

Chapter 1

Introduction

1.1 The waters around Australia contain many species of sharks. Although most species are not dangerous to humans, in a number of tragic cases people who encounter those that are have suffered serious injuries or been killed. These encounters, or concerns about the potential for them, have led to the implementation of measures intended to promote public safety, some of which are designed to be lethal to sharks but can also result in the unwanted capture of other marine life. Although lethal measures are in place in certain parts of the country, Australian governments have, over many years, contributed to global conservation efforts in response to concerns about declining shark populations. Australia is party to international agreements that seek to ensure shark populations are managed sustainably and some shark species are protected under Commonwealth law.

1.2 Essentially, this inquiry examines the effectiveness of the lethal and non-lethal measures taken in Australia to protect the public from dangerous species of sharks. In doing so, the committee explores how the public safety measures, shark conservation efforts and Commonwealth environmental law interact; considers whether the current arrangements represent the most desirable and effective response; and looks to the future to understand developments that may improve public safety significantly without harming the marine environment.

Referral

1.3 On 30 November 2016, the Senate referred the following matter to the Environment and Communications References Committee for inquiry and report:

The efficacy and regulation of shark mitigation and deterrent measures, with particular reference to:

- (a) research into shark numbers, behaviour and habitat;
- (b) the regulation of mitigation and deterrent measures under the *Environment Protection and Biodiversity Conservation Act 1999*, including exemptions from a controlled action under section 158;
- (c) the range of mitigation and deterrent measures currently in use;
- (d) emerging mitigation and deterrent measures;
- (e) bycatch from mitigation and deterrent measures;
- (f) alternatives to currently employed mitigation and deterrent measures, including education;
- (g) the impact of shark attacks on tourism and related industries; and
- (h) any other relevant matters.¹

1 *Journals of the Senate*, 2016–17, no. 22 (30 November 2016), pp. 710–11.

1.4 The committee was initially required to report by 30 June 2017. However, on 19 June 2017, the Senate granted an extension of time to report until 29 November 2017.² On 28 November 2017, the reporting date was extended further to 12 December 2017.³

Conduct of the inquiry

1.5 In accordance with its usual practice, the committee advertised the inquiry on its website and wrote to relevant individuals and organisations inviting submissions. The date for receipt of submissions was 3 March 2017.

1.6 The committee received 78 submissions, which are listed at Appendix 1. In addition to the detailed submissions, a form letter from 223 individuals was received and published.

1.7 The committee held ten public hearings for this inquiry, as follows:

- Sydney, 16 March 2017 and 17 March 2017;
- Perth, 20 April 2017 and 28 July 2017;
- Byron Bay, 2 May 2017;
- Brisbane, 31 July 2017;
- Cairns, 29 August 2017;
- Townsville, 30 August 2017; and
- Canberra, 20 October 2017 and 14 November 2017.

1.8 A list of witnesses who appeared at the hearings is at Appendix 2.

1.9 The public submissions and transcripts of evidence are available on the committee's website at www.aph.gov.au/senate_ec.

Acknowledgement

1.10 The committee thanks all of the individuals, organisations and Commonwealth government departments and agencies that contributed to the inquiry.

1.11 The committee is particularly grateful to the individuals personally affected by shark bite incidents who were prepared to discuss their experiences with the committee at the public hearings. These individuals included: Mr Dale Carr, who was bitten in August 2015; Mr Rick Gerring, whose brother died in May 2016 as the result of a shark attack; and Dr Sharon Burden, whose 21-year-old son died in a shark attack in 2011. The committee also received evidence from individuals involved in the response to shark bites.

2 *Journals of the Senate*, 2016–17, no. 45 (19 June 2017), p. 1472.

3 *Journals of the Senate*, 28 November 2017, p. 2312.

1.12 As this inquiry examined issues involving matters of both Commonwealth and state government responsibility, the committee sought and received evidence from certain state governments. This included written evidence from the Queensland and South Australian governments, and the then Premier of Western Australia, the Hon Colin Barnett. Evidence was also given at a public hearing by the Hon David Kelly MLA, Western Australian Minister for Fisheries, and officers of his department. The committee wishes to record its appreciation to these state governments for the assistance provided during this inquiry.

Structure of the report

1.13 This report comprises eight chapters, as follows:

- Chapter 1—this chapter has outlined introductory matters regarding the referral and conduct of the inquiry. The remaining sections of the chapter provide background information about sharks in Australian waters and the legal framework that applies to shark protection and conservation.
- Chapter 2 considers the frequency of human–shark interactions in Australian waters. The chapter also explores various other matters, such as public awareness and fear of sharks, and the available evidence about the impact of shark bites on regional tourism.
- Chapter 3 presents an overview of existing shark mitigation and deterrent measures used in Australia, including both non-lethal measures (such as surf lifesaving and aerial surveillance) and the lethal shark control programs operated by some state governments.
- Chapter 4 continues with the discussion of lethal shark control programs by examining the conflicting points of view about whether such programs are effective.
- Chapter 5 examines the Commonwealth's responsibilities with respect to the lethal shark control programs arising under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- Chapter 6 addresses the evidence received about new and emerging technologies that may provide beachgoers with more effective protection from dangerous sharks while also minimising any impact on the marine environment.
- Chapter 7 continues on the topic of alternative methods for managing the risk of human–shark interactions by examining evidence received about other approaches that are not necessarily dependent on new technology, such as shark spotting and education programs. The chapter also outlines the evidence received on whether new, emerging or other approaches to shark management are, at this time, able offer reliable protection.
- Chapter 8 contains the committee's conclusions and recommendations.

1.14 In addition, Appendix 3 to the report presents a selection of myths and misconceptions about sharks. These myths were discussed during public hearings and are highlighted in this report as it was argued that they have implications for informed policymaking about sharks.

Shark numbers, species, behaviour and habitat

1.15 The following section provides background information about the types of sharks that can be found in Australian waters.

Overview

1.16 Around 180 species of sharks can be found in Australian waters.⁴ Most sharks live in marine environments, however, a small number of species have adapted to freshwater habitats, such as the Northern River shark (*Glyphis garricki*) and spartooth shark (*Glyphis glyphis*) found in northern Australia.⁵

1.17 Sharks comprise around one per cent of all fishes and 'share nearly all the major features of their finned relatives', including the use of gills to extract oxygen from water.⁶ The following information published by the Department of the Environment and Energy (DoEE) provides an overview of the feeding habits of sharks in Australian waters:

Most sharks are predators. Many sharks species become active after dusk and hunt during the night. The majority of sharks feed on other fishes. Large sharks, such as the white shark (*Carcharodon carcharias*) and tiger shark (*Galeocerdo cuvier*), prey on large marine mammals such as seals, sea-lions, dolphins as well as large fishes, turtles and even sea birds.

While some sharks are probably not very selective feeders, certain sharks eat some foods more than others. For example, hammerhead sharks are known for eating stingrays; bull sharks eat other sharks; and smooth dogfish eat crabs and lobsters.⁷

1.18 Not all shark species are dangerous to humans. Available data indicate that the overwhelming majority of shark bites in Australia, including 99 per cent of fatalities, can be attributed to three species of sharks: the white shark (*Carcharodon*

4 Department of the Environment and Energy (DoEE), 'Sharks in Australian waters', www.environment.gov.au/marine/marine-species/sharks (accessed 2 November 2017).

5 DoEE, 'Sharks in Australian waters'.

6 DoEE, 'Sharks in Australian waters'.

7 DoEE, 'Sharks in Australian waters'.

carcharias), tiger shark (*Galeocerdo cuvier*) and bull shark (*Carcharhinus leucas*).⁸ Information published by the DoEE suggests that, at present, it is understood that the shark species known to be dangerous to humans do not target humans as prey, instead 'the majority of shark attacks can be attributed to the shark confusing us with its normal prey'.⁹

Population

1.19 Potentially declining shark populations has been a matter of concern for a sustained period, as demonstrated by the 1999 United Nations International Plan of Action for Conservation and Management of Sharks. Concerns about shark numbers and the need for shark conservation follow overexploitation of certain shark species, with their recovery affected by 'slow rates of growth, late age-at-maturity and low fecundity compared with bony fishes'.¹⁰ Globally, sharks are harvested for meat, fins, skin, cartilage and liver, with shark meat and fins used for food, shark skin primarily used for leather, cartilage used for food and in the pharmaceutical industry, and liver 'mostly used to extract oils and other hydrocarbons, which have been used in a wide array of industries throughout history'.¹¹ Approximately one-quarter of the total number of shark species are threatened with an elevated risk of extinction, largely due to over-fishing, including as bycatch.¹²

1.20 In addition to fishing activity that targets shark species, sharks are also caught as bycatch by fishing efforts directed at other marine species.¹³ Shark populations are also vulnerable as a result of recreational fishing, habitat degradation and shark control activities.¹⁴

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- 8 Taronga Conservation Society Australia, 'Australian shark attack file: FAQs', <https://taronga.org.au/conservation/conservation-science-research/australian-shark-attack-file/faqs> (accessed 5 December 2016). See also New South Wales Department of Primary Industries (DPI), 'Identifying sharks', www.dpi.nsw.gov.au/fishing/sharks/identifying-sharks (accessed 5 December 2016).
- 9 DoEE, 'Sharks in Australian waters', www.environment.gov.au/marine/marine-species/sharks (accessed 2 November 2017).
- 10 Food and Agriculture Organization of the United Nations (FAO), 'Sharks', www.fao.org/ipoa-sharks/background/sharks/en/ (accessed 20 January 2017).
- 11 FAO, 'Sharks', www.fao.org/ipoa-sharks/background/sharks/en/ (accessed 20 January 2017).
- 12 Professor Colin Simpfendorfer, *Committee Hansard*, 30 August 2017, pp. 1–2.
- 13 Department of Agriculture, Fisheries and Forestry, *National Plan of Action for the Conservation and Management of Sharks 2012*, www.agriculture.gov.au/SiteCollectionDocuments/fisheries/environment/sharks/sharkplan2-final/sharkplan2-action.pdf (accessed 10 January 2017), p. 1.
- 14 DoEE, 'Sharks in Australian waters'.

1.21 As at October 2017, nine shark species are classified under the EPBC Act as threatened species due to declining populations. In particular, the east coast population of the grey nurse shark (*Carcharias taurus*) and the spartooth shark (*Glyphis glyphis*) are listed as critically endangered species. The white shark is listed as vulnerable.¹⁵

1.22 In relation to the white shark, it is listed as vulnerable on the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species.¹⁶ The DoEE advised that it was first listed as vulnerable under Commonwealth legislation in 1997 under the *Endangered Species Protection Act 1992*. This listing was transferred to the EPBC Act's threatened species list in 2001. The DoEE noted that the white shark 'is also provided legislative protection under state and territory legislation throughout its range in coastal waters, and is protected under the Convention on International Trade in Endangered Species and Convention on Migratory Species conventions'.¹⁷

1.23 Many submitters noted that accurate information about the population of shark species is limited. As noted by CSIRO, there 'are no current reliable estimates of population size in Australian waters for white, bull or tiger sharks'. CSIRO explained that these species have not been the primary focus of commercial fisheries, and the conventional data required to produce reliable estimates 'such as detailed catch records over suitable time periods, is limited, unreliable or non-existent'.¹⁸

1.24 CSIRO added:

White sharks have been protected in Australian waters since the late 1990s, but data on their historical and contemporary catch has been poorly recorded and is inadequate for estimating population size or trend. Bull and tiger sharks have not been the focus of targeted research to estimate population size in Australian waters, although analyses of tiger sharks captured in the Queensland Shark Control Program...indicate significant declines in catch rates and average size between 1993 and 2010...¹⁹

15 DoEE, 'Sharks in Australian waters'.

16 International Union for the Conservation of Nature (IUCN) Red List, '*Carcharodon carcharias*', www.iucnredlist.org/details/3855/0 (accessed 12 July 2017). The IUCN Red List catalogues the global conservation status of animal, fungi and plant species. It seeks to determine the relative risk of extinction and highlight those that are facing a higher risk of global extinction. See IUCN Red List, 'Introduction', www.iucnredlist.org/about/introduction (accessed 12 July 2017).

17 DoEE, Answers to questions on notice, 16 March 2017 (received 19 April 2017), p. 3.

18 CSIRO, *Submission 33*, p. 7.

19 CSIRO, *Submission 33*, p. 7 (citation omitted). See also Dr Daniel Bucher and Professor Peter Harrison, *Submission 23*, pp. 2–3.

1.25 The SEA LIFE Trust explained that a lack of information on population status of white sharks is a global problem that is not just limited to Australia. The SEA LIFE Trust submitted:

The population status in Australia, and globally, is...poorly known owing to a lack of robust abundance indicators. Quantitative stock assessments are not possible. The Great White Shark is, however, uncommon compared to other sharks and evidence (from game fishing, bycatch, shark netting or from observational data) indicates a declining global population.

Evidence suggests that the population may have declined by at least 20% over the last three generations and, in some areas, the species is considered to have declined even more substantially over the same period.²⁰

1.26 Regarding white sharks, in 2014 CSIRO and partners in the National Environmental Science Program 'reported the first ever empirical estimate of adult white shark abundance—provisionally 750 to 1,200 adult white sharks for the eastern Australia population'. CSIRO added that subsequent data and refinements to the analysis 'suggest that the figure is more likely to be at the lower end of this scale'.²¹ CSIRO further added that the total population of white sharks is likely around ten times the adult population.²²

1.27 Dr Daniel Bucher and Professor Peter Harrison also referred to the recent estimate of the east coast population of adult white sharks. However, Dr Bucher and Professor Harrison noted that 'there are no estimates for juvenile and sub-adult white sharks, which are the size categories (2.0–3.5 m) generally found in coastal waters and implicated in recent events'. Overall their joint submission concluded that:

There is...historical evidence of a greater decline in white shark numbers than other shark species and no current evidence supporting a recovery in numbers...Furthermore, it is widely acknowledged that many large shark species (>2 m) are unable to increase their populations rapidly due to life history characteristics such as slow growth, late maturity and low reproduction rates...²³

1.28 Other submitters also provided reasons supporting the proposition that there has been a long-term decline in the white shark population. Sharksafe Barrier, a South African company that supplies eco-friendly barriers designed to separate humans from sharks (these devices are discussed in Chapter 6), submitted:

20 SEA LIFE Trust, *Submission 25*, pp. 3–4.

21 CSIRO, *Submission 33*, p. 6.

22 Professor Nic Bax explained that 'if you...look at the simple demographics of white shark—how long they live, how many pups they produce, how frequently the females reproduce—you would come up with an estimate that the total population of sharks would be about 10 times the adult population'. Professor Nic Bax, Senior Principal Research Scientist, CSIRO, *Committee Hansard*, 20 October 2017, p. 4.

23 Dr Daniel Bucher and Professor Peter Harrison, *Submission 23*, p. 3 (citations omitted).

White sharks have long lifespan, slow growth, have low estimated fecundity, and low natural mortality within the marine ecosystem (only orca are known to prey on adult white sharks in areas where the two species overlap). It is therefore believed that increasing conflict with man during the past century is the main cause of population declines of this ancient top-predator.²⁴

1.29 Sharksafe Barrier added that there are three key human-related drivers of declining white shark populations: depleted food resources, bioaccumulation of pollutants and lethal beach protection measures.²⁵

1.30 Some individuals, however, questioned how assessments about the conservation status of shark species, particularly the white shark, can be made when reliable population information is not available. For example, Mr John Heaton, a resident of the New South Wales north coast, submitted:

I keep hearing from shark experts and scientists that world-wide, Great White numbers are still low. However the frustrating thing is that no expert, scientist or organisation can say how many Great Whites are actually travelling along the east coast of Australia and/or is that number adequate or not for the marine habitat. Local professional fisher people tell me the ocean off the North Coast of NSW coastline is teeming with sharks, including Great Whites.²⁶

1.31 A similar sentiment was expressed by a Western Australian resident:

Scientists do not know the numbers of great white sharks. Daily WA ocean users see the evidence of increasing numbers and this 'local knowledge' cannot be discounted. Old time fishermen who have fished off our coast all their lives say the ocean off Perth and our south west is now teeming with sharks, including great whites. It is common sense that great white numbers have increased since they became a protected species in 1997. This coincided with an increase in the migrating whale population and the decline of our commercial fishing fleet. The decision to close the Perth fishery was a foolish one because it was an economically efficient way to manage great white numbers.²⁷

1.32 Mr Donald Munro remarked that commercial fishers on the east coast suggest that the estimate referred to in paragraph 1.26 'is a mile out'. Mr Munro added:

It is a little bit hard for me to come to grips with the fact that with today's technology they cannot get a more accurate figure. We could stick a man on the moon in 1969 and bring him back, for God's sake. This is 2017. So it is

24 Sharksafe Barrier, *Submission 29*, p. 4.

25 Sharksafe Barrier, *Submission 29*, p. 4.

26 Mr John Heaton, *Submission 11*, p. 2.

27 Mrs Rebecca Clough, *Submission 66*, p. 1.

frustrating, but definitely, categorically I will state that direct information from commercial fishermen particularly...is that the numbers are way up.²⁸

1.33 However, scientists involved in shark research and other stakeholders cast doubt on claims regarding significant increases in white shark numbers and explained that there are particular difficulties associated with studying white sharks. For example, in response to the suggestion that coastal waters are 'teeming' with white sharks, Professor Nic Bax, a senior principal research scientist at CSIRO stated:

...given the life history strategies of the white shark—and you're looking at the life history parameters—it would be hard to imagine that their growth rate could be more than about four per cent a year. So an explosion in that sense, four per cent a year, depending on how you consider a four per cent increase, is the maximum rate of increase we would expect given the shark demographics...And, of course, we have no evidence that it is increasing at four per cent. It could be decreasing at four per cent. We don't know.²⁹

1.34 Other submitters also asserted that anecdotes about shark populations are not credible. For example, Humane Society International (HSI) submitted:

There is a limited amount of data on white shark population numbers, behaviour and habitat preferences. We note that while there have been claims in the media of 'increases' in white shark numbers in Australia, these anecdotal reports have not been verified by scientists who work specifically with the species. Presentations during the 2015 NSW Shark Summit focused on the lack of evidence of any kind of surge in white shark numbers. The Summit addressed the fact that the species continues to be listed under federal law as vulnerable to extinction. It seems that in the case of the white shark, opinion is given credence over evidence.³⁰

1.35 Professor Jessica Meeuwig argued that it is 'unlikely that there has been a population boom in white sharks, given their basic, fundamental biology'.³¹ After noting that white sharks only start reproducing between 17–20 years of age and 'have one or two offspring every couple years', Professor Meeuwig emphasised that white sharks 'are just not capable of rapid rebound like a herring or a pilchard'.³²

1.36 Professor Meeuwig added that anecdotal information about increases in shark populations could be linked to an increase in sampling efforts; that is, a greater number of people being in the water results in a higher number of observations.³³

28 Mr Donald Munro, President, Le-Ba Boardriders; and Spokesperson, Lennox Head National Surfing Reserve, *Committee Hansard*, 2 May 2017, p. 3.

29 Professor Nic Bax, CSIRO, *Committee Hansard*, 20 October 2017, p. 4.

30 Humane Society International, *Submission 43*, p. 5.

31 Professor Jessica Meeuwig, *Committee Hansard*, 20 April 2017, p. 36.

32 Professor Jessica Meeuwig, *Committee Hansard*, 20 April 2017, p. 44.

33 Professor Jessica Meeuwig, *Committee Hansard*, 20 April 2017, p. 44.

In addition, Professor Bucher commented that the number of observations might be affected as people 'tend to remember the big things, the shocking things'; Professor Bucher added that people will remember when they see a shark but will not 'remember so much how many times [they] did not see a shark'.³⁴

1.37 Changes in the areas favoured by sharks could also be resulting in an increased frequency of shark observations. Professor Meeuwig explained that climate change could affect the distribution of animals on which sharks prey, leading to white sharks approaching the coast but not being indicative of an overall increase in the population.³⁵

1.38 On the difficulties in studying white sharks, Professor Colin Simpfendorfer told the committee:

All species can provide challenges. As technology has developed we have become much better at doing it. But some of the challenges are that it is a very big ocean and there is not a huge number of white sharks, for example, out there. So finding them and studying them when you find them is difficult. The other challenge they present is that they move over vast distances. We have white sharks that swim regularly between Australia and New Zealand, for example. When you are moving over that sort of distance, it is a challenge to understand what is going on. Technology also only gives us answers about so many bits and pieces.³⁶

1.39 Ms Tooni Mahto from the Australian Marine Conservation Society (AMCS) emphasised the need to consider the migratory nature of species such as white sharks when considering population estimates. Ms Mahto stated:

White sharks move. They are migratory animals and travel huge distances across the oceans. They are not permanent residents at any location around our coastline. So sporadic anecdotal increases in particular locations are not an indication of a population increase and are more likely the result of changes in prey distribution in their physical environment.³⁷

1.40 Nevertheless, given the scientific uncertainty about the white shark population, some submitters questioned how future decisions about categorising the white shark as a listed threatened species under the EPBC Act could be made.³⁸

34 Professor Daniel Bucher, *Committee Hansard*, 2 May 2017, p. 50.

35 Professor Jessica Meeuwig, *Committee Hansard*, 20 April 2017, p. 44.

36 Professor Colin Simpfendorfer, *Committee Hansard*, 30 August 2017, p. 3.

37 Ms Tooni Mahto, Senior Marine Campaigner, Australian Marine Conservation Society, *Committee Hansard*, 2 May 2017, p. 53.

38 See Mr John Heaton, *Submission 11*, p. 2.

1.41 Despite advising that the lack of reliable data means it is 'not currently possible to say' if the populations of bull, tiger or white sharks are increasing, decreasing or stable, CSIRO informed the committee that research is underway to develop means for obtaining white shark population estimates. CSIRO explained that it is undertaking research in a partnership under the National Environmental Science Program with the aim of developing, applying and refining 'novel techniques for estimating total population size for white sharks in Australian waters'.³⁹ CSIRO added that data collected for the 2014 estimate of adult white shark abundance for the eastern Australia population are being 'further developed to give an estimate of total population size' as well as to extract information about the juveniles in the population.⁴⁰ The data collected from this process will support the recovery plan for the white shark (which is discussed in Chapter 5).⁴¹

1.42 CSIRO also noted that data on the incidence and frequency of shark bites 'may not have a direct relationship to local shark abundance and cannot be used as a proxy for shark population trend'.⁴² Furthermore, CSIRO added that although the data it is collecting to estimate the white shark population will be 'a highly statistically robust estimate', the data will be an estimate of abundance, not the trend in population.⁴³

1.43 Finally, in an answer to a question taken on notice, CSIRO identified the need for additional research to enhance understanding of the current state of shark populations. CSIRO suggested that a focus of this research could be the 'ongoing data collection and monitoring to support the determination of population trends', with this data collection effort to include sampling of white sharks in state government tagging programs as well as white sharks caught in shark control programs and as commercial fisheries bycatch. CSIRO submitted:

Current research will provide a more precise estimate of when the assessment should be updated and further tested for population trend, but practical reasons would suggest reassessment once about 100 new samples have been collected or after 1–2 years. The majority of tissue samples are being taken as part of the State run tagging programs; these programs are critical for obtaining the necessary data to estimate population size and trend, and will ensure the required number of samples to estimate these parameters are obtained in the shortest possible time.⁴⁴

39 CSIRO, *Submission 33*, p. 1.

40 CSIRO, *Submission 33*, p. 7.

41 Professor Nic Bax, CSIRO, *Committee Hansard*, 20 October 2017, p. 3.

42 CSIRO, *Submission 33*, p. 10.

43 Professor Nic Bax, CSIRO, *Committee Hansard*, 20 October 2017, p. 4.

44 CSIRO, *Answers to questions on notice*, 20 October 2017 (received 24 November 2017), p. 2.

Behaviour and habitat

1.44 CSIRO explained that bull, tiger and white sharks have similar movement patterns in that they 'roam over considerable distances (1000s of km)...and utilise both nearshore and offshore waters as part of their normal habitat'. Regarding white sharks, CSIRO noted that they 'are not permanent residents at any one site' with movements that 'indicate temporary residency at various sites, mixed with periods of long-distance travel that may include common corridors'.⁴⁵ Furthermore:

Research indicates broad-scale movements of white sharks in eastern Australia between Tasmania and central Queensland and between eastern Australia and New Zealand. Movements include multi-year return and occupancy of two known east coast nursery areas (Port Stephens, New South Wales and 90 Mile Beach-Corner Inlet area, Victoria).

Nearshore areas, including surf zones and some estuaries, are common habitat for juvenile white sharks with sporadic areas of temporary residency along the coast likely in response to the distribution of prey.⁴⁶

1.45 CSIRO added that, although Bass Strait is not a barrier to movement, 'the general pattern is for sharks to remain either east or west of Bass Strait'.⁴⁷

1.46 In their joint submission, Dr Daniel Bucher and Professor Peter Harrison provided the following insights into shark behaviour:

While there is a lack of data on shark behaviour, 'normal' behaviour for sharks is generally considered to be following and hunting prey. These prey are primarily fish, however, depending on the species, sharks also eat a variety of other marine animals (marine mammals, other sharks, sea turtles, squid, crustaceans and seabirds). Food availability is generally driven by seasonal changes in weather patterns, ocean currents and water temperatures. Furthermore, sharks are inquisitive (and opportunistic) animals, and will investigate almost anything in the water column or on the surface...⁴⁸

1.47 The submission continued with observations about the movement patterns of white, tiger and bull sharks:

Both juvenile white sharks and tiger sharks show a 'hot-spot-highway' style of movement with regular visits to 'preferred' or 'residency' locations as well as wide-ranging patterns of movement...Juvenile white sharks are known to be more common in northern NSW waters in winter when sea

45 The committee was also advised that 'white sharks are highly specialised endotherms capable of maintaining high metabolic rates in cool temperate areas, and hence they do not follow predictable seasonal patterns of movement'. See Government of South Australia, *Submission 65*, p. 2.

46 CSIRO, *Submission 33*, p. 1.

47 CSIRO, *Submission 33*, p. 7.

48 Dr Daniel Bucher and Professor Peter Harrison, *Submission 23*, p. 3 (citations omitted).

surface temperatures are cooler...following schools of large snapper and Australian salmon (and possibly the humpback whale migration), and stopping wherever food is prevalent...Tiger sharks tend to follow seasonal changes in water temperatures, generally moving further into NSW waters during warmer months when sea surface temperatures are higher... Bull sharks occur year-round in NSW waters north of Sydney...Immature animals use rivers and estuaries and mature animals use inshore marine areas, entering estuaries in summer to breed. Broad-scale movements between coastal populations have also been recorded in mature animals...⁴⁹

1.48 Professor Bucher noted that sharks 'will go wherever there is food'. He explained that sharks travel to places:

...where there is a lot of food and where the ocean temperature and currents, and so on, are just right—it might be a permanent spot; it might be something that comes and goes with the seasons or from year to year...The individuals are constantly moving around, and what we are getting are these little aggregations in different spots at different times.⁵⁰

1.49 Evidence received by the committee also commented on the influence of sharks on the structure of marine ecosystems. Dr Bucher and Professor Harrison submitted that sharks 'are believed to play a key role in the structure and functioning of marine communities, and are a vital component to coastal ecosystem health'. They explained:

By selectively removing weakened animals from prey populations and scavenging whale carcasses and flood debris, sharks can serve to keep prey population healthy and vigorous. The further decline of shark populations, combined with other anthropogenic pressures in coastal waters (climate change, habitat loss and degradation, pollution), could have dire consequences (economic and environmental) for these highly productive marine systems....⁵¹

1.50 On the role sharks play in shaping marine ecosystems, Professor Bax commented:

I think there's a general acceptance in the biological community that large apex predators, like white sharks, are important to the way the ecosystem functions. While I believe it would be true...we don't have the specific information which allows us to say, 'If white sharks were gone this would happy to the ecosystem,' there have been instances, especially in terrestrial areas, with the reintroduction of large predators like wolves in Yellowstone,

49 Dr Daniel Bucher and Professor Peter Harrison, *Submission 23*, p. 3 (citations omitted).

50 Professor Daniel Bucher, *Committee Hansard*, 2 May 2017, p. 50.

51 Dr Daniel Bucher and Professor Peter Harrison, *Submission 23*, p. 4 (citation omitted). Similar evidence about the role performed by sharks as apex predators and how they regulate the food chain was provided by Ms Amanda Elizabeth Morgan (see *Committee Hansard*, 28 July 2017, p. 2); Dr Jan-Olaf Meynecke (see *Committee Hansard*, 31 July 2017, p. 11); and Mr Paul O'Dowd, *Committee Hansard*, 29 August 2017, pp. 2–3.

where their presence changed the behaviour of other animals and changed the whole ecosystem. In Yellowstone national park, it's led to the resurgence of a particular kind of tree and it's led to a change in the landscape because of the presence of this apex predator. It's not just their direct role in predation or feeding; it's how they change the behaviour of other animals in the system.⁵²

1.51 When commenting on shark behaviour, some witnesses emphasised that, of the small number of shark species that are considered to be dangerous to humans, those sharks are not considered to preferentially hunt humans as prey. For example, Mr Brendan Donohoe of the Surfrider Foundation Australia commented that sharks 'are not after people'. Mr Donohoe stated:

...to the best of my knowledge there has never been a shark caught post-attack that has had in its intestines the evidence of involvement in more than one incident. They are not the rogue lion, the rogue this, the rogue that. Shark incidents happen. Sharks have been hunted, and successfully hunted, and found. They have found bits of boards and things when people have been taken, but they have never found bits of board from two different attacks. They are not return hunters. These things are not after people. They are not crocodiles. They do not lie in wait for us. They investigate. From all reports, as sharks, particularly whites, hit maturity and become bigger specimens, they start to change their feedstock from large fish to seals and the like.⁵³

1.52 However, other individuals expressed frustration regarding what they consider is a lack of authoritative information about perceived changes in shark behaviour and spikes in regional human–shark encounters. Mr Heaton stated:

The experts, for whatever reason, cannot give any sort of reason as to why for a two-year period they came close to the shore and encountered or attacked people—whatever terminology you want to use. Why did they come in so close to shore and attack people? Surfers only go about 100 metres off the coastline. Why did the sharks come within 100 metres over that two-year period?⁵⁴

1.53 Generally, it was accepted that further research is necessary to gain a better understanding about sharks, particularly regarding their behaviour, movement and breeding patterns.⁵⁵ In particular, CSIRO identified that it might 'be possible to build a predictive model' to better understand shark abundance and location. CSIRO provided

52 Professor Nic Bax, CSIRO, *Committee Hansard*, 20 October 2017, p. 9.

53 Mr Brendan Donohoe, Northern Beaches Branch President, Surfrider Foundation Australia, *Committee Hansard*, 17 March 2017, p. 23.

54 Mr John Heaton, *Committee Hansard*, 2 May 2017, p. 3.

55 See, for example, Ms Amanda Elizabeth Morgan, *Committee Hansard*, 28 July 2017, p. 4; Mr Kent Stannard, Founder and Trustee, Tag For Life, *Committee Hansard*, 31 July 2017, p. 41.

the following explanation of how a predictive model could be developed and the benefits that such a model could provide:

The NSW DPI, through their tagging program, are amassing a significantly larger data holding on the distribution and movements of white sharks (and other species) than previously available. If the data and modelling can identify a suitable suite of environmental predictors it could be very useful in reducing shark-human interactions. Understanding shark movements to identify behavioural patterns, habitat preferences, and fine-scale residence behaviours of sharks, particularly into highly populated areas, and understanding our ability to detect white shark presence, are key components to understanding human-shark interactions supporting improved management policies and mitigation responses. A continued collaboration with all the States would ensure that collected data are analysed in a consistent way that will support increased precision in estimates of population size, juvenile mortality and trends in adult population size.⁵⁶

1.54 Finally, marine scientists noted that particular aspects of shark behaviour have implications when considering shark deterrent and management measures. Professor Shaun Collin noted that 'not all sharks are the same with respect to how they react to environmental cues'. As a result, Professor Collin commented that deterrent measures may need to be species specific to account for differences between species, such as white sharks being visual specialists, bull sharks relying on electro reception and tiger sharks basing 'most of their behaviour on smell'.⁵⁷ Evidence received from interested observers of the marine environment provided further insight into this. Mr Ian Wiese, who undertakes photography using an unmanned aerial vehicle (drone) off the south west coast of Western Australia explained that the bronze whaler sharks he has observed are 'extremely shy...as soon as they became aware of something in the vicinity they would turn away'. Mr Wiese remarked that this species is 'not as dangerous as many people imagine'.⁵⁸

1.55 Professor Meeuwig added that the age of sharks is significant as juvenile sharks are generally more aggressive.⁵⁹ Professor Meeuwig indicated that targeting the large, adult sharks has implications for the overall population, as the adult sharks 'are the reproductive engines of these populations'.⁶⁰

56 CSIRO, Answers to questions on notice, 20 October 2017 (received 24 November 2017), p. 2.

57 Professor Shaun Collin, *Committee Hansard*, 20 April 2017, pp. 37, 38.

58 Mr Ian Wiese, *Committee Hansard*, 28 July 2017, p. 41.

59 Professor Meeuwig referred to behavioural studies to demonstrate this point. In Professor Meeuwig's words: 'within a population or a species, it is the young animals that are aggressive. It is not the big ones. It is the teenagers who do not understand a V8 engine. They just bang into your cameras and are quick to come in, and the older sharks within the same species—the bigger ones—are sitting there going, "Not too sure about that".' *Committee Hansard*, 20 April 2017, p. 45

60 Professor Jessica Meeuwig, *Committee Hansard*, 20 April 2017, p. 45.

Conservation

1.56 A small number of shark species are protected under Commonwealth legislation due to concern about their declining populations. Australia has also committed to international agreements intended to help conserve and manage sharks to ensure their sustainable use.

The EPBC Act

1.57 The EPBC Act provides a framework for protecting matters of national environmental significance. As noted above, nine species of sharks are classified as 'threatened' under the EPBC Act and are therefore protected. The EPBC Act also protects migratory species, Commonwealth marine areas and the Great Barrier Reef Marine Park.

1.58 The EPBC Act discussed further in Chapter 5.

Bonn Convention

1.59 Australia is a signatory to the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), which provides a 'global platform for the conservation and sustainable use of migratory animals and their habitats'.⁶¹ Species listed under the Bonn Convention, such as the white shark, are included in the EPBC Act's list of migratory species.

1.60 The EPBC Act includes offences that are designed to give effect to Australia's obligations under the Convention and various provisions of the EPBC Act stipulate that the minister must not act inconsistently with Australia's obligations under the Bonn Convention.⁶²

National Plan of Action for the Conservation and Management of Sharks 2012

1.61 Australia is a signatory to the United Nations International Plan of Action for the Conservation and Management of Sharks (IPOA–Sharks), which is a 'voluntary international instrument developed so that nations can take positive action to ensure the conservation and management of sharks, and their long-term sustainable use'.⁶³

1.62 In response to the IPOA–Sharks, Australian governments have developed national plans of action for the conservation and management of sharks. The current plan was released in 2012 and is referred to as 'Shark-plan 2'.

61 Convention on the Conservation of Migratory Species of Wild Animals, 'CMS', www.cms.int/en/legalinstrument/cms (accessed 8 April 2017).

62 *Environment Protection and Biodiversity Conservation Act 1999*, ss. 34E, 37H, 54, 140 and 146L.

63 Department of Agriculture and Water Resources, 'Sharks', www.agriculture.gov.au/fisheries/environment/sharks (accessed 10 January 2017).

1.63 Among other things, Shark-plan 2 identifies as an issue for shark conservation and management the current 'understanding of the effects of shark fishing, control programs for bather protection and management practices on ecosystem structure and function'. Five actions are identified to improve understanding, including 'periodic assessment of the ecological impacts of shark control programs for bather protection'. The Plan classifies this issue as a 'medium-low' priority.⁶⁴

64 Department of Agriculture, Fisheries and Forestry, *National Plan of Action for the Conservation and Management of Sharks 2012*, www.agriculture.gov.au/SiteCollectionDocuments/fisheries/environment/sharks/sharkplan2-final/sharkplan2-action.pdf (accessed 10 January 2017), p. 16.

