Chapter 5

Environmental and economic impacts in the event of an oil spill

5.1 This chapter examines the potential economic and environmental impacts on the Great Australian Bight in the event of an oil spill.

5.2 The capacity to mitigate the effect of an oil spill is discussed in Chapter 6.

Oil spill modelling

5.3 Oil spill modelling is crucial to understanding the potential impact of an oil spill on the surrounding natural environment, local industries which rely on the marine and coastal environment, and nearby communities. This section provides an outline of the results of oil spill modelling conducted for BP's proposed drilling in the Great Australian Bight.

Modelling commissioned by The Wilderness Society

5.4 BP submitted its Environment Plan to NOPSEMA for approval on 1 October 2015. At that time, the company had not publicly released any oil spill modelling which would demonstrate the impact of a potential spill in the Great Australian Bight. As a result, The Wilderness Society commissioned Mr Laurent Lebreton, an independent consultant, to conduct a stochastic analysis[1] of deep sea oil spill trajectories in the Great Australian Bight.

5.5 Mr Lebreton's analysis considered a range of potential incidents including an 'optimistic' scenario of 5,000 barrels of oil per day being released, and a 'pessimistic' scenario of 50,000 barrels of oil per day being released. The model also utilised a 'conservative worst case' spill duration of 87 days based on the time it took to cap the Deepwater Horizon spill and an optimistic scenario of 35 days based on BP's publicly stated ability to cap wells within 35 days.[2]

5.6 The numerical model predicted that 'regardless of the oil spill scenario' it is 'predicted that at a minimum, there is a 70 per cent to 80 per cent likelihood of oil droplets reaching the Australian coastline'.[3] It also predicted that if an oil spill

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1 Stochastic modelling demonstrates the probability of where an oil spill may impact for defined time periods by running a series of trajectories under various wind conditions from historic records. These outputs illustrate the waters and shorelines that are most at risk from oiling during various seasons. It is primarily used for contingency planning purposes to develop a range of possible planning scenarios.

2 The Wilderness Society, *Submission 43*, p. 39.

3 The Wilderness Society, *Submission 79*, p. 7. See also Mr Laurent Lebreton, *Submission 35*, Attachment 1, for a complete copy of the analysis.

occurred in summer then oil would very likely impact the shores of Western Australia, reaching as far as Albany and Denmark. If an oil spill were to occur in winter, then the model showed that oil would very likely impact the Eyre Peninsula, Kangaroo Island, and Spencer Gulf in South Australia. Further, it was predicted that it could also reach much of the Tasmanian and Victorian coastline, through the Bass Strait towards New Zealand.[4]

5.7 Mr Lebreton's modelling was referred to by a number of submitters[5] who raised concerns with the potential impact of an oil spill in the Great Australian Bight. However, it was also criticised by other organisations.[6]

Release of BP's 'worst credible case' oil spill modelling

5.8 In September 2016, BP publicly released 'worst credible case' oil spill modelling it had conducted for the proposed Stromlo-1 and Whinham-1 wells.[7] This modelling utilised a 149 day oil release scenario based on BP's assessment that it would take this long to drill a relief well to permanently stop a blowout. The scope of the modelling examined the potential risk of exposure to the surrounding waters, and contact with coastlines during three distinct seasons. Namely, summer (October to March), transitional periods (April and May), and winter (June to September).[8]

5.9 Table 5.1 below contains a summary of BP's modelling. It shows the probability of moderate shoreline contact in each of the modelled seasons, and at a number of key locations. It shows that if there is an oil spill it may reach as far as the New South Wales South Coast, Tasmania, and the coast of Western Australia.[9]

4 The Wilderness Society, *Submission 43*, pp. 39–40.

5 See The Conservation Council of South Australia, *Submission 14*; Dr David Ellis, *Submission 30*; Clean Bight Alliance Australia, *Submission 23*; International Fund for Animal Welfare, *Submission 29*; Miss Rebecca Faulkner, *Submission 38*; Emeritus Professor Robert Bea, *Submission 73*; Whale and Dolphin Conservation, *Submission 76*.

6 The Norwood Resource Incorporated, *Submission 35*, p. 3.

7 BP, *Fate and effects oil spill modelling assumptions, parameters and results*, 14 September 2016, http://www.bp.com/content/dam/bp-country/en_au/about-us/what-we-do/exploring-great-australian-bight/fate-effects-oil-spill-modelling-assumptions-parameters-results.pdf, (accessed 24 February 2017). See also The Wilderness Society, *Submission 79*, Attachment 1.

8 BP, *Fate and effects oil spill modelling assumptions, parameters and results*, 14 September 2016, p. 3.

9 BP, *Fate and effects oil spill modelling assumptions, parameters and results*, 14 September 2016, pp. 14–15.

Table 5.1—Modelling showing probability of moderate shoreline contact

Shoreline	Season	Probability of moderate shoreline contact (%)
Adelaide	Summer	58
	Transitional	97
	Winter	86
Port Lincoln	Summer	91
	Transitional	100
	Winter	98
Kangaroo Island	Summer	95
	Transitional	100
	Winter	94
Great Australian Bight Marine National Park	Summer	20
	Transitional	8
	Winter	97
Esperance (WA)	Summer	29
	Transitional	7
	Winter	64
Apollo Bay and Wilsons Promontory (Vic)	Summer	56
	Transitional	91
	Winter	70
New South Wales South Coast	Summer	3
	Transitional	21
	Winter	41
Tasmania	Summer	46
	Transitional	66
	Winter	19

Source: BP, Fate and effects oil spill modelling assumptions, parameters and results, 14 September 2016, pp. 14–15.

Economic impact in the event of an oil spill

5.10 Oil spill modelling demonstrated that coastal communities and industries which rely on the marine environment would be affected in the event of an oil spill resulting from activities in the Great Australian Bight. Some submitters argued that any potential economic benefit of offshore oil or gas production in the Great Australian Bight must be weighed against the risk to other industries such as tourism, aquaculture and fisheries, in the event of an oil spill. The City of Victor Harbor stated that 'an oil spill within the Bight may represent a low occurrence risk, however such an event would represent a potentially catastrophic consequence risk'.[10]

5.11 In considering the effects of an oil spill in the Great Australian Bight, the South Australian Oyster Growers Association (SAOGA) questioned who would be 'responsible and what is the capacity to support industries impacted by oil spill event(s)' especially if impacts extend for long periods of time. It submitted that in the event of an oil spill:

> Compensation for impacted businesses must be immediately available (not after lengthy legal proceedings) and must include consumer perceptions in the situation through and following a spill (the experience of seafood producers and harvesters in the Gulf of Mexico was that consumer perceptions were still prevalent years after the product was officially cleared for sale).[11]

5.12 Ms Trudy McGowan, Executive Officer of SAOGA, told the committee that in the event of a catastrophic oil spill, the industry's brand would not be able to be recreated. Ms McGowan stated:

> I personally do not believe you can recreate the brand. If we had a catastrophic oil spill that wiped out the coast of South Australia, firstly, the industry would go. The majority of them are not going to be able to wait for six years; they are family businesses. They are going to have to do something else.[12]

5.13 A number of submitters also raised concern that as a premier eco-tourism destination, the tourism industry would be damaged in the event of an oil spill in the Great Australian Bight. For example, Dr David Ellis submitted that:

> Ecotourism business such as scuba diving, dolphin and whale watching tours, fishing charters and guided tours such as the many operating on Kangaroo Island would be unable to operate and boast the Southern Ocean's reputation as a clean, wild and healthy ecosystem to their clients, many who visit from overseas. The South Australian government's very own

10 City of Victor Harbor, *Submission 12*, pp. 2–3.

11 South Australian Oysters Growers Association, *Submission 82*, p. 3.

12 Ms Trudy McGowan, SAOGA, *Committee Hansard*, 16 November 2016, p. 53.

> ecotourism 'business' Seal Bay would have to close and many international visitors would no longer come to South Australia.[13]

5.14 The City of Victor Harbor, in noting that the Great Australian Bight provides a critical sanctuary for many threatened species, and supports a significant tourism industry stated that:

> If an oil spill interfered or discouraged the annual migratory habits of Southern Right Whales or other migratory species, there will be economic and social consequences for our community and our visitors. One only needs to reflect on the 2010 BP Deepwater drilling rig blow out in the Gulf of Mexico to understand how extensive the consequences could be.[14]

5.15 Similarly, the AMCS described the tourism industry in the Gulf of Mexico as 'wrecked' by the Deepwater Horizon disaster. [15]

5.16 Mr Ben Byass, a tourism operator on Kangaroo Island expressed concern that in the event of an oil spill, 'tourism and aquaculture industries would be decimated'. Mr Byass also drew comparisons to the Gulf of Mexico and concluded that oil and gas activity in the region 'is a serious threat to our way of life and economy.[16]

5.17 The Kangaroo Island Council submitted that it:

> …did not consider the multibillion-dollar tourism, fisheries and aquaculture industries in SA, Victoria and Tasmania should be put at risk for the meagre potential economic gains from an industry that is fast becoming a dinosaur for future energy resources to supplement world consumption.[17]

5.18 The Aboriginal Lands Trust, which operates the Head of the Bight Visitor/Interactive Centre stated that it 'is committed to the economic prosperity of the Region through engaging with local and other Aboriginal stakeholders through its procurement arrangements'. This includes a range of activities including 'the purchase of Aboriginal specific merchandise to contracting services for maintenance'.[18]

5.19 The Aboriginal Lands Trust went on to state that:

> Through its interest in the protection of cultural and conservation values, the Trust has been able to provide economic benefit to Aboriginal people in the region. It is concerned that these benefits could be undermined by a potential oil spill.[19]

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13 Dr David Ellis, *Submission 30*, p. 78.

14 City of Victor Harbor, *Submission 12*, p. 2.

15 Australian Marine Conservation Society, *Submission 19*, pp. 3–4.

16 Mr Ben Byass, *Submission 66*, p. 1.

17 Kangaroo Island Council, *Submission 78*, p. 2.

18 Aboriginal Lands Trust, *Submission 84*, p. 3.

19 Aboriginal Lands Trust, *Submission 84*, p. 3.

Impact on Indigenous communities

5.20 Aboriginal groups along the coast of the Great Australian Bight uphold strong spiritual and physical connections the area. The committee received evidence that an oil spill could potentially harm these connections. The Aboriginal Lands Trust submitted that:

> The HOB [Head of the Bight] and its cultural relevance continues to be significant to the local, regional and wider Aboriginal stakeholders with the various groups continuing to maintain their interest in the traditional knowledge systems and structures that emerge from this area.[20]

5.21 Ms Colbung, Chief Executive of the Aboriginal Lands Trust, told the committee that the area is 'very rich in cultural heritage' and that:

> …there are important storylines that run right down to the Head of the Bight and also that there could be potential damage to some of those storylines, as far as the local groups like the Mirning are concerned, because the southern right whales, as I understand it, represent those totemic species that are integral to the maintenance of Aboriginal culture…[21]

5.22 Mr Bunna Lawrie, an Elder and songman of the Mirning people, explained that the Nullabor and the Great Australian Bight are central to the Mirning people's spiritual beliefs and customs. Mr Lawrie told the committee that the Mirning people believe that during the Dreamtime, the great white whale Jiddara came to the Great Australian Bight to give life and to give breath into the land and the ocean. The Mirning people also believe that during the Dreamtime, whales used to come into the caves of the Nullabor cliffs and the Mining people 'used to look after the whales and treat them when they were not singing'. Mr Lawrie explained that the Mirning medicine men and whale songmen protected the land and 'that is why that beautiful country and that beautiful land is still standing and looking good today and clean and untouched'.[22]

5.23 Mr Lawrie emphasised the spiritual importance of the area, telling the committee that it was where his initiation took place and that the area:

> …is full of energy, it is full of life and healing; it is a medicine to the whales and it is a medicine to my people, the Mirning people. And it is a very spiritual place too, so it is a place where us Mirning people—we honour that tradition, that custom. We honour that Dreaming.[23]

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20 Aboriginal Lands Trust, *Submission 84*, p. 3.

21 Ms Kerry Colbung, Aboriginal Lands Trust, *Committee Hansard*, 16 November 2016, p. 13.

22 Mr Bunna Lawrie, *Submission 62*, p. 1.

23 Mr Bunna Lawrie, *Submission 62*, pp. 1–2.

5.24 Mr Lawrie also highlighted the importance of the area as a place of learning for the Mirning people and described it as a museum and a university. He also stated that:

> This ocean is sacred. It is very sacred to mankind. It is sacred to all the marine life. It is sacred to all the mammals in the ocean. It is a sacred place, and also it is an energy, so it is a living being. It is part of the earth. It gives life, and the main thing: it keeps our planet earth alive. It sustains all we need. [24]

5.25 Mr Lawrie told the committee that his duty and responsibility as an Elder and a whale songman is to 'protect and preserve our country' and as such 'we are at great risk and danger if oil spills happen in the Great Australian Bight'.[25] He concluded that:

> We do not want BP or any other oil companies in our Great Australian Bight. We want you out of here, because you have already done damage around other parts of the world, and we do not want you to come here and destroy our beautiful oceans and the Great Australian Bight.[26]

5.26 Similarly, the committee received evidence from Ms Sue Coleman Haseldine, a Kokatha Mula custodian from Ceduna who stated that she is dependent on the ocean for food, and that an oil spill would result in the loss of her livelihood and traditional lifestyle. Ms Coleman Haseldine told the committee that:

> If we get any kind of interference with our ocean, all our traditional ways are going to be gone. We will not be able to go for raids to fish scallops, oysters, cockles, crabs—anything that we can get when the tide is out or even from a boat. Everything we have treasured will be gone.[27]

5.27 Ms Colbung also told the committee that the local Aboriginal people rely on the area as a source of food. Ms Colbung stated:

> …the local Aboriginal people rely on [the marine life] as a food source right through from the Head of the Bight to the vicinity of Dog Fence Beach. People rely on that part of the coast to fish and camp, and the marine life—mulloway, salmon et cetera—is a fantastic supplemental source of food for the local Aboriginal people.[28]

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24 Mr Bunna Lawrie, *Submission 62*, p. 1.

25 Mr Bunna Lawrie, *Submission 62*, p. 1.

26 Mr Bunna Lawrie, *Submission 62*, p. 2.

27 Clean Bight Alliance, *Submission 23*, Attachment 1, p. 1.

28 Ms Kerry Colbung, Aboriginal Lands Trust, *Committee Hansard*, 16 November 2016, p. 9.

Impact on the marine environment in the event of an oil spill

5.28 The waters of the Great Australian Bight are recognised as being some of the most biologically diverse in the world. They provide habitat for between 12,000 and 14,000 invertebrate species, 1,500 algal species, 612 fish species (occurring above 50m depth), 16 breeding seabird species, 33 mammal species, and 12 seagrass species. A number of the species of fauna such as southern right whales and Australian sea lions are recognised as internationally and nationally significant. Further, 95 per cent of seagrasses, 85 per cent of fish species and 75 per cent of red algae in the Great Australian Bight are found nowhere else in the world.[29]

5.29 The City of Victor Harbor stated that:

> The Great Australian Bight is a relatively pristine ocean environment and a critical sanctuary for many threatened species. There are species found in the Bight that are found nowhere else in the world. And it is an important migratory path for several marine species. It is these unique qualities that our South Australian Marine Parks network was established to protect for future generations.[30]

5.30 Mr Collis, International Fund for Animal Welfare (IFAW) similarly explained that the Great Australian Bight is:

> …home to nearly half of all the world's species of whales and dolphins, and all three species of seals and sea lions found regularly in mainland Australian waters. The Australian government has mapped biologically important areas in the bight for blue whales, southern right whales, sperm whales and the Australian sea lion, some of which overlap directly with, or are in close proximity to, BP's proposed drilling area. The bight is also recognised as globally important for elusive and rarely seen beaked whales.[31]

5.31 As such, the key concern raised in evidence was the potentially catastrophic impact of an oil spill on: marine wildlife such as cetaceans and seabirds; fisheries; seabed flora and fauna; habitats; and food species. Oil spills have the potential to have negative effects both at the individual, and at the population level. The Wilderness Society submitted that:

> Individual impacts include death, disease, impaired reproduction, genetic alterations, changes to endocrine or immune functions, hypothermia and a range of other biological disorders. Group-level impacts include changes to local population sizes, community structures and overall biomass. The most

29 Conservation Council of South Australia, *Submission 13*, p. 1. See also International Fund for Animal Welfare, *Submission 29*, p. 1; Sea Shepherd Australia, *Submission 18*, pp. 1–2; Australian Marine Conservation Society, *Submission 19*, p. 3; Greenpeace Australia Pacific, *Submission 22*, p. 2.

30 City of Victor Harbor, *Submission 12*, p. 2.

31 Mr Matthew Collis, IFAW, *Committee Hansard*, 28 April 2016, p. 27.

> obvious toxic impact of spilled oil is direct contact with wildlife and habitat.[32]

5.32 Mr Matthew Collis, IFAW, told the committee that:

> …it is important to remember that much of the damage to wildlife would be out in the ocean, far from the coast, where animals rely on this habitat for feeding and migration. Potential effects of a spill on marine mammals include hypothermia and metabolic shock, organ dysfunction due to ingestion of oil and exposure to toxic metals, lung disease and damage, gastrointestinal ulceration and haemorrhaging, eye and skin lesions, decreased body mass due to restricted diet, and stress due to oil exposure and behavioural changes.[33]

5.33 Any ability to predict the potential impact of an oil spill in the Great Australian Bight is influenced by the size of the potential spill, the mitigation strategies which would be employed, and the time of year it occurs. As such, many submitters provided general evidence of the potential effects of oil pollution in the marine environment, and evidence of the effects of incidents such as the Deepwater Horizon and Exxon Valdez spills. It isn't known which of these effects would be seen in the Great Australian Bight in the event of an oil spill, but it is possible that they may occur.

Wildlife

5.34 Oil is comprised of thousands of chemical compounds, each with varying levels of toxicity to humans, wildlife and the environment. The most acutely toxic components of oil are water-soluble fractions (WSFs) and volatile organic compounds (VOCs) which evaporate into the air or mix with marine waters. These components include benzene, naphthalene, xylene and toluene. Once released into the environment and after being subjected to weathering, the WSFs and VOCs are generally lost. The remaining oil generally contains proportionately higher levels of polycyclic aromatic hydrocarbons (PAHs). These are also toxic to both wildlife and humans, and potentially linger in the environment for many years.[34]

5.35 NOPSEMA submitted that the skin, fur and plumage of marine wildlife are often the first part of the animal to be exposed to direct contact with oil and oil-dispersant mixtures. For cetaceans and dugongs, skin contact with oil can lead to skin irritation, inflammation, burns and necrosis. It can also increase the risk of secondary health problems such as infection from open sores and lesions.[35]

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32 The Wilderness Society, *Submission 43*, p. 27.

33 Mr Matthew Collis, IFAW, *Committee Hansard*, 28 April 2016, p. 27.

34 The Wilderness Society, *Submission 43*, p. 27.

35 NOPSEMA, *Submission 7*, Attachment 6, p. 72.

5.36 When birds are exposed to oil, their plumage is affected in such a way that the feathers are no longer able to provide insulation or repel water. This can affect the ability of birds to swim, fly or forage, and rescued birds have shown signs of hypothermia. Similarly, the haircoat of pinnipeds provides insulation, regulates body temperature, and provides buoyancy. When oil covers the haircoat, it allows water to come into direct contact with the animal's skin resulting in rapid onset hypothermia.[36]

5.37 The Wilderness Society stated that 'a large spill can cause a massive acute die-off of oiled birds. These mass seabird deaths can also create trophic cascade effects that impact their prey species and fisheries'.[37] The Wilderness Society submitted that in the six months following the Deepwater Horizon:

> …wildlife responders had collected "8,183 birds, 1,444 sea turtles, and 109 marine mammals affected by the spill—alive or dead, visibly oiled or not". The US Department of the Interior for Fish, Wildlife and Parks stated that the three most affected bird species appeared to be brown pelicans, northern gannets, and laughing gulls. It has been estimated that approximately one million seabirds and between 600,000 and 800,000 coastal birds were killed as a result of the oil spill. More than 1,000 sea turtles were found dead following the spill and between January and March 2011, 200 dead dolphins were found in the Gulf of Mexico.[38]

5.38 Greenpeace Australia Pacific also highlighted that mass mortalities were recorded in the Gulf of Alaska following the Exxon Valdez spill with 250,000 seabird deaths recorded in the immediate days after the incident. It also noted that a number of marine bird populations continue to show signs of exposure, and a decline in population in studies conducted 9 years after the incident.[39]

5.39 Oil making direct contact with the eyes of wildlife has also been found to cause significant injuries. NOPSEMA noted that necropsies of harbour seals exposed to the Exxon Valdez oil spill showed signs of suffering conjunctivitis. It also noted that though research on other species is rare, it should be anticipated that such effects would be found in other species that swim through, or break the surface of oil-affected water.[40]

5.40 Marine wildlife is also likely to suffer from the negative effects of ingesting oil when foraging, feeding, and grooming. In particular, cetaceans, pinnipeds, dugongs and birds are at considerable risk of ingesting oil while foraging in oil-affected areas, and in consuming oil-affected food resources. NOPSEMA highlighted that baleen whales are particularly susceptible to oil ingestion due to their mouth anatomy and

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36 NOPSEMA, *Submission 7,* Attachment 6, p. 72.

37 The Wilderness Society, *Submission 43*, p. 28.

38 The Wilderness Society, *Submission 43*, p. 31.

39 Greenpeace Australia Pacific, *Submission 22*, p. 2.

40 NOPSEMA, *Submission 7,* Attachment 6, p. 72.

feeding behaviour. In particular, filtering large volumes of oil-affected water while feeding has the potential to lead to the fouling of the baleen which in turn can adversely affect the animal's ability feed.[41] IFAW submitted that:

> Although not specified in the public summary that was released of BP's recent environment plan submission, the original oil spill modelling referenced in BP's EPBC Act referral back in 2013 estimated the probability of hydrocarbon contact with whale foraging areas in the water column in the GAB was 50-60% with no intervention (BP, 2013). This would likely have a significant impact on blue, sperm and beaked whales feeding in the water column in these areas both in terms of ingesting oil (and potentially toxic dispersants) and on prey availability in these areas.[42]

5.41 Similarly, Mr Collis, IFAW told the committee that:

> The issue for marine life is that, particularly for deep-diving species like sperm whales and beaked whales and also blue whales that feed in the Great Australian Bight, is that they often feed at depth under water. Blue whales are what we call filter feeders—they gulp in large amounts of water and extract krill from that. So they will be taking in large amounts of water which will include whatever level of oil has spilled in the water column, not just at the surface. However, they would also be affected at the surface when they come to breath. So there are those dual aspects of how marine mammals would be affected by oil both in the water column and at the surface.[43]

5.42 Dugongs may also have their ability to feed affected by oil collecting on the sensory hairs around their mouth. These hairs are believed to have a role in dugong foraging behaviour. As well as feeding in oil-affected waters, birds spend considerable amounts of time preening their feathers and there is a high likelihood that an oiled bird will ingest oil as a result. [44]

5.43 Ingested oil can cause a range of injuries and physiological effects on wildlife. It can damage the gastrointestinal tract which can in turn effect digestion and the uptake of nutrients. It can also damage the kidneys and liver both of which play important roles in the metabolism of waste and toxins. Studies have also found ulcers, diarrhoea, a decreased ability to absorb nutrients from food, and a negative effect on egg condition in marine life which has ingested oil.[45]

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41 NOPSEMA, *Submission 7,* Attachment 6, pp. 72–73.

42 International Fund for Animal Welfare, *Submission 29*, p. 5.

43 Mr Matthew Collis, IFAW, *Committee Hansard*, 28 April 2016, p. 32.

44 NOPSEMA, *Submission 7*, Attachment 6, p.73.

45 NOPSEMA, *Submission 7*, Attachment 6, p. 73.

5.44 IFAW submitted that researchers found a high prevalence of hypoadrenocorticism (low functioning of the adrenal gland which alters stress response) in live bottlenose dolphins in Barataria Bay, Louisiana, after the Deepwater Horizon spill. In addition, skin tissue of sperm whales collected from the Gulf of Mexico found elevated concentrations of toxic chemicals such as chromium and nickel. According to IFAW, researchers suggested that exposure to toxic metals is an understudied area of concern for whale populations swimming in oil contaminated waters.[46] IFAW also highlighted that a study found that dispersants used during oil spill recovery efforts can both kill cells and damage cell DNA in sperm whale skin, at relatively low levels of exposure. This exposure can lead to sub-lethal but potentially long-term harmful effects in whales.[47]

5.45 The inhalation of oil droplets and volatile hydrocarbons[48] also has the potential to damage the mucous membranes and respiratory tissues of wildlife. Following the Exxon Valdez oil spill, harbour seals were found with symptoms of pneumonia and interstitial emphysema, and NOPSEMA submitted that such similar effects might be anticipated in other mammals. Inhalation of hydrocarbon vapours is also known to cause nerve damage and behavioural problems in humans, and it may also be reasonable to assume such an impact will be seen in marine mammals.[49] The Wilderness Society submitted that following the Exxon Valdez spill, an estimated 302 harbour seals most likely died from the inhalation of toxic fumes.[50] Similarly, IFAW highlighted a study that found a high prevalence of lung disease in bottlenose dolphins in Barataria Bay, Louisiana, United States of America, following the Deepwater Horizon spill.[51]

5.46 Exposure to oil pollution has also been linked to an increase in cetacean strandings, and foetal loss in pregnant cetaceans. The US National Oceanic and Atmospheric Administration (NOAA) declared an Unusual Mortality Event in (UME) for cetaceans in the Northern Gulf of Mexico from 2010–2014 which determined that the Deepwater Horizon oil spill is the most likely explanation of the persistent, elevated stranding numbers of cetaceans in the Gulf of Mexico. It also found that evidence supports that exposure to Deepwater Horizon pollution was the most likely explanation for adrenal and lung disease in dolphins, and increased foetal loss. In research published in April 2016, scientists stated that 'exposure to petroleum compounds following the Deepwater Horizon oil spill severely harmed the reproductive health of dolphins living in the oil spill footprint in the northern Gulf of

46 International Fund for Animal Welfare, *Submission 29*, p. 5.

47 International Fund for Animal Welfare, *Submission 29*, p. 5.

48 Volatile hydrocarbons are compounds that are either gases or liquids that can evaporate and act as a gas.

49 NOPSEMA, *Submission 7*, Attachment 6, p. 73.

50 The Wilderness Society, *Submission 43*, p. 33.

51 International Fund for Animal Welfare, *Submission 29*, p. 5. See also Mr Matthew Collis, IFAW, *Committee Hansard*, 28 April 2016, p. 31.

Mexico'. In addition, 'Gulf of Mexico bottlenose dolphins were particularly susceptible to late term pregnancy failures, signs of foetal distress and development of in utero infections including brucellosis'.[52]

5.47 Mr Collis, IFAW, stated that:

> The true extent of impact on marine mammals from the Deepwater Horizon spill in the Gulf of Mexico is only just coming to light. Over 1,500 whales and dolphins are stranded since the Gulf of Mexico spill. To put that in context, the historical average in the affected region is six strandings per year. The huge death toll represents a minimum number of animals that have died as a result of that spill, since not all animals that have died will wash ashore or be found. Scientists studying historical stranding rates in the Gulf of Mexico have estimated that carcasses recovered after the disaster represented only two per cent of spill related deaths. Therefore the actual death toll could be up to 50 times higher. Any large spill in the bight will likely see similar impacts on whales and dolphins in terms of lethal and sublethal injuries and extended periods of disease and mortality, and whales being forced to relocate away from biologically important habitat.[53]

5.48 Ms Kathryn Warhurst, Conservation Council of South Australia, told the committee that if the main nursery areas for the southern right whales along the coastline of South and Western Australia are polluted during an oil spill 'then you are going to have a whole bunch of southern right whales that are likely to have significant issues in reproduction and ongoing health issues'.[54]

5.49 Sea Shepherd Australia stated that:

> A spill in the GAB would be catastrophic to the southern right whale population. It would destroy the whale nursery where the mothers give birth and nurture their young. Southern right whales either skim along the ocean filtering the water for food or at times, are bottom feeders. Either way, a spill would annihilate the population of southern right whales still recovering from the commercial whaling era.[55]

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52 National Oceanic and Atmospheric Administration, http://www.nmfs.noaa.gov/pr/health/mmume/cetacean_gulfofmexico_results.html, (accessed 15 February 2017). See also International Fund for Animal Welfare, *Submission 29*, p. 5.

53 Mr Matthew Collis, IFAW, *Committee Hansard*, 28 April 2016, p. 27. See also International Fund for Animal Welfare, *Submission 29*, p. 1 and p. 5.

54 Ms Kathryn Warhurst, Conservation Council of South Australia, *Committee Hansard*, 28 April 2016, p. 19.

55 Sea Shepherd Australia, *Submission 18*, p. 4.

5.50 The Wilderness Society noted that following the Exxon Valdez spill, some whale species such as bowhead whales were observed avoiding oil contaminated areas, however other species such as killer whales were seen swimming through oil slicks. Following the spill, 22 killer whales died—a single pod lost seven members in the first week, and seven or eight over the next two years.[56]

Intertidal and seabed flora and fauna

5.51 Intertidal flora and fauna are particularly at risk if an oil spill reaches the shoreline. This includes: mangroves; saltmarshes; coral reefs; seagrass beds; macroalgal stands and their inhabitants; filter feeding organisms such as sponges, and soft corals and their inhabitants; inhabitants of rocky and sedimentary shores; microalgal assemblages such as stromatolites and rhodoliths; and any other living organisms and assemblages that occur on the seabed or seashore.[57]

5.52 Oil can cause mortality in flora through smothering caused by oil covering photoreceptors and pores for oxygen exchange. Mangroves, which are dependent on oxygen supplied through pores in aerial roots, are particularly susceptible to smothering. In mangroves, it has been found that toxic compounds present in oil can also damage cell surfaces in subsurface roots, impair the plant's salt exclusion process and interfere with the plant's ability to maintain a salt balance. Seagrasses have also been found to blacken when in contact with oil, and have lowered rates of growth.[58]

5.53 Intertidal habitats such as mangroves, coral reefs and rocky shores also encompass microhabitats such as rockpools, overhangs, cracks and crevices which are populated by soft bodied sessile animals such as sea anemones, sponges, echinoderms, and sea squirts. They also provide refuges for molluscs, crustaceans and fish. Though oil on the surfaces of these shores is often quickly washed away, it can concentrate in these habitats and cause considerable damage to both flora and fauna.[59]

5.54 Seabed flora and fauna inhabiting sedimentary shores or in seabed sediments in both intertidal and subtidal zones are also susceptible to being smothered by oil, particularly at low tide. Oil can penetrate sediments killing resident fauna such as crabs and worms, and can coat molluscs, barnacles, and bivalves on the sediment surface. Oil can persist and remain toxic in sediments for many years and can inhibit seed establishment and asexual vegetative seasonal growth in a number of flora species. NOPSEMA noted that the long term effect of residual oil has been well documented in the northern hemisphere. For example, the survival and growth rates of

56 The Wilderness Society, *Submission 43*, p. 33.

57 NOPSEMA, *Submission 7*, Attachment 6, p. 70.

58 NOPSEMA, *Submission 7*, Attachment 6, p. 70.

59 NOPSEMA, *Submission 7*, Attachment 6, p. 70.

intertidal clams and fish were still affected more than five years after the Exxon Valdez spill.[60]

5.55 NOPSEMA also noted that following the Deepwater Horizon oil spill, there has been a documented decline in the health of corals present in the area. It stated that studies have found that dinoflagellate[61] function has been affected by both exposure to oil and dispersants. Studies have also found that coral larval fertilisation, metamorphosis and survival have been affected by exposure to oil and dispersants. NOPSEMA also noted that greater investigation of the impact of exposure to oil on corals and other seabed flora and fauna in deep water habitats is warranted.[62]

5.56 Sea Shepherd Australia noted the rich biodiversity of the Great Australian Bight and stated that high density zooplankton communities support the highest densities of small fishes in Australian waters.[63] It noted that following the Deepwater Horizon disaster, there was a 'massive die-off' of foraminifera—microscopic organisms at the base of the food chain. It also noted that other studies have shown that plankton have been killed by oil and dispersants, or have absorbed PAHs before being consumed by other marine life.[64]

Fish and fisheries

5.57 Oil spills have a wide range of negative effects on fish and fisheries including on the development and survival of eggs, embryos and larvae. NOPSEMA noted that though mass mortalities are rarely observed in mobile species of fish, seabed fish and fisheries species, and strongly habitat associated demersal fishes are more likely to be affected.[65]

5.58 NOPSEMA noted that the direct impacts of an oil spill on fish are likely to be greatest for eggs, embryos, and larvae as they are particularly sensitive to pollution events. For example, toxic compounds such as polycyclic aromatic hydrocarbons can affect the growth, development and survival of embryos and larvae. Oil in sediment on the seabed is likely to affect seabed egg-layers such as damselfishes, squid and trigger fishes while contaminated surface waters are likely to affect pelagic fish species.[66]

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60 NOPSEMA, *Submission 7*, Attachment 6, p. 70.

61 Dinoflagellates are microscopic unicellular algae which often have a mutually beneficial symbiotic relationship with corals.

62 NOPSEMA, *Submission 7*, Attachment 6, p. 70.

63 Sea Shepherd Australia, *Submission 18*, p. 1.

64 Sea Shepherd Australia, *Submission 18*, p. 8.

65 NOPSEMA, *Submission 7*, Attachment 6, p. 71.

66 NOPSEMA, *Submission 7*, Attachment 6, p. 71.

5.59 Mariculture operations[67] are inherently vulnerable to the effects of an oil spill as fish are unable to actively avoid pollution. Intertidal mollusc mariculture operations are considered particularly vulnerable to the effects of an oil spill, with long term effects likely where oil is retained in sediment.[68] Greenpeace Australia Pacific noted that following the Exxon Valdez spill, the area's salmon populations were found to have stunted growth and lower survival rates, and highlighted the implications for the Great Australian Bight's fisheries.[69]

5.60 Mariculture operations are also vulnerable to tainting, which renders fish and molluscs unfit for consumption. Tainting refers to the uptake of oil derived substances in the tissues of the fish or molluscs, and which creates an odour and flavour which is foreign to the food product. It can occur through either direct absorption from contaminated water and sediments, or indirectly through the consumption of contaminated prey species. Bivalve molluscs, such as oysters, and fish with high fat content such as tuna are particularly prone to tainting, and have a high bioaccumulation potential. Tainting also has the potential to considerably damage the fisheries and aquaculture industries, as consumers may avoid purchasing seafood for long periods of time—even after levels of hydrocarbons in fish tissue have been found to return to normal.[70]

Ecosystems and habitats

5.61 Oil spills have the potential to significantly affect the functions of an ecosystem through changes in habitat, and changes in predator-prey relationships. Populations which rely on specific habitat features for feeding, breeding and nursing young are likely to be significantly affected. For example, a reduction in the availability of prey species is likely to affect the health and survival of higher order consumer species.[71]

5.62 The Wilderness Society submitted that

> Apex predators, particularly those that are long lived, can also be especially impacted by toxic oil spill pollution. Some animals that are high on the food chain already experience the effects of bioaccumulation of persistent organic pollutants through bio-magnification. This continues in each predator-prey interaction, and animals at the top of the food chain, such as southern bluefin tuna, great white sharks and toothed whales, as well as humans, can accumulate high levels of these toxins.[72]

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67 Mariculture is a specialised branch of aquaculture involving the cultivation of marine species in enclosed sections of the ocean. For example, tuna and salmon farming, and oyster production.

68 NOPSEMA, *Submission 7,* Attachment 6, p. 71.

69 Greenpeace Australia Pacific, *Submission 22*, p. 3.

70 NOPSEMA, *Submission 7,* Attachment 6, p. 71.

71 NOPSEMA, *Submission 7*, Attachment 6, p. 73.

72 The Wilderness Society, *Submission 43*, p. 28.

5.63 A number of submitters highlighted the importance of natal site fidelity in species common in Great Australian Bight, and the impact that an oil spill would have on that behaviour. IFAW stated that there would be 'longer-term repercussions if specific breeding or calving sites were impacted'.[73] Similarly, the Humane Society International noted that:

> As an endemic species found only in South and Western Australia, the Australian Sea Lion stands to be significantly impacted by an oil spill, as females have high site fidelity to breeding locations and feeding locations, making them unable to avoid the impacts of such a spill should one occur.[74]

5.64 Ms Kathryn Warhurst from the Conservation Council of South Australia similarly told the committee that:

> South Australia has 85 per cent of the Australian sea lion population in the world. The other 15 per cent is in Western Australian waters. A large part of that area would be catastrophically impacted if there were a spill…if there were any kind of significant event, I think it would be game over for that species, or it would be very likely to be game over. The way this species operates, too, is that it has a lot of genetically unique subpopulations. If these subpopulations are knocked out, if there is a major mortality event, they do not go back to those areas, because the females only go back to breed where they were born. So there will be no re-immigration from other sea lion populations. That area will effectively be dead to sea lions, so that just will not be an option in terms of recovery in the future.[75]

5.65 Mr Lyndon Schneiders, The Wilderness Society, told the committee that the Great Australian Bight is a unique oceanic system with 'huge subsea canyons' on the edge of the continental shelf. Mr Schneiders explained that:

> Those subsea canyons drive what is called deepwater upwellings. What happens is that huge amounts of phytoplankton is driven from deep below the surface up to the shallows. That is what drives the southern Australian marine environment. That is why there are so many big whales that move through there. That is why, for instance, the big pelagic species like the southern bluefin tuna and others move through, because they of course feed on the pilchards that feed on the zooplankton. Zooplankton is the base of the food chain. Zooplankton is also very sensitive to oil.[76]

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73 International Fund for Animal Welfare, *Submission 29*, p. 4.

74 Humane Society International, *Submission 3*, p. 2.

75 Ms Kathryn Warhurst, Conservation Council of South Australia, *Committee Hansard*, 28 April 2016, pp. 18–19.

76 Mr Lyndon Schneiders, The Wilderness Society, *Committee Hansard*, 28 April 2016, p. 33.

5.66 NOPSEMA noted that outside of predator-prey relationships, oil spills are likely to have other flow-on effects on marine ecosystems. For example, seagrasses and mangroves provide important habitat to a number of fauna species. These flora assemblages also provide crucial services such as fish nursery habitats, and damage from oil spills is likely to affect ecosystems beyond the immediate habitat.[77]

5.67 NOPSEMA also noted that a number of species are involved in maintaining water quality through the removal of detritus from the water. If species such as amphipods and fiddler crabs are removed from an area, decomposition may significantly slow and water quality is likely to be affected. Similarly, the removal of species such as crabs and starfish which predate on snails and mussels may alter an ecosystem's grazing balance and create competition for space. [78]

5.68 Long-term changes in the abundance and diversity of both flora and fauna species have been seen following oil spills. For example, following the Prestige oil spill in Spain there were found to be decreases in the biomass, size and species abundance of algae in rocky shore assemblages six months after the spill. However, in the longer term there was an increase in richness and diversity as a result of changes in the abundance of dominant species. Species replacement has also been observed in experimental oil spill research on saltmarsh plants conducted in Wales, which saw the elimination of species such as the sea rush Juncus, and the flourishing of the oil tolerant fast-growing creeping grass Agrostis. NOPSEMA stated that 'the flow-on effects of an oil spill on biological assemblages should not be underestimated'.[79]

5.69 The Humane Society International submitted that:

> However for many of the threatened species found in the Great Australian Bight, there is still little scientific research to be able to identify critical habitat. As a result the impacts of oil or gas development in the area are likely to be more severe than current scientific knowledge suggests, with significant implications when considering exploration or drilling activities or should an oil spill occur.[80]

77 NOPSEMA, *Submission 7*, Attachment 6, pp. 73–74.

78 NOPSEMA, *Submission 7*, Attachment 6, p. 74.

79 NOPSEMA, *Submission 7*, Attachment 6, p. 74.

80 Humane Society International, *Submission 3*, p. 2.

Human health

5.70 Concerns were raised in relation to the potential for human health to be negatively affected through the consumption of contaminated seafood. The Clean Bight Alliance Australia also raised concern that dispersants used during cleanup activities can have a toxic effect on both the residents of contaminated areas, and those engaged in clean-up activities.[81]

5.71 In BP's Environment Plan summary, it acknowledged that concerns regarding the toxicity of dispersants had been raised during public consultations. In particular, references were made to the impact of dispersants used during the Deepwater Horizon incident. BP stated that it provided information on the kinds of dispersant that may be used in the Great Australian Bight in the event of a spill. It also noted that the Australian Oil Spill Control Agents (AOSCA) Register sets requirements for the toxicity and efficacy testing of dispersants prior to approval for use in Australia.[82]

81 Clean Bight Alliance Australia, *Submission 23*, p. 5.

82 BP Developments Australia Pty Ltd, *Submission 20*, Attachment 5, p. 21.