Swimming with Humpback Whales

Potential risks from sharks

Report to

Queensland Parks and Wildlife Service
Department of National Parks,
Recreation, Sport and Racing

by

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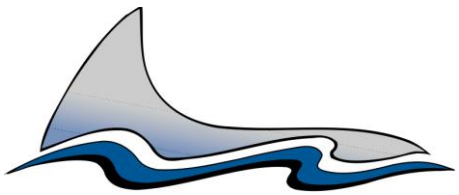
August 2014



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1.0 Introduction

1.1 Background

The migration of humpback whales along the eastern and western Australian coastlines is a predictable seasonal event. Each winter, thousands of adult whales travel from Antarctic waters to aggregation sites off Queensland's Great Barrier Reef and Western Australia's Southern Kimberley to calve (Dawbin 1966, DEH 2005). These two areas reflect genetically different populations of humpback whale (Chittleborough 1965, DEWHA 2008b) with calving occurring from mid-August before the return southern migration commences. Similar events for humpback whales are also well known in the northern Atlantic Ocean, northern Indian Ocean, northern Pacific Ocean and other regions of the southern hemisphere (DEWR 2007, DE 2014).f

On the southward return during spring, the cow and calf pairs slowly move down the coast regularly stopping to rest in sheltered areas. These young calves face predation threats from killer whales (*Orcinus orca*) and sharks in the first 11–12 months, before becoming independent (DEWR 2007). In Australian waters these sheltered resting areas on the east coast are situated in the Whitsundays, Hervey Bay, Moreton Bay, the Swain Reefs complex, Bell Cay, and the Palm Island Group (DE 2014). Some of these resting areas were formally sites of whaling stations before the *Whale Protection Act* was passed in 1978 (Paterson *et al.* 1994) and are known sites for scavenging events on whales from predatory sharks.

Since the disestablishment of whaling in Australia, the population sizes of the east and west coast have grown continuously by ~10% per year (Bryden *et al.* 1990; Bannister and Hedley 2001; Paterson *et al.* 2004; Noad *et al.* 2006) and are defined as still recovering stocks. This steady growth in whale populations has seen a concomitant increase in tourism through whale watching ventures and other ecotourism activities which have resulted in increased human interaction with whales. Likewise, the documentation of scavenging events on dead whale carcasses by large predatory sharks has also increased (Dicken 2008; Fallows *et al.* 2013).

This review focuses on possible associations of whales and predatory shark species and assesses possible implications that may result from swimming near humpback whales. We focus on the eastern Australian coast, but draw on information from other parts of the world where such interactions occur.

2.0 Brief literature review

2.1 Shark Ecology

The white shark (*Carcharodon carcharias*) and the tiger shark (*Galeocerdo cuvier*) are globally distributed marine predators, capable of large-scale movements on oceanic scales (Domeier 2009; Holmes et al 2014).

The predatory nature and large size of white sharks has enabled them to become versatile hunters with prey composition ranging from finfish, rays and shark species as juveniles (<3m) to marine mammals as adults (Bruce and Bradford 2012; Carey *et al.* 1982; Casey and Pratt Jr 1985; Dicken 2008; Long and Jones 1996). These observations have been validated by vertebral isotope analyses, which indicate that by a length of 3.4 m, individuals undertake a dietary shift to include marine mammals (Estrada *et al.* 2006). However, feeding on mammals is not exclusive to adults – juvenile white sharks (including some as small as 1.5m) have been observed to scavenge on floating whale carcasses when the opportunity permits (Carey *et al.* 1982; Dicken 2008).

2.2 Ecological relationships between predatory sharks and whales

Direct observations of sharks feeding on various baleen whale species have been widely documented throughout the scientific and general literature. As reports of these feeding events have increased, so has the knowledge of their ecological significance as apex predators, and scavengers (Carey *et al.* 1982; Domeier 2009; Fallows *et al.* 2013; Long and Jones 1996). Such events occur worldwide, some of the main areas for documented whale carcass scavenging events including the coasts of Australia (Naessig and Lanyon 2004), South Africa (Dicken 2008; Fallows *et al.* 2013), and the United States of America (Carey *et al.* 1982; Dudley 1997; Domeier 2009; Long and Jones 1996; Taylor et al 2013). In each of the regions the scavenged baleen whale species may vary depending on their geographic distribution, however, the predatory shark species appear to remain consistent. The shark species responsible for the greatest number of scavenging or predatory events on whales are white sharks and tiger sharks. Notably these two species of shark are also believed to be responsible for the highest fatality rates on humans (Dudley 1997).

2.3 Migratory links

In Australia, as in other parts of the world, the whale species targeted for food by large predatory sharks are those known to undertake seasonal migrations for calving (Dawbin 1966). As mentioned, in early winter, mature humpback whales travel north along the east and west coasts of Australia, before returning to Antarctica in spring. Cow-calf pairs often rest in sheltered bays causing them to lag behind others in the migration (DE 2014). This pattern is known to coincide both with water temperature and with known seasonal movements of white and tiger sharks.

Satellite tagging of white sharks by CSIRO off southern and southeastern Australia has revealed movements in various directions. Whereas juvenile white sharks

appear to make northward movements along the east and west coasts from autumn to spring (Bruce *et al.* 2006), some sub-adult and adult white sharks tagged off South Australia have been shown to move right along the east coast at the same times that humpback whales make their annual northerly and southerly migrations. Figure 1 below shows the projected path of a tagged 3.6 metre white shark which moved north as far as central Queensland in early winter, then a period of some months when it remained in that general area, followed by a very rapid southerly movement in spring, coinciding with humpback whale movements. Figure 2 shows a track of shorter duration by a sub-adult 2.4 metre white shark that moved rapidly northwards along the east coast in June.
This seasonal pattern is supported by the seasonal capture of white sharks in shark control programs in New South Wales and Queensland. The Queensland and New South Wales governments have operated shark control programs since 1962 and 1937 respectively. Data from the shark control programs on Australia's east coast show a pronounced seasonal trend in catch rates of white sharks. These patterns reflect increases in the catches of white sharks from May to November with a peak from September to November in New South Wales waters (Reid and Krogh 1992) and from September and October in Queensland (Paterson 1986).

It has been suggested that white sharks may spend extended periods in one area when food resources are available, before rapidly dispersing with directed movement away from such areas, presumably in search of other prey sources (Bruce *et al.* 2006).

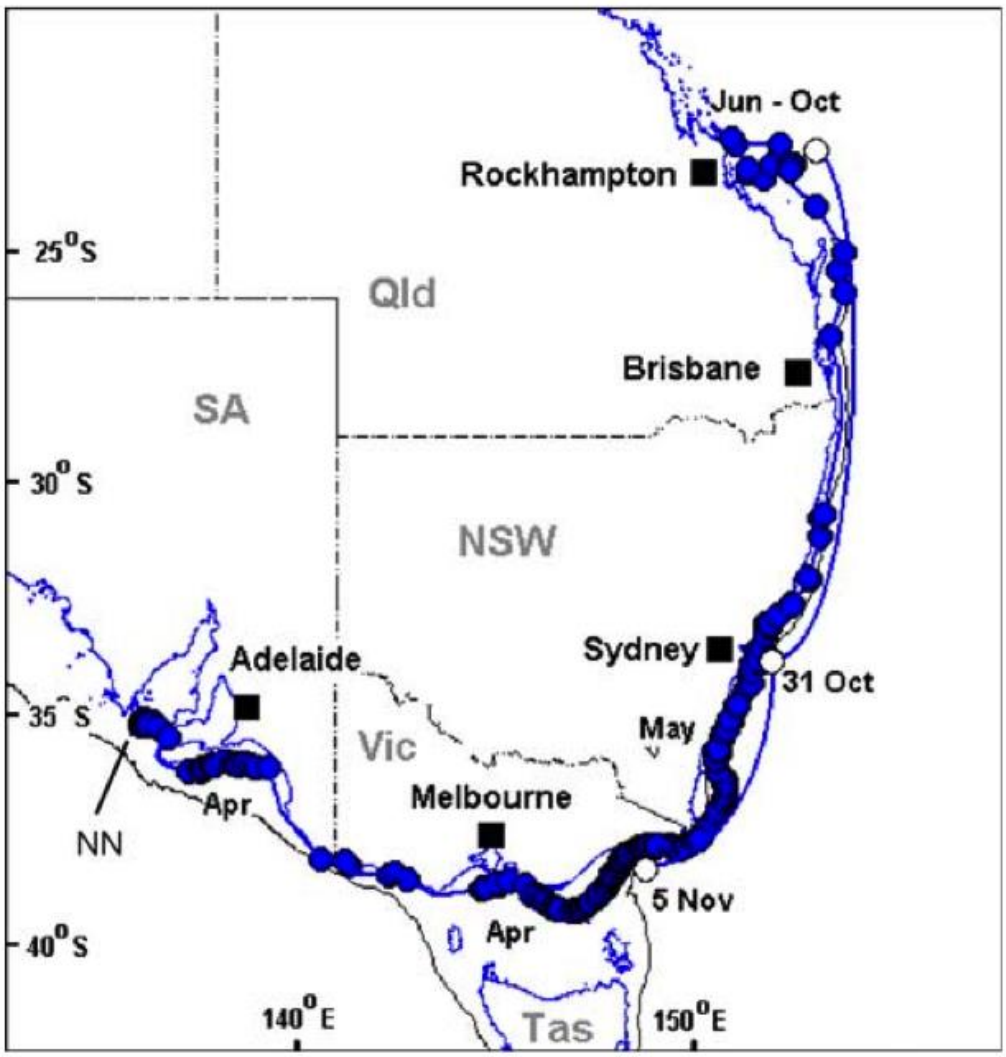

Figure 1. Movement of a 3.6m white shark tagged with a satellite tag off South Australia in April 2004. This shark moved northwards along the NSW and QLD coasts between May and June, staying near Rockhampton until October when it commenced a rapid movement south to the Victorian during October. (from Bruce *et al* 2006).

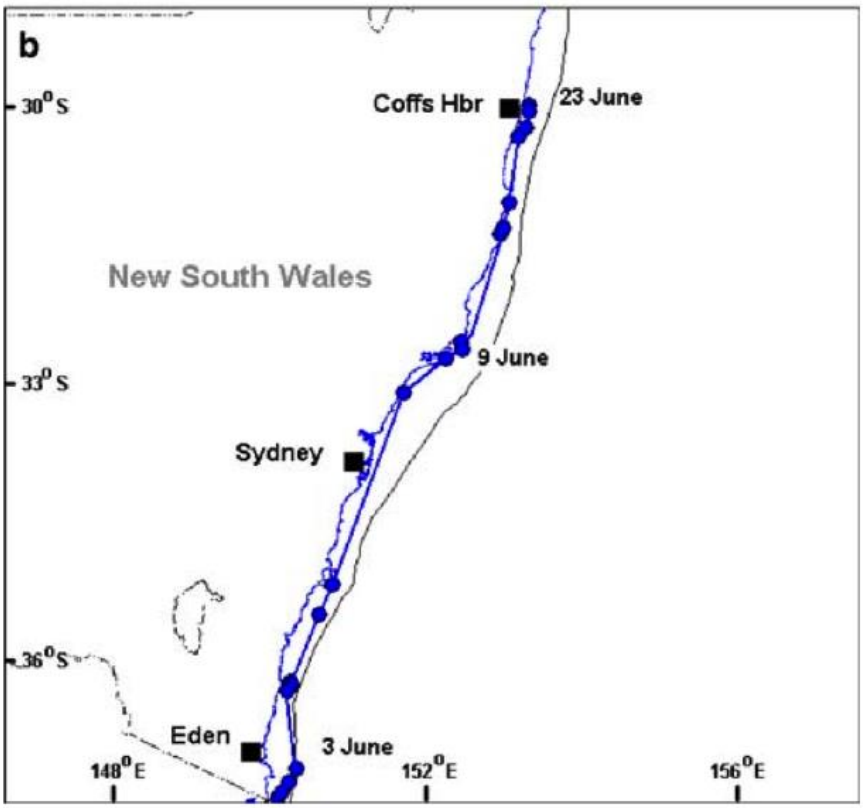

Figure 2. Rapid northerly movement by a 2.4m white shark during early winter 2001. (From Bruce *et al* 2006).

Similar movements are also exhibited by tiger sharks on the east coast of Australia, which move north from New South Wales into Queensland waters in May and June, before returning in late August (Holmes et al. 2014).

To reiterate, the directed movements of these two species of shark indicate a possible association with the seasonal migration of humpback whales both north and south along the eastern Australian coast. Although the movements of both humpback whales and sharks are correlated clearly with seasons, and therefore with surface water temperatures, the evidence suggests that whale abundance may be an additional factor influencing the seasonal movements of white and tiger sharks along the coast.

2.4 Correlation between whales and shark attacks on humans

The focus of recent research has been to investigate the relationship between sharks that may pose a threat to human life with environmental variables and geomorphology associated with risk of shark attack (Curtis *et al* 2012). Such research ranges from observations of predatory activity (Klimley *et al.* 2001; Martin *et al.* 2005), to photographing or tagging individual sharks for mark-recapture analyses (Domeier and Nasby-Lucas 2007) to tagging of individual sharks to identify the movement and behavioural patterns (Bruce *et al.* 2006; Jorgensen *et al.* 2010; Klimley *et al.* 2001).
The results from these studies have been integrated with data on the environmental conditions prevailing at the times of shark attacks to identify natural drivers of shark/human interactions.

The correlation between white shark attacks on humans and weather conditions and other factors at the time of attack have recently been evaluated by the Western Australian Government to discern any common trends (WAFD 2012). This study concluded that the presence of humpback whale carcasses was one of five higher risk factors associated with shark attacks.

The study recommended that: "While this may be coincidental, white sharks are known to feed on whales, so caution should be exercised near a whale carcass or other such attractant." (The four other significant interactions were: Being offshore (ie, greater than 30 m from the coastal shore); Winter/Spring; Cooler water (less than 20ºC) and Deeper water (greater than 5 m depth) (WAFD 2012).

The report noted that of the 26 attacks investigated, the highest number of attacks had occurred "more than a kilometre offshore with SCUBA divers and snorkelers (44%) having the highest incidence followed by surfers and sea kayakers (37%). Swimmers, despite being the most numerous users of the ocean have comprised the smallest number of attacks (WAFD 2012)." It could therefore be assumed that combining the high risk factors of being in close proximity to whale carcasses, in cool, deep offshore water during spring would produce a higher likelihood of an attack occurring on a human (WAFD 2012).

In contrast to this, an overview by the Australia Shark Attack File by West 2011, identified that patterns of attack have changed substantially over time which he surmised to mainly result from changing population and human behaviour. One such pattern was the shift of peak attacks whereby, cooler months experienced an increase from 15 incidents between 1970 and 1990 to 26 attacks between 1990 and 2010. This is similar to the patterns observed by WAFD 2012, however West 2011 speculated that the increase in winter attacks may be due to greater availability of wetsuits allowing people to spend more time in the water. Despite similar trends outlined in the WAFD report, West 2011 concluded that the chances of being attacked by a shark in Australia remain generally low.

To further evaluate the previous studies, Sprivulis (2014) analysed the risks associated with water activities and shark bite. He suggested a direct correlation between the risk of being bitten by a shark and the seasonal presence of migrating humpback whales in Western Australia. The results indicate that the majority of large white shark bites on humans occurring off metropolitan Perth and southwest coast are during late spring when humpback whales are undertaking their southward migration with their newly born calves. This study determined that increases in human population or increases in water activity showed little correlation with the occurrence or increase in shark bites (Sprivulis 2014).

2.5 Predation on dead whales

The earliest documented scavenging events on whale carcass occurred off Australia and the United States (Carey *et al.* 1982; McCosker 1985; 1987; Randall 1973). These events usually consisted of a single species of shark feeding on a dead carcasses which drove the perception that it was usually an isolated event. However, in the last two decades, work to understand shark feeding dynamics has shown that concurrent scavenging of multiple tiger sharks and white sharks is not uncommon (Dicken 2008; Dudley 1997). In fact white sharks and tiger sharks will passively feed alongside each other with up to 28 individual sharks observed feeding on a single carcass (Dicken 2008). Other reported events of multiple feeding between the two species were the presence of five to ten sharks off Long Island (Casey and Pratt Jr 1985), between seven and ten off KwaZulu-Natal, South Africa (Dudley 1997) and three to five off St Croix Island (Dicken 2008). From these observations it is apparent that sharks will continue to feed on whale carcasses until satiated and have even been observed to regurgitate food in order to continue to gorge on blubber even after satiation (Dicken 2008; McCosker 1985).

One investigation on the South African coast suggested that such large numbers of sharks rapidly being attracted to a whale carcass may be driven by adult white sharks actively patrolling the coastline in search of dead, dying or weak whales during the migration periods (Fallows et al. 2013). That study demonstrated that the presence of strong southerly winds resulted in rapid increases in shark abundance at the site of dead whale carcasses. As a result, it has been theorised that increased wind speed is a primary factor for attracting large, mature sharks from throughout the region to the site of dying whales due to slicks of whale oil being dispersed more rapidly in the surface waters (Fallows *et al.* 2013).

2.6 Predation on juvenile or moribund whales

Predation on live marine mammals by sharks is a well-recognised ecological interaction. Live shark attacks have been reported on dolphins, seals, sea lions and whales. Though predation on live baleen whales is less common than on other marine mammals, it is recognised that sharks do pose a threat particularly to juvenile or moribund whales (Weller, 2002). This is justified by observations that shark attacks have been shown to cause serious injuries affecting the swimming capacity, ultimately leading to death in some cases (Naessig and Lanyon 2004).

Predation and attacks from sharks on live adult humpback whales has been verified through necropsies on fresh carcasses off Hawaii (Mazzuca 1999). Several of these reports concluded that fatal shark attacks were the final cause of death. However, it was assumed that these whales were most likely in a moribund state from entanglement by floating debris leaving them in a weakened state prior to the fatal attacks. An investigation at the Abrolhos Bank in eastern Brazil found that while 22% of all humpback whale carcases were fed on by large sharks, an additional three live whales were also observed to have bite scars inflicted by large sharks (Bornatowski *et al.* 2012).

Attacks by large sharks on humpback whales were documented to take place during calving season (Bornatowski et al. 2012), enabling predators to target calves before becoming independent from their mothers (DEWR 2007). In the north Atlantic, researchers undertaking aerial surveys on right whales (*Eubalaena glacialis*) observed direct predation events by sharks on live calves, four of which were attributed as the direct cause of death (Taylor *et al.* 2013). The young right whales were predated upon within the calving grounds and individuals ranged from 8 days old to approximately 2 years. Two of these whales showed evidence of possibly being moribund due to entanglement prior to predation (Taylor *et al.* 2013).

Other notable reports of live predation events are by white sharks on pygmy sperm whale *Kogia breviceps* off the Californian coast (Long and Jones 1996) and on humpback whales in Western Australia (Holyoake 2012). The Western Australian study presented evidence of scavenging on carcasses, but also of a live abandoned

calf moving out to sea with several large sharks following it before later becoming stranded (Holyoake 2012).

2.7 Dietary shift to blubber

The increased activity of large sharks reported around the site of whale strandings or floating carcasses can partly be attributed to their metabolic needs. The ability of these large predators to undertake seasonal trans-oceanic movements may be directly linked with feeding on the fat of marine mammals since considerable energy expenditure is required to undertake such long distance movements.

Research into the energy consumption of white sharks suggest that shifts in dietary composition can greatly influence the metabolic needs. Estimates of the metabolic yield provided by 30kg of whale blubber, suggest a 4.5 m white shark can be satisfied for, from two weeks (Semmens *et al.* 2013) up to 1.5 months (Carey *et al.* 1982). This is supported by many direct observations of sharks feeding on whale carcasses indicating that sharks will leave behind muscle tissue in attempts to fully satiate themselves on blubber (Carey *et al.* 1982; Domeier 2009).

2.8 Swim-with-whale operations in other areas

Swimming-with-whale tourism is a direct interaction which is has been deemed illegal under a number of national or state legislations. These implications were facilitated by the International Whaling Commission Scientific Committee (IWC SC), which recognised that whale swims have the potential to negatively impact whales through harassment and disturbance. Despite this whale swims occurred both in the presence and absence of domestic legislation to prohibit whale disturbance. Examples of such behaviour are in Argentina where a statute (Chubut Law 2381/84 and 2618/85) specifically prohibits swimming with southern right whales, yet encounters continue to persist. In a review of swim-with-whale tourism, humpback and minke whales were found to be the most frequently targeted species (Hendrix & Rose, 2005. Locations where whale swims occurred included the Dominican Republic (humpbacks), with at least seven companies operating tours (an increase of one in two years); Tonga (humpbacks) with at least thirteen operators (an increase of five in two years); and the Great Barrier Reef (minkes) with at least five operators (a decrease of one in two years). Several areas, including Rurutu (French Polynesia) and Mayotte (Mozambique Channel) had recently commenced swim-with-whale operations (Hendrix & Rose, 2005). The review concludes by stating the necessity for studies to evaluate the effect of these interactions (Hendrix & Rose, 2005). With the number of swim-with-whale tour operations increasing in countries such as Tonga, there has been local media debate regarding the establishment of similar ventures on the east coast of Australia on the Fraser coast (ABC 2014). However, this has been met with criticism by environmentalists who suggest the area is too dangerous and the interactions would interfere with normal social behaviour of whales (ABC 2014).

3.0 Discussion/Conclusions

In discerning whether or not the presence of humpback whales may increase risk of shark attacks on persons in the water near whales, several sources of information were examined. These included shark ecology, relationships between sharks and whales, scavenging on dead whales by sharks, predation by sharks on live whales, links between migrations of whales and sharks and spatial coincidence of whales and shark attacks on humans.

There is evidence of movements of both tiger and white sharks along the same migratory routes as humpbacks at the same times of year. This is based on the satellite tagging of relatively few animals, and not all tagged white and tiger sharks have been recorded making such movements. For this reason, further studies aimed at elucidating the coastal movements of adult white and tiger sharks along the eastern Australian coast are recommended.

There is little doubt that both white and tiger sharks will be readily attracted to a floating, dead whale, and it is reasonable to assume that both species would stay within limited distance of migrating whales, probably via olfactory cues, not just from dead whales, but from the presence of bodily fluids and solids.

Although there is limited evidence of shark attacks on live adult humpbacks, there is some, and there is also some evidence of attacks on live calves. There is certainly evidence of attacks by white sharks on live southern right whale calves in southern Australian waters.

Following the unprecedented series of human fatalities by white sharks in Western Australia, the WA Department of Fisheries considered five risk factors associated with these incidents, and cautioned against swimmers being near dead whales. Furthermore, such risk was considered greatest in offshore water (greater than 30 m from shore and greater than 5 m deep) during spring.

In conclusion, in weighing up the information available, there is reasonable cause to suggest that being in the water near humpback whales, especially during their southerly migration with calves, could constitute a heightened risk of interaction with white or tiger sharks.

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