NSW Shark Meshing (Bather Protection) Program
2017/18 Trigger Point Review Report

Introduction

The 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).

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 annual performance report for 2017/18 (Dalton and Peddemors, 2018) identified that the trigger point for the objective of '*minimising the impact on non-target species and threatened species*' was tripped for Greynurse Sharks, Hawksbill Turtles and Great Hammerheads. The trigger points related to the other objectives of: reducing the risk to humans from shark attacks at meshed beaches; work health and safety (WHS) risks; and transparent monitoring and reporting were not tripped during the 2017/18 reporting period.

Greynurse Shark and Great Hammerhead Shark are listed as endangered and vulnerable, respectively in the FM Act; and Hawksbill Turtle, a protected species in the *Biodiversity Conservation Act 2016*.

The trigger points are considered to be 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

Greynurse Shark (*Carcharias taurus*)

Trigger point description

Of the 20 Greynurse Sharks (*Carcharias taurus*) caught during the 2017/18 season, 10 were released alive and 9 were retained for necropsy and contributed to the NSW DPI Fisheries database for this species (one animal was too decomposed for necropsy when retrieved).

Review findings

Greynurse Sharks were caught in all regions of the SMP, other than Sydney Central, but a substantial proportion (40%) were caught in the northern-most region (Hunter). The beach with greatest Greynurse Shark catch was Stockton Beach (5 sharks). Stockton Beach also had the greatest catch of Greynurse Sharks in 2015/16 and 2016/17. Reid *et al*. (2011) found no peak in Greynurse Shark catch for any beach over the 60 year dataset analysed; however, the Hunter Region did consistently report more Greynurse Shark catch during the three decades pre-1980, but these then dropped to similar levels as other SMP regions (Reid *et al*., 2011).

Greynurse Sharks were also caught throughout the meshing season, with no single month representing a notably greater mortality rate.

The SMP nets are generally set away from reef structure to minimise their damage, enhance ease of operations for the contractors, and to reduce the potential for capture of predominantly reef-associated species such as Greynurse Sharks. The nets are generally set in similar positions throughout and between years, and the materials and other specifications have not changed. Therefore, operational matters are unlikely to account for the higher catches and tripping of the trigger point, suggesting an unknown habitat or other environmental driver is

affecting catches of Greynurse Shark in the northern region of the SMP.

Conclusions

The catches of 19, 17, and 20 Greynurse Sharks in the last three years, respectively, were more than three times the previous ten-year annual average catch in the SMP. Successive annual catches of that magnitude have not been reported in the SMP since the 1970s (Reid *et al.,* 2011), a time when the SMP season was a full calendar year, not eight months as it is now.

Although the trigger point was tripped following the capture of these 20 Greynurse Sharks, this is likely due to the three successive years of relatively high catch preceded by a long period of substantially lower reported catch for this species during the preceding decade. An increase in Greynurse Shark catches could be expected due to the recently estimated annual rate of adult population increase of 3.4 and 4.5%, depending on age at sexual maturity (Bradford *et al.*, 2018).

Fifty per cent of Greynurse Sharks caught were released alive with no statistically significant difference in size between animals found alive or dead in the nets. All but one Greynurse Shark caught were female. The ongoing and high catch, particularly of females, is of significant concern and has led to a new PhD project with Macquarie University investigating the bioecology and movements of Bull and Greynurse Sharks. Unfortunately, there are currently no known effective methods to completely mitigate bycatch of Greynurse Sharks from shark nets like those used in the SMP. The data also suggests it is not feasible to implement operational changes to reduce the catch, as those changes would also affect the catch of White Sharks. While consistent with the JMA, it would undermine the primary role of the SMP, which is to reduce the chances of human interactions with target sharks.

Recommendations

The NSW SMP nets have continuously caught low numbers of Greynurse Sharks over the past decade, however, the release of over 50% of all Greynurse Sharks since the implementation of the first JMA in 2009 highlights the efficacy of more regular checking of nets by the contractors through reducing the number of hours between checks of nets to a maximum of 72 hours. It is anticipated that these released individuals will survive and this will be determined through the use of pop-up satellite archival tags (PSAT) to measure post-release survivorship during subsequent years. Twenty PSATs have been ordered and are due for delivery early in 2019 (i.e. mid-2018/19 SMP season). Released Greynurse Sharks will be tagged from early 2019 onwards following training of contractors in line with the Department's Animal Ethics approval.

An analysis of Greynurse Shark catch, including historical data, will be conducted during the 2019 by a Macquarie University PhD student to determine whether there are any areas of higher catch that could benefit from changes in gear; however, at this stage there are no readily identifiable deficiencies or issues to be addressed from an operational perspective of the JMA and Management Plan.

Alternative bather protection devices, such as SMART Drumlines, could achieve reduced impact on threatened species such as Greynurse Sharks whilst still providing bather protection from shark interactions and warrant further investigation into the practicalities of incorporating into the NSW SMP. DPI is investigating the potential for SMART drumline trials alongside the SMP nets in the Hunter and Sydney North regions during the summer of 2018/19.

Great Hammerhead Shark (*Sphyrna mokarran*)

Trigger point description

The entanglement of three Great Hammerhead Sharks (*Sphyrna mokarran*) during the 2017/18 shark meshing season tripped the trigger point for non-target species as it was preceded by one entanglement in each of the preceding two meshing seasons after nine years of no reported catches for this species.

All animals were retained as whole carcasses for research purposes.

Review findings

Historically, Great Hammerhead Sharks are rarely represented within the SMP, with the preceding two seasons reporting a single capture per annum after nine years of no catch. The three animals captured during the current season were all caught north of Sydney and over a two month period. A potential factor behind the recent captures over the last two seasons of a tropical species may be due to the changes in ocean circulation, leading to the increasing intensity and warming of the East Australian Current (EAC) (Hughes et al., 2016).

Conclusion

The capture of five Great Hammerhead Sharks over the past ten years precludes detailed analysis to determine potential environmental factors leading to this occurrence, albeit over three consecutive years. However, movement of warm water eddies and/or the EAC closer to the coast may contribute to tropical species such as the Great Hammerhead Shark interacting with the SMP nets.

Recommendation

Due to the rare nature of Great Hammerhead Shark interactions with the SMP, the 10 year average of 0.5 interactions, and large litter sizes (6-33 pups; Last et al., 2009), it is unlikely that SMP-induced fatality will negatively impact the population. Research into spatio-temporal and environmental drivers of Great Hammerhead Shark movements will complement existing life history information.

Hawksbill Turtle (*Eretmochelys imbricata*)

Trigger point description

The entanglement (and subsequent death) of two Hawksbill Turtles (*Eretmochelys imbricata*) during the 2017/18 shark meshing season tripped the trigger point for threatened species entanglements. 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 affecting trigger points for this species. Analysis of catches of all turtle species combined (as per historical reporting classifications) does not trip the trigger point. The tripping of the trigger point for Hawksbill Turtles in the current reporting year may therefore not represent an unusually high catch for this species, but may be an artefact of the historical lack of species differentiation in reporting.

One of the Hawksbill Turtles caught were retained and provided to the Taronga Zoo for necropsy and accessioning of specimens into the Australian Registry of Wildlife Heath; but the other was decomposed and returned to the sea after measuring.

Review findings

Nets are generally set away from reef structure to minimise their damage, enhance ease of operation for the contractors, and are less likely to capture reef-associated species such as Hawksbill Turtles.

Although Hawksbill Turtles are considered to occupy shallow waters (less than 30m), they are infrequently caught in either the Queensland Shark Control Program or NSW SMP.

Although Hawksbill 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 in NSW (Department of the Environment, 2017).

A review of their strandings along NSW beaches highlighted a skewed stranding frequency to northern NSW beaches (Ferris, 2016), suggesting that the region of the NSW SMP is outside of their preferred range. However, it is possible that a range extension southward could be expected with warmer waters associated with climate change.

The size range of 37-45 cm curved carapace length (CCL) corresponds to the size at recruitment onto reef habitat from the pelagic environment (Limpus, 1992; Limpus et al., 2008). The months of capture in the SMP reflect increased periods of strandings in NSW waters (Ferris, 2016) and may reflect changes in the strength and seasonal variation of the East Australian Current (EAC).

Conclusions

Although the trigger point was tripped following the capture of these two Hawksbill Turtles, this is likely due to the historical long period of zero reported catch for this species when turtles were not reported to species level. This highlights the benefits of the JMA and associated Management Plan in ensuring that the program accurately reports on all species caught, thereby allowing determination of long-term trends in catch rates and potential for impact on the populations of species affected by this program.

The SMP has maintained an active policy 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.

Recent studies into reducing turtle bycatch in passive net fisheries have highlighted the potential to use LED lights to illuminate nets and reduce bycatch (Gilman et al., 2010; Wang et al. 2010, 2013; Ortiz et al., 2016). The wavelengths produced by lightsticks often incorporated into longline gear appear to attract Loggerhead Turtles (Swimmer et al. 2017), because Loggerhead, Leatherback, and Green turtles rely extensively on visual cues (Constantino & Salmon 2003; Wang et al. 2007; Young et al. 2012), particularly when foraging (Swimmer et al. 2005; Southwood et al. 2008; Wang et al. 2010). These LED lights are now actively produced and internationally endorsed as turtle excluder devices, e.g. in the European Union http://ec.europa.eu/environment/integration/research/newsalert/pdf/352na1_en.pdf, and Australia http://www.abc.net.au/science/articles/2013/07/24/3809278.htm.

Recommendations

The NSW SMP nets have caught few Hawksbill Turtles over the past decade, however, it is anticipated that catches for this species could increase with increasing temperature of nearshore waters and subsequent movement of warm-water species into central NSW waters.

Although it is unlikely that the current rate of SMP-induced fatality of Hawksbill Turtles will negatively affect the population, it is imperative that ongoing efforts to reduce any bycatch be continually re-assessed. Incorporation of special LED lights in the SMP nets could potentially reduce bycatch of all turtle species, including Hawksbill Turtle, and warrant further investigation into the practicality of their use in NSW waters. An analysis of historical turtle catches will be conducted to determine whether there are any beaches with peaks in sea turtle (all species combined) catches to potentially identify sites of preferred LED experimentation where a BACI test will allow determination of their efficacy in reducing turtle catch.

Positioning of the nets well away from reef may reduce entanglement of reef-associated species such as Hawksbill Turtles.

Alternatively, ensuring nets are not stretched tight when they are laid could assist turtles to reach the surface post-entanglement and thereby potentially reduce turtle mortality.

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