

There is a **high likelihood** (Likelihood Level 5) that only a few individuals from each of the other species of sharks and rays will be caught and the rays are likely to be released alive and therefore generate **negligible impacts** (Consequence Level 0) on the populations. This generates a **Risk Score of 0**. With these anticipated catch levels, the Proposal represents **negligible risks** to this group of species.

This is an acceptable level of risk with no actions necessary.

Demersal scalefish and finfish

Background

Only two teleosts (both tuna, *Thunnus* spp.) were captured on drum lines in southeast Queensland over a 16 year period and so far no demersal scalefish have been caught in Western Australian drum lines.

Anticipated catch levels

The design of the gear (e.g. large hook size and circle like design) makes it highly unlikely that any of the main demersal scalefish species will be caught under the Proposal. It is not expected that many of any other finfish species will be captured on the drum lines. The only finfish species to be captured in the trial program was one north-west blowfish.

Risk analysis and evaluation

There is a **high likelihood** (Likelihood Level 5) that **no demersal scalefish** will be caught and also that **few, if any, other finfish** species will be caught (Consequence Level 0) generating a **Risk Score of 0**. With these expected catch levels, the Proposal represents **negligible** to **no risk** to these species.

This is an acceptable level of risk with no actions necessary.

Analysis of risks to other protected/listed species

Grey nurse shark

Background

Unlike populations in eastern state regions, the western population of grey nurse sharks (*Carcharias taurus*, Rafinesque, 1810) which is located in Western Australia has never been subjected to targeted fishing (commercial or recreational). Incidental catch and catch rate data from the demersal gillnet fishery, prior to their listing in the mid-late 1990s indicates that grey nurse sharks were relatively abundant in temperate Western Australian waters and that the population

was stable (Cavanagh *et al.,* 2003; Chidlow *et al*. 2006). Given the subsequent reductions in effort that have occurred in the commercial fisheries that occasionally captured this species, including the metropolitan closure to commercial net and line fishing, the level of annual catch of grey nurse sharks in Western Australia will have significantly declined even from these low sustainable levels.

Anticipated catch levels
The number of captures of this species under the Proposal is anticiapted to be very low. In the unlikely event that any are caught, their survival prior to release should be high given their ability to buccally ventilate and maintain neutral buoyancy. Consistent with the predictions, none of these sharks were captured during the trial program.

Risk analysis and evaluation
There is a **high likelihood** that no grey nurse sharks will be caught and, even if a few are caught they are most likely able to be released alive resulting in **no** or **negligible impacts** (Consequence Level 0) generating a **Risk Score of 0**. With these anticipated catch levels, the Proposal therefore represents **negligible risk** to grey nurse sharks.

This is an acceptable level of risk with no actions necessary.

Shortfin mako shark

Background
Due to concerns for populations of shortfin mako (*Isurus oxyrinchus*) elsewhere in the world this species was included in Appendix II of the CMS and therefore listed as a migratory species under the EPBC Act.

Anticipated catch levels
It is anticipated that the small number caught in the trial program (five) is likely to continue at similar levels under the Proposal. Therefore, the annual capture rate is anticipated to be in the range of five to 20. This is a small amount compared to the historical captures of shortfin mako shark taken annually as bycatch by the commercial fisheries in Western Australia (between two and five tonne).

Risk analysis
There are no particular concerns about anthropogenic impacts on shortfin mako sharks in Australian waters with continued recreational and commercial catches still being allowed by the Commonwealth despite their listing (CoA 2010). The anticipated level of capture of this species under the Proposal is small which would likely have only negligible impacts on this species' Australian population.

Risk evaluation
There is a **high likelihood** that this program will have a **negligible impact** (Consequence Level 0) on the shortfin mako shark population of Australia generating a **Risk Score of 0**. This therefore represents a **negligible risk**.

This is an acceptable level of risk with no actions necessary.

Other listed elasmobranchs (sharks and rays)

Background
Both the Whale Shark (*Rhincodon typus*, Smith, 1828) and the Manta ray (*Manta birostris*, Walbaum, 1792) are listed migratory species that have distributions that extend to the West Coast Bioregion (Last & Stevens 2009). They are both plankton feeders and are mainly found in tropical waters, only occasionally being observed in more temperate waters.

Anticipated catch levels
Neither of these species is commonly observed in the southern area of the Western Australian coast, and they are even less likely to be present within the inshore locations where the drum lines

are to be deployed under the Proposal. The diet of both of these species makes it implausible that any individual whale shark or manta ray would be captured on a drum line hook. In terms of entanglement, with the single float arrangement used, the likelihood of this occurring is reduced, even in the unlikely event that an individual of these species will pass through the areas where the drum lines are deployed. Finally, as the drum lines are monitored regularly, any entanglement event is likely to be addressed in a timely manner.

No whale sharks or manta rays were captured in the trial program and this situation is likely to continue under the Proposal.

Risk analysis/evaluation
With no captures expected to occur there is a **high likelihood** of **no impact** (Consequence Level 0) generating a **Risk Score of 0**. Therefore the program poses a **negligible risk** to whale sharks and manta rays.

This is an acceptable level of risk with no actions necessary.

Seals and sea lions

Background
There are no records of these species being captured on large hooks off Western Australia.

Anticipated catch levels
The size and design of the hooks make it a remote likelihood that any individual pinniped will become captured as part of this program. None were captured in the trial program and this situation is likely to continue under the Proposal.

Risk analysis and evaluation
With no captures anticipated to occur there is a **high likelihood** of **no impact** (Consequence Level 0). This generates a **Risk Score of 0** and therefore the Proposal poses **no** or **negligible risk** to pinnipeds.

This is an acceptable level of risk with no actions necessary.

Turtles

Background
Turtles are not common in the more temperate regions where the MMAs are located. Individuals of most turtle species are therefore highly unlikely to be in the vicinity of the MMAs and therefore to even interact with the drum lines. Furthermore, as the lines are monitored frequently, there is a likelihood of successfully releasing alive any turtles that are captured or entangled in the lines.

Anticipated catch levels
The size and design of the hooks make it a remote likelihood that any turtle will be captured on the drum lines. None were captured in the trial program and this situation is likely to continue under the Proposal.

Risk analysis and evaluation
With no captures anticipated to occur there is a **high likelihood** of **no impact** (Consequence Level 0). This generates a **Risk Score of 0**, and therefore the Proposal poses **no** or **negligible risk** to turtles.

This is an acceptable level of risk with no actions necessary.

Whales

Background
The time period (November–April) of the Proposal occurs outside the typical migration and breeding seasons for the whale species that migrate along the Western Australian coast reducing

the likelihood of encountering drum line ropes. In addition, the positioning of these lines is inshore of where the majority of movements occur plus the use of single floats reduces the likelihood of entanglements if they are encountered.

Although a small number of whales have become entangled in gillnets in south east Queensland (26 in 16 years) no whale entanglements have occurred on Queensland's drum lines. Should entanglement of one of these species occur, DPaW has considerable expertise in disentanglement procedures and will be available to assist where required. Furthermore these whale populations are generally considered to have recovered significantly from their previously threatened status. Consequently, from a stock sustainability perspective, even in the extremely remote likelihood that an entanglement occurs and causes a death, this would still represent a negligible risk to the stock (see Stoklosa 2013).

Anticipated catch levels
No whales were captured or entangled during the trial program and this situation is likely to continue under the Proposal.

Risk analysis and evaluation
With no captures anticipated to occur there is a **high likelihood** of **no impact** (Consequence Level 0) generating a **Risk Score of 0**. Therefore the Proposal poses a **negligible risk** to whales.

This is an acceptable level of risk with no actions necessary.

Dolphins

Background
Dolphins are reported as scavenging off hooks used on drum lines in Queensland. Even though the J shaped hooks used in Queensland are more likely to enable dolphins to be caught, very few have actually been captured in 16 years of drum line operations and all were released alive.

Anticipated catch levels
Given the size and design of the hooks to be used under the Proposal, it is highly unlikely that dolphins will be captured. None were captured or entangled during the trial program and this situation is likely to continue under the Proposal.

Risk analysis and evaluation
With no captures anticipated to occur there is a **high likelihood** of **no impact** (Consequence Level 0) therefore the **Risk Score is 0**. The proposal therefore poses **no** or **negligible risk** to dolphins.

This is an acceptable level of risk with no actions necessary.

Seabirds

Background
There are a number of listed seabirds that may occur within the marine areas where the drum lines are to be deployed (see Appendices 16 and 17).

Anticipated catch levels
Given the large size and circle design of the hooks used, the size of the bait, and the depth below the surface at which the hook sits (a minimum of approximately two metres) it is highly unlikely that seabirds will be captured by the gear. Moreover the method of individually deploying single drum lines with a single large hook and large bait means that even if seabirds are in the vicinity of the gear they are unlikely to become entangled when the gear is being deployed. No seabirds were captured or entangled during the trial program and this situation is likely to continue under the Proposal.

Risk analysis and evaluation

With no captures anticipated to occur there is a **high likelihood** of **no impact** (Consequence Level 0) generating a **Risk Score of 0**. Therefore the Proposal poses **no** or **negligible risk** to listed seabirds. This is an acceptable level of risk with no actions necessary.

Analysis of risks to the broader ecosystem

Habitat

Background

The drum lines are only to be operated within very small areas of the West Coast Bioregion with a maximum of 72 drum lines to be deployed at any one time. Each of the anchors are not substantially different in nature to those used by the tens of thousands of recreational boats that operate in the region. Consideration was given to the location of drum line deployment through the development of the trial program with sandy substrates preferred and areas of reef substrate excluded from deployment locations. This work was undertaken initially using ArcGIS spatial layers at a desktop level, and subsequently confirmed for the metropolitan region during a field verification trip.

Anticipated level of impact

The precise footprint of these drum line anchors will be in direct contact with << 1% of the coastal habitat. Even in the specific areas where they are deployed they are not expected to have a lasting effect on the habitat especially in areas where they are deployed on sandy substrates.

Risk analysis and evaluation

The extremely small footprint of the anchors used for the drum lines and the high resilience of the sandy substrates where most are deployed results in **high likelihood** (Likelihood Level 5) of only **negligible impacts** (Consequence Level 0) which generates a **Risk Score of 0**. The Proposal therefore represents **a negligible risk** to the habitats within the West Coast Bioregion. This is an acceptable level of risk with no actions necessary.

Community Structure

Background

Most documented changes to community structure resulting from removals most likely arise from general and widespread overfishing whereby the entire abundance of all species in a trophic level are significantly reduced resulting in 'trophic cascades' (*sensu* Pauly *et al.* 1998). For example, the loss of most large coastal sharks from the north-west Atlantic reduced overall predation on cownose rays, which in turn preyed upon bay scallops, leading to the collapse of a commercial fishery (Myers *et al.* 2007). This example resulted from the loss of an entire functional group of 11 species of large shark due to two decades of overexploitation (Baum & Myers 2004). A similar functional group of large sharks exists in West Coast Bioregion (Table 10). These sharks have not however been subjected to the same levels of overexploitation.

Table 10. List of large shark species captured in the West Coast Bioregion.

Common name	Scientific name
Dusky shark	*Carcharhinus obscurus*
Bronze whaler	*Carcharhinus brachyurus*
Spinner shark	*Carcharhinus brevipinna*
Common blacktip shark	*Carcharhinus limbatus*
Sandbar shark	*Carcharhinus plumbeus*
Tiger sharks	*Galeocerdo cuvier*
Grey nurse shark	*Carcharhias taurus*
Shortfin mako	*Isurus oxyrichus*
White shark	*Carcharodon carcharias*
Scalloped hammerhead	*Sphyrna lewini*
Great hammerhead	*Sphyrna mokarran*
Smooth hammerhead	*Sphyrna zygaena*

The other potential pathway for a significant change to occur to the community structure of a region is from significant reductions in the numbers of just one species, where this species alone has the controlling influence over a major trophic pathway. Such species are described as keystone species (*sensu* Paine 1966). This is not the same as just being a higher order predator, and these are relatively rare (Powers *et al.,* 1996). A keystone species, by definition, cannot occur if there is a high level of redundancy in functional roles of other species across the same trophic level (i.e. other species occupy the same trophic level and there are clear overlaps in potential diet). This level of redundancy is the situation for the large suite of shark species that occur within the West Coast Bioregion. Most of these shark species, but especially tiger sharks, are noted to be generalists ('true scavengers') with a broad diet, including the white shark (Malcolm *et al.* 2001; Last & Stevens 2009). Consequently, while these may operate as higher order predators, none would be considered keystone predators within the West Coast Bioregion system.

Anticipated types of impacts
The ecological footprint of the Proposal is relatively small within the context of the West Coast Bioregion. The individual assessments completed for each of the species and groups (outlined above) indicate only negligible impacts on each of these. This is therefore not consistent with the conditions that lead to a change in trophic levels.

The only species where the level of capture is close to having a measurable impact on the abundance at the population level is the tiger shark.

Collectively the capture of all the species under the Proposal (the vast majority being sharks) is estimated to be approximately 45 tonne per year, based on the capture of ~40 tonne of tiger sharks, a negligible catch of non-shark species, and an additional catch of up to 5 tonne of other shark species. These removals are only going to occur within very small parts of the West Coast Bioregion (<5%) during less than six months per year and for only three years.

While tigers sharks are considered to potentially play a role in regulating the community structure of Shark Bay by their predation on turtles and dugongs (Heithaus *et al.* 2008), this situation does not apply in the southern West Coast Bioregion. In this region dugongs are extremely rare and turtles are significantly less abundant than in the Gascoyne Bioregion. Moreover, there is a higher number of other shark species present in the more temperate and open ocean habitats of the West Coast Bioregion region compared to those sharks species commonly present within the embayment conditions within Shark Bay.

Comparative impact levels
The historical level of shark catches by various commercial fisheries operating in the West Coast Bioregion was over 400 tonne per year to 2005 (Figure 26). Since this time, a series of management changes have occurred in the West Coast Bioregion including large spatial closures off the metropolitan region (for sectoral allocation purposes), temporal closures, and effort reductions. These management changes have resulted in the annual commercial catch of the suite of sharks in the West Coast Bioregion (including tiger sharks) falling by more than half from over 500 tonne in 2005-06 to less than 250 tonne in 2011-12 (Figure 26).

The anticipated increase in the catch level of sharks in the West Coast Bioregion by the Proposal therefore represents only 5% of the historical level. Moreover, by adding the anticipated drum line catch to the current commercial catch level, the cumulative total is still about 50% below the historical average yearly cumulative catch.

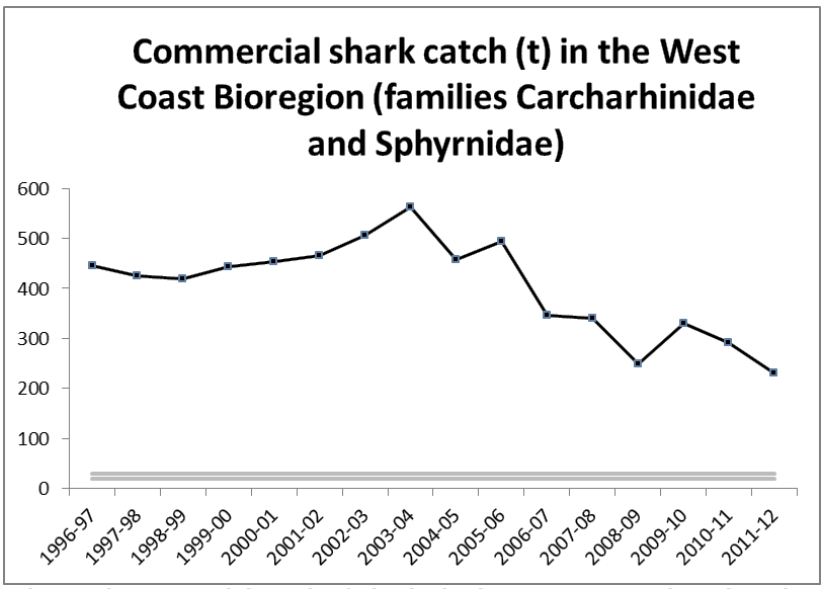

Figure 26. The total commercial catch of sharks in the West Coast Bioregion since 1996-97. The grey line indicates the expected level of additional shark captures as a result of the proposed drum line program. (Family Carcharhinidae refers to requiem sharks and the Family Sphyrnidae refers to hammerhead sharks.)

Risk analysis

The ecosystem impacts of the various fisheries in the West Coast Bioregion, including those generated by the historical levels of catch by the various shark fisheries, have already been investigated by Hall and Wise (2011). Their assessments of the community structure and trophic level of all commercially caught fish species in the West Coast Bioregion over the past 30 years found no evidence that there have been any systematic changes. Therefore, there is no indication that the fish faunas have been impacted by the historic levels of shark catch taken by the various commercial fisheries that operated in the West Coast Bioregion to the extent that ecosystem function was materially affected (Hall & Wise 2011).

As the expected annual cumulative total for all shark captures under the Proposal is relatively small (<10% of historical levels), even when combined with current commercial catches this still represents only 50% of historical levels of the total catch of the suite of shark species. Given that the historical level of catch (>500 tonne) was not found to have generated any measurable shift in the community structure for the broader fish community for this bioregion, the additional ~45 tonne of sharks to be captured by the Proposal is **highly likely** (Likelihood 5) to have **no measurable effect** (Consequence Level 0) on community structure which generates a **Risk Score of 0**.

Risk evaluation

Given:

1. the comparatively healthy status of populations of large coastal sharks in Western Australia;
2. the high level of functional redundancy in the ecosystem; and
3. the lack of any measurable changes observed when catch levels of this suite were much higher;

it is not plausible that the removal of an additional ~45 tonne of common species of sharks per annum from limited areas over just three years would initiate material changes to the fish or other assemblages of the West Coast Bioregion.

The Proposal therefore represents **a negligible risk** to functioning of the community structure of the marine ecosystems within the West Coast Bioregion.

This is an acceptable level of risk with no actions necessary.

4.2.4 Meeting the EPA's objective

In considering:

1) the development and refinement of a draft Management Plan, to employ a broad range of mitigation measures including:
   a) the use of a large (no smaller than an approximate 25/0 circle) hook designed to limit the types and sizes of non-target species likely to be captured;
   b) limited number of drum lines (a maximum of 72 drum lines to be deployed at any one time);
   c) monitoring and maintenance of static drum lines to occur between 0600 and 1800 hours, seven days a week;
   d) beaches selected in conjunction with aerial and land patrols, so that the contractor may be notified of any captures;
   e) a limited area in which static drum lines are to be deployed (<0.1% of Western Australian waters and <1% of the Western Australian coastline);
   f) a limited time in which static drum lines are to be deployed (5.5 months per year);
   g) the removal of static drum lines between 1 May and 14 November each year to avoid annual whale migrations along the Western Australian coastline;
   h) a preference for the use of shark as bait to reduce interactions with other marine species;
   i) no deployment of nets or any net meshing system:
   j) the low frequency and small number of temporary drum lines that may be deployed (a maximum of five per response) and the high level of monitoring that will occur if they are deployed;
   k) defining only three target species, of 300cm TL or greater;
   l) suitable distance of the hook below the sea surface to reduce interactions with seabirds;
   m) development of ranges or levels of acceptable catch for each of the target species and other potential bycatch species;
   n) actual numbers captured to be examined against acceptable ranges each year to ensure that the risk levels have not materially altered;
   o) maintenance of detailed records of all catches for weekly monitoring of catch data to identify potential trigger points as discussed in the draft Management Plan;
   p) provision of detailed records of all catches (including digital photographs) to relevant authorities for ongoing assessment and species identification purposes;
   q) provision for an additional review to be undertaken prior to the standard annual review should a major increase in the rate of captures for any species occur within a season;
   r) training in animal handling and best practice techniques to increase the chance of survival of non-target species;
   s) assessment throughout and following the end of the program by relevant technical experts from DoF and, where necessary, DPaW;
   t) a requirement for observers to be aboard each vessel on the first day of deployment and on a defined number of trips thereafter;
   u) the restriction of the program to operate for only three years, after which a further review of the program will be undertaken; and
2) a risk assessment of the Proposal which, in considering the mitigation measures above, has found a low risk to the tiger shark population and only either no or negligible, or negligible risks to the population status of the other two target species, the non-target species and the broader ecosystem;

the Proposal meets the EPA's environmental objective for Marine Fauna. The deployment of static and/or temporary drum lines is not considered to impact on the diversity or geographic distribution of any fauna. Moreover, the Proposal is not considered to pose a risk to the viability or sustainability of any Marine Fauna at the species or population levels.

The anticipated annual catches or catch levels for all species are currently considered to be in acceptable ranges, in particular when considered against historical levels of commercial and recreational catch and bycatch. Catch data will be monitored weekly and reviewed annually to ensure catch levels are not materially exceeding those anticipated. Through regular monitoring of

catch data, appropriate contingency actions can be developed and enacted in line with the draft Management Plan to ensure any potential impacts to species or groups of species are identified and managed appropriately (see Section 8 of Appendix 2).

Having regard to the mitigation hierarchy and all measures taken to avoid, minimise, rectify and reduce environmental impacts, the Government considers there will be no significant residual impacts from the Proposal and therefore is not proposing any offsets as part of the Proposal (see Appendix 19 for Environmental Offsets Reporting Form).

4.3 Comparisons with shark control measures used elsewhere

Drum lines, long lines and gillnets have been used to target potentially dangerous sharks in other locations including Queensland, New South Wales, South Africa, Brazil and Hawaii (McPhee, 2012). Direct comparisons between the operations of different shark control measures are complicated by a number of factors. These include differences in oceanographic conditions and therefore regional species composition, background abundance levels and movements of different shark species, histories of commercial fishing effort, fishery management and marine conservation measures, plus differences in available data series and how long after initiation of the programs the collection of data commenced. In addition, gear types, hook sizes and bait types also vary within and between these programs.

In terms of the number of hooks used, the trial Western Australian program was similar in scope to the drum line program coordinated by the Natal Sharks Board in KwaZulu-Natal, South Africa, but with a much smaller number of hooks than that used in the Queensland drum line program. The hook size used in Western Australia was much larger than any used elsewhere. Importantly, the customized hook-design featured a point that was strongly re-curved back towards the shank, analogous to the design found on circle hooks. This design closes the gape of the hook compared to standard J hooks. As was predicted in the initial risk assessment for the trial program (DoF 2014a), the combination of a larger hook size and closed-gape used in Western Australia appears likely to have contributed to the very low numbers of non-shark bycatch species captured compared to other locations. The catch in the Western Australian trial program was dominated by tiger sharks, a target species, with minimal other species captured and effectively no non-shark bycatch (see Section 4.2.1 for catch data analysis of the trial program).

Similar to Western Australia, tiger sharks form a major component of the Queensland drum line catch, with an annual average of over 200 tiger sharks having been caught by the Queensland Shark Control Program over the past 10 years. It is less similar to the long line catch in Brazil and even less similar to the South African catch (Figure 27). This pattern probably reflects the susceptibility of tiger sharks to static baits (i.e. they are recognised as scavengers, as well as being active predators) along with differences in average water temperatures and the tropical/subtropical distribution of this species. Most of the other programs capture a wider range of species including non-shark bycatch.

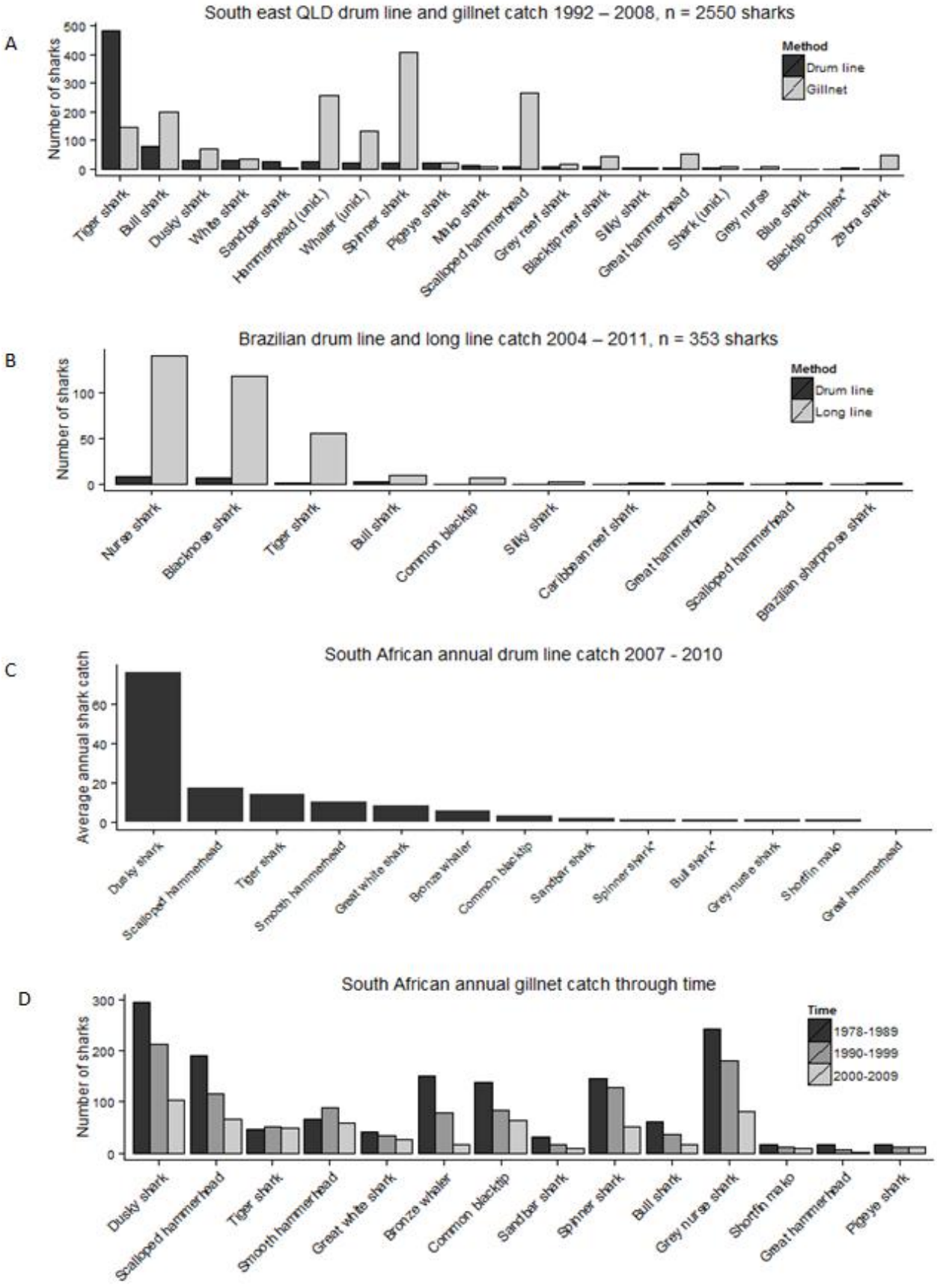

Figure 27. Shark catch from shark control measures.
(A) south east Queensland, (B) Recife, Brazil, (C) KwaZulu-Natal (KZN) South Africa (drum line) and (D) KZN (gillnets). Note that graphs (C) and (D) show the annual catch and not the total catch. Graphs reproduced from data presented in Cliff and Dudley (2011), Sumpton *et al.* (2011) and Hazin and Afonso (2013).

4.4 Socio-economic and cultural considerations

The definition of 'environment' under s 528 of the EPBC Act includes 'ecosystems and their constituent parts, including people and communities' and allows for consideration of 'social, economic and cultural aspects' (SEWPaC 2012a). In granting an exemption from Part 3 of the EPBC Act in January 2014, the Commonwealth Minister for the Environment acknowledged the imminent threat to public safety and significant economic concerns associated with shark attacks. The socio-economic element of the drum lining program; the potential impacts relating to humans, Western Australian culture and its economy through human-shark interactions; and the potential consequences of not proceeding with the action, are also therefore considered in the context of the environmental impact assessment.

Western Australia has experienced the third highest occurrence of fatal shark attacks in Australia over the past 100 years. Ten fatal attacks have occurred in the last 10 years and seven in the last three and a half years. Such an aggregation of fatalities over a short period of time has had a significant impact on people's perceptions of the ocean and their enjoyment of water based activities. In conjunction with this is a change in attitude towards, and values placed on, the coastal waters of Western Australia by both interstate and international tourists.

The latest fatality occurred in the south west region in November 2013, during the same weekend that more than 10,000 visitors were in the region for the Margaret River Gourmet Escape, an international and local food and wine event. The day following the tragedy, newspapers reported "…press from all over the world were invited to the food and wine festival, but sadly they will again be focusing on the dangers lurking off our coast."

It is not for debate that unprovoked attacks by sharks on humans are infrequent, particularly when compared to other risks of using the ocean and dangers faced daily by society, but it also cannot be disputed that when they do occur, they are extremely traumatic events (Curtis *et al.* 2012). The trauma experienced following a fatal shark attack extends further than the immediate family and can have long lasting impacts on the local community and regional area. Repeated shark attacks within a certain area that result in injuries or deaths are not only extremely traumatic but can also lead to adverse economic impacts on coastal communities in close proximity to attack locations (Hazin *et al.,* 2008).

Millions of people engage in swimming, surfing, boating, snorkelling and scuba diving in the ocean each year, providing billions of dollars in revenues to coastal communities worldwide (Curtis *et al.* 2012) and it is widely accepted that ocean recreation forms a significant part of the Western Australian culture and economy. The waters off Cottesloe beach, one of the State's most popular beaches, were traditionally full of early morning swimmers, a part of life for residents as well as visitors, and for more than 100 years Cottesloe Beach has been the traditional place for Western Australian country families to holiday (Australian News Commentary 2014).

However, seven fatal shark attacks in just over three years have given many beach lovers and surfers serious concerns about entering the water (Australian News Commentary 2014). In total, the Western Australian tourism industry is valued at $8.52 billion p.a. (Tourism WA 2012) with 64% of international visitors participating in ocean based activities (swimming, diving or surfing) in the metropolitan area (Tourism WA 2013a), and 84% of international visitors undertaking these activities in the south west (Tourism WA 2013b). It has been reported that the tourism industry is deeply concerned about the long-term consequences of the rise in shark attacks and of the reputation of the Western Australian coastline becoming referred to as the 'death coast'. The unprecedented number of shark fatalities experienced in the State has had an impact on events-based organisations in trying to promote the region as a suitable venue for ocean events such as surfing competitions and carnivals, while attendance at Cottesloe beach is thought to have dropped by possibly as much as two thirds (Australian News Commentary 2014, Washington Post 2014).

Comments received during consultation meetings undertaken by the Government (see Section 3 for full details) reinforced the lasting impacts that shark fatalities in the last 10 years in Western Australia have had on local communities and on the level of confidence people have in using the ocean. It is understood that males, and in particular male surfers, in roughly the 35-60 age bracket have been most greatly affected by recent attacks. Many have adjusted their behaviour accordingly, with some choosing not to swim or surf through the winter months, some choosing not to enter the water at all and with many extremely cautious at allowing their children to take part in water based activities. Stakeholders did however report a re-installation of confidence following the deployment of drum lines, particularly in the south west region. Many reports referred to a level of comfort offered at seeing a vessel patrolling just beyond the surf breaks and relief that measures were being taken to address the presence of large and potentially dangerous sharks in close proximity to high use areas.

The consequences of not implementing the Proposal therefore must be considered. The Government's first contemplation must be the potential for further fatalities as a result of shark attack off the Western Australian coast. While no further shark attacks cannot be guaranteed, the Government has a duty of care to take efforts, in addition to those already in place (see Figure 1), to offer safety measures where possible and practicable. The only shark hazard mitigation measure that will always prove effective is to not enter the water. Some jurisdictions, including Brazil and La Réunion island have attempted to ban surfing and entering the ocean as one of their shark hazard mitigation measures. However, this is clearly not a realistic solution for a State with such a great affinity with the ocean.

While it is not currently possible to quantify the exact impact of shark attacks on the economy, or the impact of introducing a drum lining program on the local economy, it should be considered likely that any further fatalities will have a significant bearing on interstate and international tourists' decision to visit the State. The potential risks to the culture of Western Australians and their association with the ocean, and to local communities should another shark fatality occur, should also be considered when deciding whether or not the Proposal should be implemented. It appears clear at least, that the option of doing nothing, is not an option at all.

4.5 Principles of environmental protection

The principles of environmental protection as identified under s 4A of the EP Act have been considered throughout the development of the Proposal. The Government respects and acknowledges these principles and their relevance to the Proposal where appropriate. All of the principles, and measures taken to address the principles where relevant, are addressed in Table 11.

Table 11. Principles of environmental protection and their consideration in the PER.

Principle	Relevant	If yes, consideration
Precautionary Principle	Yes	A comprehensive risk assessment has been undertaken. Serious or irreversible environmental damage is unlikely to result from the Proposal. Measures are being taken to reduce scientific uncertainty with regard to white shark populations and behaviour. Ongoing monitoring of catch data will ensure the prevention of any irreversible impacts. It should be noted however that, in considering public safety, treatment of uncertainties in data sources may be potentially different to treatment applied if outcomes were for commercial or other social amenity benefits. In this regard, the precautionary approach towards human safety has been appropriately applied.
Intergenerational equity	Yes	Any impacts on the environment as a result of the Proposal are not considered to impact upon the health, diversity and productivity of the environment for future generations. Public safety, Western Australian culture and restoring confidence to water users are important considerations of the Proposal.
Conservation of biological diversity and ecological integrity	Yes	The Proposal is not considered to have the potential to impact upon genetic, species or ecosystem diversities. The potential impacts on biological diversity and ecological integrity have been considered as part of a thorough risk assessment, and measures have been put in place to protect biodiversity.
Improved valuation, pricing and incentive mechanisms	No	
Waste minimisation	No	

5 MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE (MNES)

5.1 Identification of MNES

As discussed in Sections 2 and 4, the Government referred a proposed action to DoE on 7 April 2014 for assessment of a further three year program. On 7 May 2014 the Commonwealth Minister for the Environment announced the proposed action to be considered a 'controlled action' in respect of the white shark being listed as vulnerable under s 178 and as migratory under s 209, and the following MNES protected under the EPBC Act:

- listed threatened species and communities (ss 18 and 18A); and
- listed migratory species (ss 20 and 20A).

On 7 May 2014, under s 75 of the EPBC Act, the Commonwealth Minister for the Environment also announced the assessment approach to be under bilateral agreement with the EPA. This allows matters considered under the EPBC Act to be addressed within the PER and assessed by the EPA.

The threatened species which may be present in the two MMAs include:
- birds, including various species of albatross and petrel;
- mammals, including whales and sea lions;
- turtles; and
- sharks including the grey nurse shark and the white shark.

The migratory species which may be present in the two MMAs include:
- birds, including various species of albatross and tern;
- whales and dolphins;
- turtles and rays; and
- sharks including the white shark and the porbeagle, mackerel shark.

The EPBC Act Protected Matters database searches recorded a number of listed threatened and migratory species that could occur in or around the MMAs. No threatened ecological communities were recorded. The EPBC Act Protected Matters database reports can be found at Appendices 16 and 17.

In deciding whether or not to approve the Proposal consideration must also be given to s 139 and s 140 of the EPBC Act, which address requirements about decisions relating to threatened species and endangered communities and decisions relating to migratory species respectively.

If the Proposal is approved, the Commonwealth Minister for the Environment may choose to set conditions under which the Proposal must be implemented.

5.2 Summary of risks to MNES

Potential impacts on MNES, together with full details of the risk assessment for all species are detailed in Section 4.2.3. A summary of the potential risks to each category of MNES has been compiled at Table 12.

In summary, the Proposal is not expected to result in unacceptable or unsustainable impacts on MNES.

Table 12. Outcomes of the risk assessment for listed threatened and migratory species under the EPBC Act as extracted from the EPBC Act Protected Matters database.

Fauna	EPBC Listing	Likelihood/Impact	Risk Score	Risk
White shark	Threatened Migratory	Remote likelihood of having a minor level of consequence on the total size and migratory patterns of the southwestern Australian population.	1	Negligible
Grey nurse shark	Threatened	High likelihood to have no or negligible impact	0	Negligible
Shortfin mako*	Migratory	High likelihood to have a negligible impact	0	Negligible
Other elasmobranchs (sharks and rays)**	Threatened Migratory	High likelihood to have no impact	0	Negligible
Australian sea lion	Threatened	High likelihood to have no impact	0	No or negligible
Turtles	Threatened Migratory	High likelihood to have no impact	0	No or negligible
Whales***	Threatened Migratory	High likelihood to have no impact	0	Negligible
Dolphins	Migratory	High likelihood to have no impact	0	Negligible
Seabirds	Threatened Migratory	High likelihood to have no impact	0	No or negligible

* Shortfin mako does not appear on the EPBC Act Protected Matters report however has been included due to its listing as a migratory species under the EPBC Act.
** Includes whale sharks, porbeagle, mackerel sharks and manta rays.
*** Includes killer whales.

5.3 Consideration of s 139 and s 140 of the EPBC Act

The risk assessment concluded there to be either no or negligible, or negligible risks to all listed threatened and migratory species (MNES) (Table 12).

In considering s 139 of the EPBC Act, the Proposal is not likely to have significant impacts on any listed threatened species and therefore will not result in actions that may be inconsistent with Australia's obligations under international treaties relating to threatened species including the Biodiversity Convention.

In addition, the Government has an ongoing commitment to research into white sharks, including population, behavioural and movement and aggregation site identification studies. DoF (2014d) are currently undertaking a study into a risk-based, weight of evidence approach to determine the range of plausible estimates for the southwestern Australian population of white sharks (Appendix 9). The Government continues to invest in the Shark Monitoring Network (SMN) through DoF. The SMN tracks the movements of acoustically tagged sharks along the Western Australian coastline using arrays of real-time satellite linked acoustic receivers (VR4G) and sea-floor mounted data-recording acoustic receivers (VR2W). In addition, as part of a joint Commonwealth and State project facilitated through CSIRO and DoF, a project is underway to identify aggregation sites of the southwestern population of white sharks using aerial surveys and DNA fingerprinting of juvenile white sharks. It is considered that this research, together with investments into applied research programs to develop non-lethal shark detection and deterrent technologies, contribute to the requirements of Objective 1 of the National Recovery Plan for the white shark (SEWPaC 2013) (Appendix 15).

In considering s 140 of the EPBC Act, and the determination of either no or negligible, or negligible risks to migratory species, including the white shark and the shortfin mako shark, the Proposal is not considered to result in actions that are inconsistent with Australia's obligations under the Bonn Convention (CMS). While the take of white sharks is prohibited through their listing under Appendix I of the CMS, article III(5)(d) provides an exception to this where extraordinary circumstances require. Public safety is considered a matter of national interest. Western Australia has experienced 20 fatal shark attacks in the last 100 years, however 10 of these have been in the last 10 years, and seven within the last three and a half years. This has resulted in Western Australia experiencing the highest number of fatal shark attacks in Australia in the last 10 years. This unprecedented density of fatalities over a short period of time, including the impacts on communities, culture, tourism and the economy (considered in Section 4.4) should therefore be considered to meet the requirement of extraordinary circumstances.

As discussed in Section 1.1, since 2008, the Government has been working to address the issue of human-shark interactions. More than $22million has been committed to 2015-16 for a broad range of shark hazard mitigation measures including aerial and beach surveillance, beach enclosure trials, community awareness and education programs and a range of research initiatives (refer to Figure 1 for a full description of the measures implemented by the Government). The latest fatality in November 2013 prompted the Government to consider the deployment of drum lines to provide a shark hazard mitigation measure for water users in addition to those already implemented.

The Proposal has been designed following a close examination of shark control programs in other jurisdictions, and a review of the catch data from the trial program. The result is a very conservative program, explicitly designed to minimise environmental impacts. The Proposal includes the setting of up to 60 static drum lines along <1% of the Western Australian coastline between 15 November and 30 April for three consecutive years. The Proposal contains provision to deploy temporary drum lines in response to an identified shark threat or incident which would see up to five drum lines deployed in a particular location and monitored continuously for up to one hour (per response) in response to a sighting, and for up to one week (per incident) in response to an incident. The Proposal is therefore conservative by design, and limited in both space and time, and as such should not result in any disadvantage to the species.

5.4 Offsets under the EPBC Act

The risk assessment provided in this PER at Section 4.2.3 concludes there to be either no or negligible, or negligible risks to all listed MNES within the two MMAs. Consequently, the Government considers there will be no significant residual impacts from the Proposal and is therefore offsets under the EPBC Act are not proposed.

6 CONCLUSION

The Proposal involves a number of mitigative measures designed to either avoid environmental impacts or where unavoidable, to minimise and/or rectify where appropriate. The measures that are proposed are:

- the use of a large (no smaller than an approximate 25/0 circle) hook designed to limit the types and sizes of non-target species likely to be captured;
- limited number of drum lines (a maximum of 72 drum lines to be deployed at any one time);
- monitoring and maintenance of static drum lines to occur between 0600 and 1800 hours, seven days a week;
- beaches selected in conjunction with aerial and land patrols, so that the contractor may be notified of any captures;
- a limited area in which static drum lines are to be deployed (<0.1% of Western Australian waters and <1% of the Western Australian coastline);
- a limited time in which static drum lines are to be deployed (5.5 months per year);
- the removal of static drum lines between 1 May and 14 November each year to avoid annual whale migrations along the Western Australian coastline;
- a preference for the use of shark as bait to reduce interactions with other marine species;
- no deployment of nets or any net meshing system:
- the low frequency and small number of temporary drum lines that may be deployed (a maximum of five per response) and the high level of monitoring that will occur if they are deployed;
- defining only three target species, of 300cm TL or greater;
- suitable distance of the hook below the sea surface to reduce interactions with seabirds;
- development of ranges or levels of acceptable catch for each of the target species and other potential bycatch species;
- actual numbers captured to be examined against acceptable ranges each year to ensure that the risk levels have not materially altered;
- maintenance of detailed records of all catches for weekly monitoring of catch data to identify potential trigger points as discussed in the draft Management Plan;
- provision of detailed records of all catches (including digital photographs) to relevant authorities for ongoing assessment and species identification purposes;
- provision for an additional review to be undertaken prior to the standard annual review should a major increase in the rate of captures for any species occur within a season;
- training in animal handling and best practice techniques to increase the chance of survival of non-target species;
- assessment throughout and following the end of the program by relevant technical experts from DoF and, where necessary, DPaW;
- a requirement for observers to be aboard each vessel on the first day of deployment and on a defined number of trips thereafter; and
- the restriction of the program to operate for only three years, after which a further review of the program will be undertaken.

The potential risks to target and non-target species arising from the deployment of static drum lines under the Proposal were assessed using risk assessment methods that conform to international standards (IEC/ISO 31010 2009; SA 2012). These procedures used the information currently available, which included, but was not limited to, the results obtained from the trial drum line program which ran between January and April 2014.

In considering all of the mitigative measures detailed above, the deployment of static drum lines was assessed as posing only negligible risks to the population status of two of the three target species, the non-target species and the broader ecosystem. The Proposal is not anticipated to impact on the effective viability or sustainability of Marine Fauna or MNES. The risk assessment identified a low level of risk to the Western Australian tiger shark population which will require a higher level of monitoring and a specific assessment for tiger sharks to be completed at the end of the three year period.

It is anticipated that fewer than 10 white sharks and even fewer in the target range (≥300 cm TL) will be caught each year, leading to a cumulative catch of less than 25 white sharks over the three year program. The anticipated catch levels would only be increasing annual catch by less than 10%. The cumulative impact of the three year Proposal, assuming catch levels close to 10 individuals per year is assessed as posing only a negligible risk to the population.

The total number of tiger sharks estimated to be captured per season is close to 300. This equates to approximately 25 to 40 tonne per year depending upon the level of release mortality (0-100%). It is determined that the Proposal may generate a minor consequence, and therefore represent a low risk to the Western Australian tiger shark population. This acceptable level of risk requires a higher level of monitoring and a specific assessment for tiger sharks to be completed at the end of the three year period.

The Proposal is anticipated to generate negligible impacts on each of the species which is also consistent with no trophic impacts being generated. The cumulative total for all captures of all species is very small (approximately 45 tonne per year) when compared to the total combined levels of commercial capture of sharks that previously occurred within this bioregion (> 500 tonne per year). The level of commercial shark capture in the West Coast Bioregion has been reduced from 500 tonne to less than 250 tonne annually, and is expected to operate at this lower level into the future.
Consequently, the additional ~45 tonne per year of sharks to be captured under the Proposal poses a negligible risk to the community structure of the Leeuwin-Naturaliste ecosystem and no impacts on the effective viability or sustainability of Marine Fauna or MNES.

Temporary drum lines
The risk assessment was undertaken based on the static drum line component of the Proposal. As discussed at Section 2.3 the Proposal also includes a provision for responding to an identified shark threat or incident in Western Australian waters at any time. The frequency with which a response is likely to be enacted is considered to be rare. Orders to deploy capture gear in response to a shark considered to be posing a threat to public safety, or following an incident, were issued only eight times over more than 480 days between January 2013 and 30 April 2014.

In the event that temporary drum lines are deployed to target a specific shark, while the capture of a target shark cannot be guaranteed, lines would be closely monitored for the duration of their deployment to minimise any environmental impacts to non-target species. Drum lines deployed in response to a sighting would be monitored continuously up to a maximum of one hour per response. Drum lines which are set in response to an attack would be closely monitored for up to a maximum of one week per incident.

The outcomes of the risk assessment of the potential environmental impacts of deploying static drum lines (as detailed above and in Section 4.2.3) have been used to guide a determination of the potential environmental impacts of the setting of temporary drum lines anywhere in Western Australian waters at any time. In considering the low frequency of when temporary drum lines may be deployed, the small number of lines that may be deployed (a maximum of five per response) and the high level of monitoring that will occur if they are deployed, it is considered that the setting of temporary drum lines in response to a shark attack or shark sighting considered to be posing a threat to public safety will have no, to negligible, risk to Marine Fauna or MNES, and pose no risk to the ecological values associated with marine protected areas, in particular to marine sanctuary or recreation zones or Fish Habitat Protection Areas.

It is with a high degree of confidence the Government considers that, in conjunction with the draft Management Plan, the EPA objective for Marine Fauna to maintain the diversity, geographic distribution and viability of fauna at the species and population levels can be met. The Proposal is also not expected to result in unacceptable or unsustainable impacts to MNES.

The Government remains committed to its investments into other shark hazard mitigation strategies including research into white shark populations and identification of aggregation sites, Surf Life Saving WA beach and aerial patrols and associated infrastructure, the construction of a watchtower at Cottesloe Beach, swimming enclosures at suitable beaches and community engagement and education.

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8 APPENDICES

Appendix 1. Western Australian Shark Hazard Mitigation Drum Line Program 2014-2017 (Assessment No. 2005) Environmental Scoping Document

Appendix 2. Draft Management Plan for the Western Australian Government Shark Hazard Mitigation Drum Line Program

Appendix 3. Guidelines for Fishing for Sharks Posing an Imminent Threat to Public Safety, Department of Fisheries.

Appendix 4. DoF (2012). A correlation study of the potential risk factors associated with white shark attacks in Western Australian waters. Department of Fisheries, Fisheries Occasional Publication No 109

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Appendix 6. DoF (2014a). *Research advice on the Proposed Shark Mitigation Strategy using drum lines for January to April 2014*. Department of Fisheries Research Division, Western Australia, January 2014.

Appendix 7. DoF (2014b). Review of the outcomes from the drum line component of the Shark Mitigation Strategy for the trial period January - April 2014. Report submitted to the Department of Premier and Cabinet, May 2014. Department of Fisheries, Western Australia.

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Appendix 9. DoF (2014d). A risk-based, weight of evidence approach to determine the range of plausible estimates for the southwestern Australian population of white sharks. *Fisheries Research Report*, Department of Fisheries, Western Australia

Appendix 10. Cliff, G. and Dudley, S.F.J. (2011). Reducing the environmental impact of shark-control programs: a case study from KwaZulu-Natal, South Africa. *Marine and Freshwater Research*, **62:**700-709

Appendix 11. Dudley, S.F.J. and Gribble, N.A. (1999). Management of Shark Control Programs. In 'Case studies of the management of elasmobranch fisheries'. FAO Fisheries Technical Paper No 378

Appendix 12. Godin, A.C., Carlson, J.K. and Burgener, V. (2012). The effect of circle hooks on shark catchability and at-vessel mortality rates in longline fisheries. *Bulletin of Marine Science,* **88 (3)**: 469-483

Appendix 13. Green, M., Ganassin, C. and Reid, D.D. (2009). Report into the NSW Shark Meshing (Bather Protection) Program, New South Wales Department of Primary Industries, Sydney

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Appendix 15. (SEWPaC 2013) Recovery plan for the white shark (*Carcharodon carcharias*). Department of Sustainability, Environment, Water, Population and Communities, Commonwealth of Australia

Appendix 16. EPBC Act Protected Matters Report for the metropolitan MMA

Appendix 17. EPBC Act Protected Matters Report for the south west MMA

Appendix 18. Risk assessment categories and levels

Appendix 19: Environmental offsets reporting form