NSW Shark Meshing (Bather Protection) Program 2021/22 Trigger Point Review Report

Introduction

The NSW Shark Meshing (Bather Protection) Program (SMP) operates in accordance with a Joint Management Agreement (JMA) and an associated Management Plan authorised by the *Fisheries Management Act 1994* (FM Act) and the *Biodiversity Conservation Act 2016*. The Management Plan contains a performance assessment and reporting framework to assess the performance of the Plan in achieving its objectives, and to communicate the results transparently. Achievement of those objectives is determined against performance indicators and trigger points and is communicated by annual performance reports and review reports.

The SMP annual performance report for 2021/22 (Dalton, Peddemors and Doak, 2022) identified that the trigger point for the objective of 'minimising the impact on non-target species and threatened species was tripped for Leatherback Turtles and Green Turtles. The other trigger points related to the objectives of Work Health and Safety (WHS); reducing the risk to humans from shark attacks at meshed beaches; and transparent monitoring and reporting were not tripped during the 2021/22 reporting period.

The trigger points are precautionary measures as they relate to the number of entanglements, not the number of animals that die as a result of entanglement.

Trigger Point Reviews

SEA TURTLES

Leatherback Turtle (*Dermochelys coriacea*)

Trigger point description

The trigger point for the objective of '*minimising the impact on non-target species and threatened species*' was tripped for Leatherback Turtles in 2021/22. Leatherback Turtles are listed as *Endangered* under the NSW *Biodiversity Conservation Act 2016*. The trigger point for this objective is that the catch in the current reporting year exceeds the ten-year annual average plus two standard deviations.

The entanglement of 16 Leatherback Turtles during the 2021/22 SMP season tripped this trigger point as it was preceded by 10 years of captures averaging 1.3 individuals per annum. Eleven of the 16 Leatherback Turtles caught were released alive (Table 1). Survivorship of animals in good health at the time of release is high (Bond and James, 2021), however post-release mortality has been observed in this species (Dodge et al., 2022; Hamelin et al., 2017; Innis et al., 2010) and correlates well (Dodge et al., 2022) with predictive measures (NMFS, 2017).

Review findings

Leatherback Turtles are the largest of all sea turtles and genetic analysis has identified three stocks in the Indo-pacific region including southwest Indian Ocean, Northeast Indian Ocean (Malaysia, Nicobar Islands) and the Western Pacific (FitzSimmons and Limpus, 2014). These animals are seldomly found close to shore in NSW as they are considered to be a pelagic species primarily found in tropical and sub-tropical waters throughout the world (Marquez 1990). However, their physiological adaptation allowing them to maintain elevated body temperatures in cold water enable them to extend their range into temperate waters. Although a few Leatherback Turtle nests have been reported for the far north coast of NSW (Tarvey, 1993) and QLD (Limpus and McLachlan, 1979), no major nesting activity for this species has been recorded in Australia (Department of Environment and Energy, 2017).

Although Leatherback Turtles are considered to occupy pelagic waters, they are caught in the Queensland Shark Control Program and infrequently in the NSW SMP. The southern waters of Australia are one of five identified foraging grounds (where area restricted behaviour occurs) (Bailey et al, 2012) so their movement through NSW waters may represent a 'corridor' between nesting sites and primary foraging sites. This likely leads to Leatherback Turtles staying offshore utilising the southward flow of the East Australian Current (EAC) and seldomly coming into nearshore waters with potential for capture in the NSW shark nets. Although Leatherback Turtles occur in NSW waters, none of their key nesting and inter-nesting areas (where females live between laying successive clutches in the same season) are located in NSW (Dept. of Environment and Energy, 2017).

During the period under review, the EAC was anomalously warm off NSW, particularly during March/April 2022, with temperatures in the 90th percentile along the coast from Port Stephens to Sydney (Neil Malan & Moninya Roughan, pers. comm. June 2022). During this period the EAC was also being nudged towards the coast by the large anticyclonic eddy positioned offshore at 31°S and 153°E (Malan, pers. comm. 07 June 2022). These unusual concurrent oceanographic events led to pelagic waters being extremely close to the coast and may have contributed to altered Leatherback Turtle distribution leading to potential increased exposure to capture in the shark nets.

This period coincided with heavy rainfall which led to flushing of some major coastal rivers including the Hawkesbury River, resulting in decreased visibility in near shore environments. NSW Central Coast shark meshing contractors commented on the high numbers of jellyfish found in nearshore waters following these events. The combination of an oceanographically-regulated distributional shift, plentiful nearshore food supply, and relatively poor vision compared to other turtle species (Brudenall et al., 2008) may have contributed to enhanced potential for Leatherback Turtle catches in the NSW shark nets.

In 2011, the NSW Scientific Committee listed Leatherback Turtle as 'Endangered' under the NSW *Biodiversity Conservation Act 2016*, based on Clause 6 'Reduction in population size of species' (NSW Office of Environment & Heritage, 2011). Leatherback Turtles are also listed as *Vulnerable* (A2bd ver 3.1) for their global status under the IUCN Red List of Threatened Species (Wallace et al., 2013), and as *Endangered* in Australian waters under the Commonwealth *Environment Protection & Biodiversity Conservation Act 1999* (EPBC Act) (Dept. of Environment and Energy, 2017b). Leatherback Turtles have had a recovery plan in place since 2007 (Dept. of Environment and Energy, 2017).

The SMP has maintained an active policy and procedure of ensuring nets are set sub-surface in an attempt to enable air-breathing marine mammals, reptiles and birds to swim over the top of the net. The Leatherback Turtle is incapable of reverse propulsion (Hamelin et al., 2017) and hence has limited ability to self-release following entanglement.

Conclusion

Although the trigger point was tripped following the capture of 16 Leatherback Turtles, this is likely due to an anomalously warm East Australian Current (EAC) off NSW during March/April 2022, concurrent with the EAC being nudged towards the coast by the large anticyclonic eddy positioned offshore at 31°S and 153°E (Malan, pers. comm. 07 June 2022), and rain-induced flushing of the Hawkesbury River leading to high density of jellyfish (preferred Leatherback Turtle prey) in nearshore waters along the NSW Central Coast. This is likely to have brought Leatherback Turtles close to shore in low visibility conditions and within range of the shark nets. It is noted that there were a number of Leatherback Turtles that washed up on NSW Central Coast beaches during the same period as the increased catch in the shark nets in this region, corroborating an influx of this species into nearshore waters. In some cases, examination of these animals revealed evidence of some type of entanglement.

Recommendation - Leatherback Turtles

The SMP nets have caught limited numbers of Leatherback Turtles over the past decade, however, it is anticipated that catches of this species may increase with increasing temperature of nearshore waters and subsequent movement of warm-water species into central NSW waters. Although it is unlikely that the historical rate of SMP-induced fatality of 11 Leatherback Turtles over 11 years between 2009/10 and 2019/20 will negatively affect their population, ongoing efforts to reduce bycatch will be continually re-assessed. Continuing the practice of ensuring nets are not stretched tight when they are laid should continue to assist turtles to reach the surface post-entanglement and thereby potentially reduce turtle mortality. Additionally, following international success in turtle bycatch mitigation in gillnets using LED lights, incorporation of LED lights in the SMP nets could potentially reduce bycatch of all turtle species, including Leatherback Turtle. Use of this technology therefore warrants further investigation into the practicality and implications of their use in NSW waters. Desktop analysis of Leatherback Turtle behaviour combined with oceanographic conditions should also be considered as a tool to predict the potential for adverse interactions between Leatherback Turtles and the SMP nets, which could then also be corroborated by the use of drones or other surveillance equipment.

The high rate of Leatherback Turtle entanglements over the 2021/22 reporting period highlights the need for improvements in the monitoring and predictive analysis techniques for the movements of these animals. That should also be supplemented by modifying the current response arrangements in the Management Plan for the SMP. This could include consideration of removal or modification of the shark nets at certain times, such as: during and after forecast extreme climatic conditions; when monitoring and predictive analysis indicates increased abundances of Leatherback Turtles in nearshore waters; when increased abundances of Leatherback Turtles and/or interactions with the nets are reported by the DPI net contractor(s); and/or trigger points are met. Any such potential removal or modification of the nets must also be cognisant of the movements and relative abundances of target sharks so as not to increase the risk to beachgoers, and should not affect payment of DPI net contractors for inspections that they can no longer undertake.

Training and equipment will be scoped and delivered for DPI net contractors in microchipping of all live released turtles as an alternative to titanium tags which are prone to biofouling and increased risk of entanglement. Alternative bather protection devices, such as SMART drumlines, have been shown to achieve reduced impact on threatened species such as Leatherback Turtles whilst still providing bather protection from shark interactions, and warrant further investigation noting they will be deployed year-round for the first time in 2022/23 within the region of the SMP.

Table 1: Detail of Leatherback Turtles (*Dermochelys coriacea*) caught in the SMP in 2021/22.

Date	Region	Beach	Common Name	Status	Size	Sex
20-Jan-2022	Central Coast South	Umina	Leatherback Turtle	Dead	1.5	Unknown
14-Mar-2022	Sydney Central	Curl Curl	Leatherback Turtle	Dead	1.8	Unknown
16-Mar-2022	Sydney North	Newport	Leatherback Turtle	Alive & Released	1.67	Unknown
16-Mar-2022	Central Coast South	Umina	Leatherback Turtle	Dead	1.1	Unknown
18-Mar-2022	Sydney South	Coogee	Leatherback Turtle	Alive & Released	1.9	Unknown
18-Mar-2022	Sydney North	Whale	Leatherback Turtle	Alive & Released	1.6	Unknown
26-Mar-2022	Sydney North	Newport	Leatherback Turtle	Alive & Released	1.8	Unknown
28-Mar-2022	Central Coast North	Shelly	Leatherback Turtle	Alive & Released	1.7	Unknown
5-Apr-2022	Central Coast South	Copacabana	Leatherback Turtle	Alive & Released	1.1	Unknown
10-Apr-2022	Central Coast North	Swansea-Blacksmiths	Leatherback Turtle	Dead	1.43	Unknown
14-Apr-2022	Central Coast South	Terrigal	Leatherback Turtle	Alive & Released	1.3	Unknown

Date	Region	Beach	Common Name	Status	Size	Sex
15-Apr-2022	Central Coast South	North Avoca	Leatherback Turtle	Alive & Released	1.2	Unknown
18-Apr-2022	Central Coast South	Avoca	Leatherback Turtle	Alive & Released	1.1	Unknown
18-Apr-2022	Central Coast South	North Avoca	Leatherback Turtle	Alive & Released	1.2	Unknown
20-Apr-2022	Central Coast South	McMasters	Leatherback Turtle	Alive & Released	1.8	Unknown
27-Apr-2022	Central Coast South	North Avoca	Leatherback Turtle	Dead	1.1	Unknown

Green Turtle (*Chelonia mydas*)

Trigger point description

The trigger point for the objective of '*minimising the impact on non-target species and threatened species*' was tripped for Green Turtles in the 2021/22 SMP season. Green Turtles are listed as *Vulnerable* under the *Biodiversity Conservation Act 2016*. The trigger point for this objective is if the annual catch has exceeded the ten-year average plus three standard deviations.

The entanglement of 19 Green Turtles (*Chelonia mydas*) during the 2021/22 SMP season tripped the trigger point for this objective, as it was preceded by an annual average of 6.7 Green Turtles. It should be noted that prior to the 2009/10 reporting period all turtles were combined at non-specific reporting levels, thereby leading to an apparent zero catch for this species during this period and subsequently potentially affecting trigger points for this species.

Five of the 19 Green Turtles caught were released alive, however adverse physiological changes have been documented in bycaught animals that may compromise post-release survivorship (Phillips et al., 2015)

Review findings

There are seven regional populations of Green Turtles that nest in different areas of Australia. It is likely that those found off NSW are part of the southern Great Barrier Reef population which was estimated at around 8000 individuals in mid-2000 (DEH, 2005). The upward trend in the southern Great Barrier Reef Green Turtle population, as indicated by nesting numbers at the principal index beach of Heron Island, has shown a three times increase in the annual nesting population after approximately one turtle generation since closure of commercial harvesting in 1950 (Queensland Dept of Environment, https://www.ehp.qld.gov.au/wildlife/animals-az/green_turtle.html). This appears to be one of the few Green Turtle populations of the world that is showing a strong increase in response to conservation measures.

Green Turtles can migrate more than 2600 km between their feeding and nesting grounds. The average migration distance of turtles nesting on the Great Barrier Reef is approximately 400 km. Individual turtles foraging in the same area do not necessarily take the same migration route (Limpus *et al.*, 1992).

Once Green Turtles reach 30 to 40 cm curved carapace length, they settle in shallow benthic foraging habitats such as tropical tidal and sub-tidal coral and rocky reef habitat or inshore seagrass beds. The shallow foraging habitat of adults contains seagrass beds or algae mats on which Green Turtles mainly feed (Musick & Limpus, 1997; Poiner & Harris, 1996; Robins et al., 2002; Whiting, 2000).

Although Green Turtles occupy shallow waters, they are infrequently caught in either the Queensland Shark Control Program or NSW SMP. They occur in NSW waters, however none of their current key nesting and inter-nesting areas (where females live between laying

successive clutches in the same season) are located in NSW (Dept. of Environment and Energy, 2017,).

Green Turtles have had a national recovery plan in place since 2007 (Dept. of Environment and Energy, 2017b). They are also listed as *Endangered* (A2bd ver 3.1) for their global status under the IUCN Red List of Threatened Species (Seminoff *et al.*, 2004), and as *Vulnerable* in Australian waters under the EPBC Act (Dept. of Environment and Energy, 2017b).

Although there has been no apparent increase in the number of Green Turtles stranded in the NSW metropolitan region covered by the SMP and admitted into the Taronga Zoo wildlife hospital during 2022 (Meagher pers comm., 30 Sept 2022), stranding records for south-east Queensland for the first half of 2022 exceeded the 10 year median for all six months and exceeded the 75% percentile from March to June (GBRMP Strandnet Report 2022 Feb-June) which may be linked to seagrass dieback following major floods (Flint et al., 2017; Limpus, pers. comm., 30 Sept, 2022).

Analysis of historical Green Turtle catches indicates there is no significant spatial or temporal influence on catch. Green Turtles are the most abundant turtle species and are caught throughout the SMP area with little influence of Chlorophyll-a, sea surface temperature, current speed, beach length or amount of reef within 1 km^2 of the shark net.

Several international studies have reported success in turtle bycatch mitigation in gillnets using LED lights (Ortiz et al., 2016; Virgilli et al., 2018). Incorporation of LED lights in the SMP nets could therefore potentially reduce bycatch of all turtle species, including Green Turtle. Use of this technology therefore warrants further investigation into the practicality and implications of their use in NSW waters.

Table 2: Details of Green Turtles caught in the SMP in 2021/22

Date	Region	Beach	Common Name	Status	Size	Sex
17-Sep-2021	Sydney South	Cronulla	Green Turtle	Dead	0.59	F
19-Sep-2021	Central Coast North	Soldiers	Green Turtle	Dead	0.6	F
6-Dec-2021	Sydney South	Bondi	Green Turtle	Dead	0.46	Unknown
6-Dec-2021	Sydney South	Cronulla	Green Turtle	Dead	0.64	Unknown
21-Dec-2021	Central Coast North	The Entrance	Green Turtle	Alive & Released	0.73	F
24-Dec-2021	Sydney Central	Narrabeen	Green Turtle	Dead	0.65	Unknown
29-Dec-2021	Central Coast South	Terrigal	Green Turtle	Alive & Released	0.6	Unknown
31-Dec-2021	Illawarra	Garie	Green Turtle	Dead	1.1	F
23-Jan-2022	Central Coast North	The Entrance	Green Turtle	Dead	0.66	M
25-Jan-2022	Sydney Central	Harbord	Green Turtle	Dead	0.7	Unknown
31-Jan-2022	Sydney South	Bondi	Green Turtle	Dead	0.54	Unknown
10-Feb-2022	Central Coast North	Catherine Hill Bay	Green Turtle	Alive & Released	0.73	F
14-Feb-2022	Central Coast North	The Entrance	Green Turtle	Dead	0.78	F
18-Mar-2022	Central Coast North	Caves Beach	Green Turtle	Dead	0.65	F
18-Mar-2022	Central Coast South	North Avoca	Green Turtle	Alive & Released	0.7	Unknown
25-Mar-2022	Sydney South	Cronulla	Green Turtle	Dead	0.8	Unknown
14-Apr-2022	Sydney South	Bronte	Green Turtle	Dead	0.59	Unknown
20-Apr-2022	Central Coast North	Swansea-Blacksmiths	Green Turtle	Alive & Released	0.7	Unknown
30-Apr-2022	Illawarra	Wattamolla	Green Turtle	Dead	0.8	Unknown

Conclusion

The NSW SMP nets have caught increasing numbers of Green Turtles over the past decade and it is anticipated that catches for this species may continue to increase with growth in Green Turtle populations off eastern Australia plus higher temperature of nearshore waters and subsequent movement of warm-water species into central NSW waters.

The capture of 19 Green Turtles in the SMP in 2021/22 is unlikely to negatively affect the viability of the Australian population for this species; however, as a listed threatened species it is imperative that every effort is made to understand the factors affecting capture and to reduce these captures.

Recommendation - Green Turtles

Although it is unlikely that the current rate of SMP-induced fatality of Green Turtles will negatively affect their population, ongoing efforts to reduce bycatch will be continually re-assessed. Following international success in turtle bycatch mitigation in gillnets using LED lights, further investigation into the practicality of this technology in NSW waters therefore warrants investigation. Additionally, continuing to ensure nets are not stretched tight when they are laid could assist turtles to reach the surface post-entanglement and thereby potentially reduce turtle mortality.

Overarching Recommendations

1. Clauses 19.2 and 19.3 of the Management Plan should be reviewed to include provision for the potential removal or modification of the shark nets to mitigate impacts on species listed as threatened under the *Biodiversity Conservation Act 2016*, whilst maintaining protection for beachgoers.
2. Assess and implement the monitoring and predictive analysis techniques for identifying likely periods of increased abundances of marine reptiles in nearshore waters.
3. Improved implementation of clause 29 (Threatened and protected species arrangements) and the Monitoring Program of the Management Plan by EHG providing training and equipment for DPI net contractors in microchipping of all turtles released alive.
4. Progress a trial of LED lights in the SMP nets to test their efficacy in reducing marine wildlife entanglement.

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