Review of the Non-Detriment Finding for CITES Appendix II listed Hammerhead Shark Species

FINAL REPORT
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EXECUTIVE SUMMARY

On 14 September 2014, the listing of the scalloped, great and smooth hammerhead sharks on the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendix II took effect.

The ability for Australia to continue to export the three listed hammerhead shark species was made possible through a positive "non-detriment finding" (NDF) made by Australia, which included defined harvest limits.

The 2014 positive NDF for hammerhead shark species was subject to (a) no further increase in the average annual catch of the species; (b) no carryover of catch levels from year to year, and (c) State and Commonwealth management agencies seeking to implement improved management arrangements to minimise the ongoing catch of these species.

The NDF also included the trigger that *"... if further information on individual species abundance, distribution and harvest becomes available through a review of trade data, ecological risk assessment or through research projects, the harvest levels contained in this NDF may be reviewed. Through the improvement of reporting (down to species level) and research, the information basis for future NDFs will improve over time."*

As at 2020, the following can be reported against each of those conditions for a positive NDF and triggers for a review of harvest levels.

Condition a. No further increase in the average annual catch of the species

In order to make any robust commentary regarding the trend in catches of the three hammerhead species, there must first be confidence in reliable catch and discard data. However, despite the NDF clear recommendation to implement measures to address the uncertainty around commercial retained and discarded catch of hammerhead sharks, this has either not occurred in some jurisdictions, or has only recently occurred, meaning that a sufficient dataset of species-specific data is not yet available.

In addition, there is a lack of observer data and/or other forms of fisheries independent data which would serve to validate the data which is available. There is also a lack of data for other forms of mortality including recreational and indigenous sectors and IUU take.

While available data does not suggest that there have been further increases in annual catch of these species, there is significant uncertainty around the actual level of mortality.

Condition b. No carryover of catch levels from year to year

There is no evidence of catch level carry over from year to year.

Condition c. Management agencies implement improved management arrangement, as specified

While some progress has been made, Australia has fully implemented only 41% of the generic recommendations (applied generally to all fisheries management agencies). Partially implemented recommendations or recommendations with implementation "in progress" represent a further 18%. 41% of recommendations have not been implemented/presumed not implemented in any form.

Recommendations were also made on a fishery-specific basis. Across all jurisdictions, 102 fishery-specific recommendations were assigned and of those only 27% have been fully implemented. A further 10% of recommendations have been partially implemented or implementation is "in progress", and 55% of recommendations have not been implemented/presumed not implemented in any form[1].

Also, some of the TSSC recommendations relating to the listing of scalloped hammerheads as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) remain unimplemented, despite the requirement for full and unaltered implementation of all recommendations by 2018.

The Wildlife Trade Operation (WTO) accreditation under the EPBC Act provides a vehicle to implement these recommendations, however the Queensland's East Coast Inshore Finfish Fishery was able to maintain its approval while not implementing these requirements. The eventual revocation of the WTO in 2020 led to swift improvement in management, however the full TSSC recommendations are still not implemented.

In 2018, the TSSC recommended that "the 2014 Non-Detriment Finding be fully reviewed and updated in 2019, taking into consideration all relevant available data, including that collected between September 2014 and June 2019." This recommendation from Australia's expert authority on threatened species has not been actioned.

While some barriers to implementation of recommendations relevant to fisheries across Australia are expected, this very low level of implementation and no progress of new and pertinent recommendations by the TSSC, results in this condition of the NDF not being met.

It is noteworthy also that no comprehensive review of management recommendations has been completed since the NDF was initiated 2014. While the 2017 review asked fishing authorities to offer up information of new management arrangements, this was not compared to the specific recommendations. If it were, it would have revealed extremely limited progress.

Trigger for review - Further information on individual species abundance, distribution and harvest becomes available through a review of trade data, ecological risk assessment or through research projects

Further relevant information and/adjustments which have occurred since 2014 include:

- *Conservation Status*. There has been a significant worsening of the conservation status. In 2018, scalloped hammerheads were listed as Conservation Dependent under the EPBC Act and in 2019 the scalloped and great hammerhead sharks were upgraded on the IUCN Red List to Critically Endangered, with the recommendation all retention and landings be prohibited

[1] 7% of recommendations were considered "not applicable" due to the fishery being closed since the 2014 NDF, or the management action is not possible due to the species' being no take.

at least as long as the global population remains in a Critically Endangered status. All three species have been listed on the Convention for Migratory Species (CMS) since 2014.

- *Stock status.* The Department of the Environment and Energy's 2017 NDF analysis was that insufficient new data was still yet to be produced to have confidence in hammerhead shark population models or stock assessments, but still no progress has been made regarding this for great or smooth hammerheads. A scalloped hammerhead stock assessment is currently in progress.
- *CITES Trade data and management***.** The CITES trade data does not reveal any concerning trends in its own right. However, the discrepancies between recorded exports and imports per consignment raise questions about the integrity of the system which is designed to provide assurances of species and volumes traded. In addition, the adequacy of the traceability requirements to ensure that only product originating from WTO fisheries is exported has been highlighted as needing improvement, yet no improvements have been made.
- *New scientific findings.* A number of new scientific findings of relevance have become available since 2014. These include new information of post release mortality, important life history parameters, stock structure, shark identification, and more.

The above list represents a significant amount of further and highly relevant information which is now available with regards to the three listed hammerhead shark species.

This review finds the performance against condition (a) and (c) of the NDF has been very limited; and the trigger for a review of the NDF in the light of new relevant information has been met.

Recommendations

Based on the findings outlined in this report, it is recommended that the NDF for the three hammerhead species be reviewed immediately on the basis that the conditions have not been met. Any new consideration of an NDF should:

1. Take into account the significant worsening of the global and national conservation status of these species.
2. Introduce a mortality limit expressed as whole live weight, as opposed to the current harvest limit. This would be a more appropriate indicator of impact and health, and incentivise regulators. Given the uncertainty in data, these limits should be set with precaution and for example, presume the highest estimates of discard mortality.
3. Revise the harvest limits to reflect the need for further precaution on the basis that significant improvement quality of data has not been delivered as was expected from the 2014 NDF.
4. Re-examine the NDF recommendations and identify new recommendations based on recent findings, including but not limited to the recommendation by the TSSC to develop a management plan for scalloped hammerhead sharks. This should include honing recommendations to ensure that each is explicitly relevant to each fishery and jurisdiction.
5. Require the incorporation of specific implementation timeframes on all recommendations, including recommendations that must be implemented prior to exporting being permitted (in addition to formal and robust stock assessments being completed).
6. Require that all these time-bound recommendations are immediately (in light of very slow progress on improvement to date) included, in full, as conditions of WTOs for all relevant fisheries.

7. Implement Cortes (2016) recommendations for achieving stock assessments, which included fishery observer programs to gather crucial fisheries data and biological information; or the undertaking of a fisheries independent survey program and fin clipping to ensure accurate species identification.

8. Require improvements to the traceability system supporting CITES export permits to validate that products from the listed hammerhead species have been harvested in fisheries operating under a current WTO. In particular the CITES Guidance on this matter should be considered a significant asset in actioning this requirement.

9. Address the need to improve compliance around the CITES export permit system including clear protocols around triggers for further checks, requirements for random spot checks and other methods which provide surety as to compliance with CITES requirements and Australian export permits. This should be extended to exports of non-CITES listed species to ensure that listed species are not being exported with a permit.

10. Investigate the cause of anomalies in CITES data and implement improvements that will address the incompatibility between the export and import data. If anomalies are due to administrative/systems errors, these should be resolved as a priority to ensure that any illegal activity is clear and apparent with no ability for them to be justified as administrative issues.

11. Include a requirement to publish an annual report on the progress against the NDF conditions including mortality related limits and recommendations and any other prescribed conditions (consideration should also be given to adopting this transparency for all CITES listed species).

12. Take into account the recent scientific findings outlined in this report, and be designed to be capable of considering new findings which will subsequently emerge.

In addition, it is recommended that:

13. The CMS reservation of the three hammerhead shark species be reviewed in the light of the progress against Commonwealth and scientific recommendations; and in the light of uncertainty of stock status due to inadequacies in the quality and quantity of data.

14. A policy be implemented which requires a review of CMS reservation decisions at appropriate frequency, at least every 3 years.

In 2014, TRAFFIC, together with (German) Federal Agency for Nature Conservation produced a CITES Non-detriment Findings Guidance for Shark Species, A Framework to assist Authorities in making Non-detriment Findings (NDFs) for species listed in CITES Appendix II (updated version 2) (Mundy et al, 2014). This guidance document, provided as a resource on the CITES website, would be a sound basis to approach the consideration of the a new NDF.

Contents

1 OVERVIEW AND PURPOSE OF THIS REPORT

On 14 September 2014, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendix II listings of the scalloped, great and smooth hammerhead sharks took effect.

The ability for Australia to continue to export the three listed hammerhead shark species was made possible through a positive "non-detriment finding" (NDF) made by Australia, which included defined harvest limits for each species which were deemed sustainable[2] (Department of Environment Australia, 2014). The NDF finding was based on relevant information regarding the biology, ecology, distribution, threats and managements of the species.

The NDF recognised numerous gaps in information and management, and thus was conditioned with a set of recommendations.

The 2014 NDF was made for a period of three years. In 2017, the Commonwealth Department of the Environment and Energy analysed newly available information and concluded that "as insufficient new data to have confidence in hammerhead shark population models or stock assessments has been produced, the 2014 NDF should be extended until such time as relevant additional information becomes available, or until it is otherwise decided to review the non-detriment finding" (Department of the Environment and Energy, 2017) [3].

Six years on from the original NDF, this report reviews changes in each of the factors that informed the 2014 conclusion. Specifically, this report reviews:

- changes in stock status and conservation status/listings
- management arrangements, in particular progress against the recommendations included in the 2014 NDF
- catch and other mortality data since 2014
- the Convention's export data since 2014
- recent scientific findings in relation to the listed hammerhead sharks

Changes since 2014 are documented, as are associated findings and recommendations based on the adequacy of the current NDF given the current circumstances and information.

2 BACKGROUND

2.1 CITES LISTING & NON-DETRIMENT FINDING RESPONSIBILITIES IN AUSTRALIA

On 14 September 2014, the following hammerhead species listings on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) came into effect:

- *Sphyrna lewini* - scalloped hammerhead shark
- *Sphyrna mokarran* - great hammerhead shark
- *Sphyrna zygaena* - smooth hammerhead shark

CITES Appendix II includes species not necessarily threatened with extinction, but for which trade must be controlled in order to avoid utilisation incompatible with their survival.

[2] https://www.environment.gov.au/system/files/resources/39c06695-8436-49c2-b24f-c647b4672ca2/files/cites-appendix-ii-shark-listing-ndf_1.pdf

[3] https://environment.gov.au/system/files/pages/4ceff86a-a3ef-470e-a264-098dd5be7c61/files/analysis-hammerhead-shark-2014-ndf.pdf

In Australia, obligations under CITES are given effect domestically by the Australia's federal environmental legislation, the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The EPBC Act requires that, amongst other matters, an export permit for a CITES Appendix II listed species may only be issued by the Minister for the Environment if a positive non-detriment finding (NDF) has been made by the Australian CITES Scientific Authority. The NDF underpins the assessment and approval as a wildlife trade operations (WTO) under the EPBC Act.

A positive NDF for the harvest of a species can be made when the sum of all harvests of the species is deemed sustainable, in that it does not result in unplanned range reduction, or long-term population decline, or otherwise change the population in a way that might be expected to lead to the species' decline (Department of the Environment Australia, 2014).

2.2 DETERMINATION OF AN NDF FOR 2014 LISTED HAMMERHEAD SHARK SPECIES

A positive NDF was made for all three hammerhead species. In making the NDF, the Australian CITES Scientific Authority determined that the harvest limits suggested by Simpfendorfer in his 2014 advice (Simpfendorfer, 2014) were sustainable and unlikely to be detrimental to the species.

The NDF stated that it had been made based on the then most current and available information including each species' range, population structure, status and stock assessments in Australian waters; an analysis of Australian commercial fisheries interacting with the listed species, including an assessment of existing management measures; and consideration of regional and global management measures, threats, stocks and harvests. This information was provided in two key documents:

- A scientific assessment which included guidance on sustainable harvest limits for each of the species (Simpfendorfer, 2014), and
- An analysis of Australian fisheries (Koopman and Knuckey, 2014) which reviewed harvests and management arrangements for these species across all fishing jurisdictions.

Table 1 outlines the NDF finding for each species, and summarises the justification provided for the NDF finding and the harvest limits that were applied.

Table 1: Summary of the NDF for 2014 CITES Appendix II listed hammerhead shark species

Species	Conclusion	Harvest level for Australian Fisheries	Justification
Scalloped hammerhead	Current levels of catch are unlikely to be detrimental to the species	The current catch level accepted as non-detrimental is 200t per year	▪ Listed as endangered under the NSW *Fisheries Management Act 1994* which restricts the capture of this species ▪ Management arrangements in place in all fisheries to protect sharks in general ▪ WA Northern Shark Fishery currently being closed ▪ Marked decrease in shark fishing in northern Western Australia over the past 5-8 years ▪ Evidence of other more heavily exploited species of sharks in northern Australia (*Carcharhinus tilstoni* and *C. sorrah*) showing positive signs of recovery

Great hammerhead	Current levels of catch are unlikely to be detrimental to the species	The current catch level accepted as non-detrimental is 100t per year	▪ Listed as vulnerable under the NSW *Fisheries Management Act 1994* which restricts the capture of this species ▪ Management arrangements in place in all fisheries to protect sharks in general ▪ WA Northern Shark Fishery currently being closed ▪ Recent research by Bradshaw et al. (2013) and Field et al. (2012) suggesting some level of recovery in northern Australian waters since Taiwanese gillnet fishing ceased in the mid 1980's
Smooth hammerhead	Current levels of catch are unlikely to be detrimental to the species	The current catch level accepted as non-detrimental is 70t per year	▪ Currently there are no indications to suggest that the population is at a level where the current harvest would be detrimental to the species

The NDF was made for a period of three years from 14 September 2014 unless reviewed earlier, and applied to harvest from approved commercial Australian fisheries that interact with the species.

3 REVIEW OF CURRENT INFORMATION AND PROGRESS

This section reviews new information relevant to the inputs, findings, conditions and recommendations laid out in the 2014 NDF finding for hammerhead sharks. In particular, the following is provided in the sections below:

- A review of reported changes in stock status
- A review of changes to conservation status/listings
- A review of management arrangements, in particular progress against the recommendations included in the 2014 NDF
- A review of catch data and consideration of other sources of mortality since 2014
- A review of CITES export data since 2014
- A review of recent relevant research and scientific findings

3.1 STOCK STATUS

3.1.1 Scalloped Hammerhead Stock Status

While neither a global or local stock assessment for scalloped hammerhead shark was available, the 2014 NDF drew upon two studies which presented some insights into the population levels for this species:

- In 2011, Simpfendorfer et al (2011) produced the largest data set of catch and effort data from fisheries and shark control programs along the eastern Australian coast. Based on analysis of this data, it was concluded that the population of scalloped hammerhead shark had declined to between 16.5 and 33.4 per cent of its original pre-exploitation levels. The analysis grouped all catches of hammerhead together because during the first few decades the catch was only recorded at the group level. However, the report surmised that most of the take was scalloped hammerheads based on size and latter species level identifications.
- An analysis of un-standardised catch rates in the Western Australian North Coast Shark Fishery (WANCSF) and the Joint Authority Northern Shark Fishery (JANSF), both now closed to fishing, showed a decline in catch rates to between 24 and 42 per cent of original levels over a 5-year period, suggesting a moderate decline in numbers (Heupel and McAuley, 2007). These catches were not identified to species level, but it was assumed that both scalloped and great hammerhead sharks made up substantial components.

Simpfendorfer (2014) concluded that: Both of these results demonstrate that hammerheads can be affected quite rapidly by fishing and that populations in Australia are well below their pre-exploitation levels. However, the lack of more detailed stock assessments meant that it could not be determined if these levels are above or below sustainable take levels. Following from this Simpfendorfer recommended a national level stock assessment to inform future NDFs.

More recently, Braccini et al (2019) quantified patterns in catch rates and mean size for 43 tropical and subtropical species, including scalloped hammerhead sharks, from 15 years of fishery-independent surveys (2002–2017) in north western Australia. This study region represents an area of ~0.8 million km2 which was closed to commercial fishing of sharks and rays in two stages, with an initial closure of ~0.35 million km2 in 1993 and a further closure of ~0.45 million km2 from 2005 due to the very high State-wide catches of sandbar and dusky sharks.

For sandbar shark, catch rates increased between 2008 and 2017 whereas for other taxa, including scalloped hammerheads, catch rates were mostly stable and fluctuating.

Mean size at capture exhibited no particular trends but fluctuated across the year range. Braccini et al (2019) commented that "unlike other parts of the world, catch rates and mean size of northwestern Australian sharks have been stable or increased in recent years."

The most significant progress since 2014 has been the establishment of a Northern Territory - Queensland - Western Australian joint technical working group to undertake a stock assessment of Australian populations of scalloped hammerhead. A stock assessment workshop was held in November 2019, which reconstructed the historic catch data to be used in the assessment.

It is understood that the stock assessment technical working group has developed a draft stock assessment and at the time of writing this report, an external review had been undertaken of the draft report and the working group were seeking advice from the relevant experts as part of the review and finalisation process *(Norris, pers comm, September 2020).*

The draft report was not made available for the purposes of this review however, it was advised that preliminary results from the assessment suggest the species is above 60% of unfished levels *(Norris, pers comm, September 2020).*

This finding is significantly divergent from that of other recent studies. The methodology and data that drove this result should be made available for independent review, which itself should be made public. Importantly, the caveats and recommendations resulting from the stock assessment will also be critical to understand.

3.1.2 Great Hammerhead Stock Status

In 2014, there was no global or local stock assessment available for great hammerhead sharks. The same two studies which presented some insights into the population levels for scalloped hammerhead sharks (see **Section 3.1.1**) were referenced in terms of great hammerhead shark stock status in the 2014 NDF.

Drawing on these two studies, Simpfendorfer (2014) concluded for great hammerhead sharks that: these results demonstrate that hammerheads can be affected quite rapidly by fishing and that populations in Australia are well below their pre-exploitation levels. However, the lack of more detailed stock assessments mean that it cannot be determined if these levels are above or below sustainable take levels.

Since 2014, there has been no further stock assessment of great hammerhead sharks relevant to Australian waters.

3.1.3 Smooth Hammerhead Stock Status

In 2014, no global or local stock assessments were available for smooth hammerhead sharks. The 2014 NDF drew upon studies which presented insights into the population levels for this species:

- Data from the Joint Authority Southern Demersal Gillnet and Demersal Longline Fishery (JASDGDLF) and the West Coast Demersal Gillnet and Demersal Longline Fishery (WCDGDLF) from 1989/90 to 2014 showed that catch per unit effort had increased steadily over time (Simpfendorfer, 2014). However, it was acknowledged that the rise in catch per unit effort may be attributed to catch being identified to species level rather than an increase in species abundance.
- Limited research and fishery catch per unit effort data for temperate Western Australian waters from 1994 to 1999 showed no change over this timeframe. From this, McAuley and Simpfendorfer (2003) concluded that catch was below the levels that would lead to population decline.

In his scientific assessment as input to the NDF, Simpfendorfer (2014) concluded that: the lack of a stock assessment made it impossible to estimate the sustainable take of this species.

Since 2014, there has been no further stock assessment of smooth hammerhead sharks relevant to Australian waters.

3.1.4 Queensland Whaler and Hammerhead Shark Assessment

In 2016, a stock assessment of whaler and hammerhead sharks in Queensland was undertaken by the Queensland Department of Agriculture and Fisheries (QDAF) (Leigh, 2016). The assessment used data on the species composition of commercial shark catches collected as part of the Fishery Observer Program (FOP) run by Fisheries Queensland between 2006 and 2012.

Based on the data and analysis, commercial shark catches in Queensland at the time were deemed to be below maximum sustainable yield (MSY) limits.

The report highlighted major concerns particularly data quality and availability of data on discard rates of sharks, and a lack of species composition data outside of the short period (2006–2012) over which the FOP operated.

Leigh (2016) advised that future stock assessments would benefit from improved catch composition data. Leigh also reported that: The biggest potential improvement to future assessments of sharks in Queensland would come from better-quality input data. If resources can be made available, major benefits would arise from a survey of fishing gear and technology in the inshore net fisheries, some means of expert species identification of future commercial harvests and discarded catch, and accurate recording of net length, net depth and water depth in commercial logbooks.

Cortés (2016) undertook an independent peer review of the QDAF stock assessment. As acknowledged by Leigh (2016), the review reported that the main limitations of the stock assessment were both the quantity and quality of data available which are detailed below:

- Logbook data only started identifying sharks to species in 2003 and even then, identification was too unreliable to allow for species-specific assessments to be undertaken so the species composition of the catch complex had to be approximated using data from a FOP.
- The total catches reported in the logbook program were uncertain because they do not include discards. The assessment had to heavily rely on the FOP.
- The lack of species-specific indices of relative abundance was identified as a major limiting factor for the credibility of the assessment results. Catch per unit effort was computed for the shark assemblage in each of 10 subregions. However, the species composition in each of these subregions was unknown (other than inferred from limited FOP data) and likely varied

interannually, making it almost impossible to understand what the catch per unit effort series are tracking in each subregion. The trends for some species could be masked by opposing trends from other species in the shark assemblage with different productivity.

- No credible series of fishing effort was available limiting the ability to accurately interpret catch per unit effort trends.

In reviewing the methodology and results, Cortés added:

- Some of the assumptions (e.g. ratios of the fishing mortality rate to natural mortality rate and ratio of parental stock size with respect to virgin levels) yielded productivity estimates that are likely too optimistic based on recent findings for these quantities for shark species.
- The model interpreted that the populations can sustain much higher removals (MSY) because of the generally increasing catch rates and reduced catches in the past decade. The catches are likely to be underreported, but assumed to be known, and the catch per unit effort s for the ten subregions do not represent the relative abundance of any species in particular, leading to significant doubt on the results of the assessment.

The review concluded with the advice that an accurate assessment of shark stock status will not be possible unless there is a serious investment in data collection, making the following recommendations to achieve this:

- Resurrect the FOP which would provide crucial pieces of information on the annual catch of gillnet fisheries: species compositions, length compositions, status and fate of captured animals, development of an alternative relative abundance index, and collection of biological samples for life history and genetic studies.
- Alternatively, implement a fishery-independent survey of shark resources for the entire area.
- Fin clips could be taken from captured sharks in the gillnet fishery to perform genetic identification and compare with logbooks reports. This could be a way to verify the inaccuracy of the species composition in the logbook data, attempt to reconstruct the species composition back in time, and adjust newly acquired logbook data.

It is understood that none of the three expert recommendations have been implemented.

FINDINGS

1. Despite numerous recommendations to improve the understanding of stock status of the three hammerhead species, to date there has been little publicly available progress

2. Significant recommendations from expert peer reviewer of the Queensland hammerhead sharks have not been implemented.

3.2 CONSERVATION STATUS

3.2.1 Scalloped Hammerhead Conservation Listings

At the time of the NDF finding in 2014, scalloped hammerheads were listed as Endangered on the International Union for Conservation of Nature Red List of Threatened species (IUCN Red List)[4]. Since that time, the listing status of scalloped hammerhead sharks has changed significantly, both the nationally and internationally:

- **Convention for Migratory Species, Appendix II, 2014.** In 2014, (following the NDF) scalloped hammerheads were listed on Appendix II of the Convention for Migratory Species (CMS)[5]. The CMS is an international environmental treaty of the United Nations, which

[4] https://www.iucnredlist.org/species/39385/10190088

[5] https://www.cms.int/sharks/en/species/sphyrna-lewini

provides a global platform[6] for the conservation and sustainable use of migratory animals and their habitats. Migratory species that need or would significantly benefit from international co-operation are listed in Appendix II of the Convention. Range States for listed species are encouraged to develop global and/or regional agreements.

However, Australia submitted a reservation to the listing meaning that it did not take effect within Australian waters. This was on the basis of "unintended consequences", specifically that the EPBC Act requires that, once listed on either Appendix to the Convention, species must be included on the list of migratory species established under the Act. Once listed as a migratory species, it becomes an offence to kill, injure, take or move the species in Commonwealth waters[7].

The Australian Government goes further to say: "Notwithstanding the reservation on the listing of the species on the CMS, Australia is continuing to fulfil the requirements of an Appendix II listing for these species through participation in, and support for, the Memorandum of Understanding on the Conservation of Migratory Sharks (Sharks MoU). In 2016, the scalloped hammerhead shark was included on the MOU Annex to facilitate cooperation and information sharing, supported by Australia. However, the tangible impact of the Shark MOU on the management or protection of scalloped hammerhead sharks in Australian waters is unclear.

There is no publicly available information on any review of the reservation decision or any set timelines in which a future review will occur.

- **EPBC Act, Conservation Dependent, 2018.** In 2018, scalloped hammerhead sharks were listed as Conservation Dependent on the threatened species list of the *EPBC Act*[8]. When assessed by the Threatened Species Scientific Committee (TSSC), the species was found to be eligible for the more protective Endangered listing. The decision to downgrade the listing to Conservation Dependent was based on undertakings from Queensland and the Northern Territory Governments to have a defined suite of management measures in place by the time the Minister listed the species. Progress against the required managed measures is reviewed in **Section 3.3.3.**

- **IUCN, Critically Endangered, 2019.** In December 2019, the IUCN global status of scalloped hammerhead was updated to Critically Endangered with the recommendation that all fishing for the species should cease[9].

3.2.2 Great Hammerhead Conservation Listings

At the time of the NDF finding in 2014, the great hammerhead shark was listed as globally Endangered on the IUCN Red List[10]. It also had an IUCN listing of 'data deficient' within Australian waters (Denham et al., 2007). Since that time, the listing status of great hammerhead sharks has changed significantly:

[6] However, not all nations are signatories to the CMS. Currently the total number of signatories is ~120, with some larger nations still not signed up (e.g. USA)

[7] Without the reservation, recreational fishers who accidentally caught any of these sharks, even when fishing in accordance with their state recreational fishing permits, could be fined up to $170,000 and face two years in jail. Entering the reservation allows the domestic management arrangements currently in place for these species to continue. This is a consequence of the construct of Australia's legislation, rather than a specific requirement of the CMS.

[8] https://environment.gov.au/marine/marine-species/sharks/hammerhead

[9] https://www.iucnredlist.org/species/39385/2918526

[10] https://www.iucnredlist.org/species/39385/10190088

- **Convention for Migratory Species, Appendix II, 2014.** In 2014, (following the NDF) great hammerhead sharks were listed on Appendix II of the CMS[11] [12]. As with scalloped hammerhead sharks, Australia submitted a reservation to the listing meaning that it did not take effect within Australian waters, and the species was not included on the migratory species list under the EPBC Act, on the basis of "unintended consequences". The Australian Government again referred to its *participation in, and support for, the Memorandum of Understanding on the Conservation of Migratory Sharks (Sharks MoU) including its support of great hammerhead sharks on the Sharks MoU annex*." Again, it is unclear how the Shark MOU has had a tangible impact on the management or protection of scalloped hammerhead sharks in Australian waters.

  There is no publicly available information on any review of the reservation decision or any set timelines in which a future review will occur.

- **IUCN, Critically Endangered, 2019.** In December 2019, the IUCN global status of great hammerhead sharks was updated to Critically Endangered with the recommendation that all retention and landings be prohibited at least as long as the global population remains in a Critically Endangered status[13].

3.2.3 Smooth Hammerhead Conservation Listings

At the time of the NDF finding in 2014, the global status of smooth hammerheads was listed as Vulnerable on the IUCN Redlist[14]. In 2020, its IUCN Red List status remains as Vulnerable and the following additional listing has been made:

- **Convention for Migratory Species, Appendix II, 2020.** In February 2020, smooth hammerhead sharks were listed on Appendix II of the CMS. As with the scalloped and great hammerheads, Australia submitted a reservation to this most recent listing meaning that it did not take effect within Australian waters, and the species was not included on the migratory species list under the EPBC Act. Reference was made that this was on the basis that Australia already has strong domestic measures in place for the species noting that it is listed on the CITES Appendix II and subject to the NDF that allows the export of 70,000 kg per year[15].

There is no publicly available information on any review of the reservation decision or any set timelines in which a future review will occur.

FINDINGS

3. The global conservation status of all three hammerhead species has declined since 2014. The need for additional international scale management of these migratory species has also been formally recognised.

4. In taking out a reservation to the Convention for Migratory Species (CMS) listing of the three hammerhead sharks, the Australian Government reported to be fulfilling its requirements under the CMS by participating in the Shark MOU. However, the tangible impact of the MOU on the management or protection of these species in Australia is not clear, and the process to review the CMS reservation decision over time is also not communicated.

[11] However, not all nations are signatories to the CMS. Currently the total number of signatories is ~120, with some larger nations still not signed up (e.g. USA)

[12] https://environment.gov.au/marine/marine-species/sharks/hammerhead

[13] https://www.iucnredlist.org/species/39386/2920499

[14] https://www.iucnredlist.org/species/39388/2921825

[15] https://www.southernseafoodproducerswa.org.au/post/smooth-hammerhead-shark-can-continue-to-be-caught-sold-and-exported-within-limits

3.3 REVIEW OF MANAGEMENT ARRANGEMENT

The positive NDF for the three hammerhead shark species were subject to Australian State and Commonwealth management agencies seeking to implement improved management arrangements to minimise the ongoing catch of these species (Department of the Environment Australia, 2014).

Specifically, a list of generic recommendations intended for Australian fisheries agencies to implement were listed in the NDF, which were:

- Landing of sharks with fins naturally attached
- Species level reporting in log books
- Discard reporting to species level and collection of data on health status
- Implement individual catch limits
- Implement max. size limits for retained sharks
- Further measures to reduce incidental capture and post release mortality as practically appropriate to specific fisheries and gear types
- An improved understanding and management focus on illegal, unreported and unregulated harvest (IUU)

In addition, the NDF provided an extensive list of fishery-specific recommendations relevant to each fishing jurisdiction, intended to improve management of relevant fisheries and provide further data necessary to enable a review of harvest limits.

This section reviews progress against the management recommendations made in the NDF as well as other signification management changes that have occurred since 2014.

3.3.1 2017 Review of NDF Management Recommendations

In 2017, the Department of the Environment and Energy published an *Analysis of Data on Hammerhead Abundance, Distribution and Harvest in Australian Fisheries Since Implementation of the 2014 Hammerhead Shark NDF* (2017 NDF Analysis) (Department of the Environment and Energy, 2017). As input to the analysis, fishing jurisdictions were asked for information on any new management practices put in place that would affect hammerhead shark stocks. These are outlined in the **Table 2** below.

The published analysis noted that some States and Territories had begun to reform management practices, but were yet to be formalised and implemented, and that these reforms were expected to improve certainty in reporting of catch and discards.

The review made a very clear statement and associated directive:

- Insufficient new data has been produced to have confidence in hammerhead shark population models or stock assessments
- To provide a greater level of certainty around harvest levels, jurisdictions should ensure hammerheads are reported at species level. This should be reflected in the conditions of relevant WTOs for fisheries approved under the EPBC Act.

Based on what is documented in the 2017 review report, the review only sought to consider information on any new management practices put in place relevant to hammerhead shark stocks. This review does not contain a review of progress specifically against suite of generic and fisheries-specific recommendations that were specifically established in relation to the 2014 NDF. This is despite the fact that the 2014 NDF itself particularly states that the positive NDF for the species *were subject to Australian State and Commonwealth management agencies seeking to implement improved management arrangements to minimise the ongoing catch of these species*.

Table 2: Summary of actions of jurisdictions on hammerhead shark management since the 2014 NDF came into effect (Department of the Environment and Energy, 2017)

	Northern Territory	Queensland	South Australia	Western Australia	Commonwealth
2014	Major review of management arrangements. - Development of management plan in consultation with industry - NESP Hammerhead stock structure project participation	QLD DAF commissioned assessment of shark stocks	No changes to management arrangements (The South Australian Research and Development Institute (SARDI) has not undertaken an assessment of the hammerhead shark population due to negligible catches).	Status of four indicator species given as adequate/sustainable (gummy and whisky sharks) and recovering (sandbar and dusky sharks). Draft harvest strategy produced as part of the Marine Stewardship Council (MSC) (Formalising the harvest strategy is being considered). A constant catch harvest strategy has been developed to avoid recruitment overfishing.	No information on changed management arrangements provided. Take has reduced further since NSW ban on the sale of hammerhead shark (approx. 5 t per year).
2015		Stock assessment of whaler and hammerhead sharks in Queensland published (Agri-science Queensland – QLD DAF) QLD DAF commissions independent review of stock assessment report		McAuley et al 2015 states that the four indicator species above may be used as an indicator of hammerhead stocks.	
2016		Desk review of Queensland shark stock assessment for fisheries Queensland. QLD Government releases green paper on fisheries management reform. ECIFFF WTO approved by DoEE.			

3.3.2 2020 Review of NDF Management Recommendations

For the current review, determining the progress against the 2014 NDF recommendations was progressed through two means:

- *Direct request from regulatory authorities* – Each regulatory authority was sent the generic and jurisdictional specific recommendations from the NDF and requested to report on progress.
- *Australian CITES Management Authority* – Given the Australian CITES Management Authority's responsibility for monitoring the implementation of the NDF including management arrangements, a request was made to the Authority for a report against the recommendations.

Some jurisdictions chose to only report through the Australian CITES Management Authority, while others provided reports directly to the author also. Where information was received from both sources, the information received was comparable.

Table 3 below displays progress by each of the fishing jurisdictions against the generic recommendations. **Appendix 1** provides more detailed responses from the jurisdictions related to the generic recommendations, where provided.

Table 4 below displays progress by each of the fishing jurisdictions against the fishery-specific recommendations contained in the 2014 NDF. Specifically, **Table 4** provides a summary of number of recommendations at the various stages of implementation. **Appendix 2** provides information of progress against each fishery specific recommendation.

The coloured categories of progress have been assigned by the author, based on the information provided, according to the following categories:

- **Green Block** or **"Implemented"** – the recommendation has been implemented
- **Red Block** – the recommendation is either:
  - **"Not implemented"** – the recommendation has not been implemented
  - **"Presumed not implemented"** – the management authority has not specifically advised of any activity against the recommendation; presumption is that no action has occurred.
- **Orange Block** – the recommendation is either:
  - **"Partially implemented"** – some progress has been made, but the recommendation is not fully implemented, with no indication of plans to fully implement
  - **"In progress"** – the recommendation is being implemented and there is a stated intention and/or plan to complete its implementation
- **"Not applicable"** – the fishery has been closed since the 2014 NDF, or the management action is not possible due to the species' being no take, hence the recommendation is not currently applicable

This review of implementation is based purely on the basis of whether or not a recommendation was implemented. It is noteworthy that many jurisdictions reported "not applicable" or similar for a number of recommendations that were applied at a jurisdictional and/or fishery level. On review on the recommendations, it does appear that a technical review of the specific relevance of each recommendation to the jurisdictions and fisheries may lead to a honed and more prioritised list of recommendations.

For the purposes of this review however, the implementation of the recommendation as articulated in the NDF is reviewed. An analysis at this level reveals that 6 years on, significant progress is still required in order to the make the improvements defined. A summary of the current state of progress is provided below.

Table 3: Implementation progress for generic NDF recommendations

Recommendation	Fishing Jurisdiction							
	C'LTH	WA	NT	QLD	NSW	VIC	SA	TAS
Require fins naturally attached								
Require some level of species-specific reporting								
Require recording of bycatch, discards & health status								
Implement individual catch limits								
Implement max. size limits for retained sharks								
Implement measures to protect sharks [16]								
Determine the extent IUU catch								
Proportion of recommendations fully implemented	29%	0%	57%	43%	43%	43%	57%	57%
Portion of recommendations in progress, partially and fully implemented	43%	29%	86%	86%	71%	43%	57%	57%

Table 4. Summary of implementation of the 2014 NDF recommendations assigned to jurisdictions

Recommendation	Fishing Jurisdiction							
	C'LTH	WA	NT	QLD	NSW	VIC	SA	TAS
Implemented	2	2	10	**9**	2	1	1	1
Partially implemented	1	1	0	0	5	0	0	0
In progress	0	2	0	1	0	0	0	0
Presumed not implemented	3	0	2	**0**	0	1	0	1
Not implemented	18	7	1	13	4	2	3	1
Not applicable	0	4	0	3	0	0	0	0
TOTAL number of recommendations	24	17	13	26	11	4	4	3
Proportion of recommendations fully implemented	8 %	12%	77%	35%	18%	25%	25%	33%
Portion of recommendations in progress, partially and fully implemented	13%	29%	77%	38%	64%	25%	25%	33%

[16] e.g. banning of wire traces & safe handling practices

For the generic recommendations (**Table 3**):

- Good progress has been made with regards to the requirement for fins to remain naturally attached to landed sharks and the requirement to report hammerhead sharks at a species-specific level. Western Australia is the notable exception, having not implemented a fins-naturally-attached policy and not requiring species specific reporting. Queensland has recently implemented a fins naturally attached policy for the east coast but processing of fins and flesh into separate components at sea remains legal in the Gulf of Carpentaria.
- Progress on reporting discards, including health status has been more limited. Queensland has made significant progress with the requirement to record discards, to species level, including health status. The Commonwealth, Northern Territory and New South Wales require bycatch to be recorded but not the health status. Other jurisdictions do not require bycatch to be recorded.
- Catch limits have been introduced in Victoria, South Australia, Tasmania and the Northern Territory. Other States have not, or only partially introduced catch limits.
- Maximum size limits have only been introduced in Queensland.
- With regards to the implementation of further measures to protect sharks once bycatch exceeds trip limits, New South Wales, Tasmania and South Australia have implemented some measures consistent with this, with Western Australia, Northern Territory and Queensland partially implementing this recommendation.
- Progress with respect to better determining IUU catch, recording of discards, taking records of length and sex, implementing maximum size limits and introducing other measures to protect sharks has been extremely limited.

In terms of proportional progress of recommendations:

- Overall, when considered the requirement for the seven defined recommendations to be applied across each of the eight jurisdictions: 41% of recommendations have been fully implemented. Partially implemented or recommendations "in progress" of implementation represent a further 18%, and 41% of recommendations have not been implemented/presumed not implemented in any form.
- At the individual jurisdiction level, when fully implemented, partially implemented and "in progress" recommendations are combined, NT, QLD and NSW report the highest levels of progress at 71-86%. South Australia and Tasmania reported 57%. All others reported 43% or below.

With regards to implementation of fishery-specific recommendations (**Table 4**):

- The highest performance in term of full implementation has been in the Northern Territory, where 77% of its recommendation have been implemented.
- All other jurisdictions have fully implemented no more than 35% of the recommendations.
- When partial implementation and implementation which is "in progress" is included, Northern Territory remains at 77%, NSW performs better at 64%; however, all other jurisdictions remain at below 38% of recommendations implemented in any form.
- Across all jurisdiction, 102 recommendations were assigned in total and of those 27% have been fully implemented. Partially implemented or recommendations "in progress" of implementation represent a further 10%, and 55% of recommendations have not been implemented/presumed not implemented in any form.

While these recommendations were applied to support the continued export of the hammerhead shark species, there is no direct link between the implementation of these recommendations and export permits. Hence, there is no incentive for exporters to encourage their respective fishing authorities to implement the recommendations, as exporters have been able to export nonetheless. Of course, if the WTO is revoked, this would prevent exports, however to date this

has very rarely occurred despite numerous fisheries not meeting WTO conditions in the timeframes set. The more direct approach of embedding activities required to meet NDF recommendations in export permits would prevent exports unless appropriate implementation actions were progressed.

3.3.3 TSSC Management Recommendations for Scalloped Hammerhead Sharks

As noted above in **Section 3.2.1**, the TSSC's determination to recommend the downgraded category of Conservation Dependent (from Endangered) of scalloped hammerheads was based on the understanding that a defined list of measures would be implemented, without alteration, and in force under law, *prior to the Minister for the Environment and Energy's listing decision under the EPBC Act being made*. The Minister accepted the advice of the TSSC and listed the species in the Conservation Dependent category effective from 15 March 2018.

In 2019, Rayns reviewed progress against the recommendations (Rayns, 2019) and in February 2020, Welsh provided an update on progress (Welsh, 2020). **Table 5** and **6** are taken from Rayns (2019) and Welsh (2020) and have been updated to reflect more recent progress.

Table 5. Queensland progress against TSSC recommendation

TSSC Recommendation	Status
An annual TACC (with regional sub-limits)	**Implemented**
When 75% of the TACC is reached then trip limits (10 net & 4 line) are introduced	**Implemented**
All hammerheads landed whole (head & fins attached)	**Partially implemented** (on east coast only; no independent validation)
Data validation (through prior reporting & at unloading)	**Implemented**
Inspections at sea and in port	**Partially implemented**
Reporting catch by phone to enable real-time catch monitoring	**Implemented**
Cross validation of data (fisher logbooks, VMS data & buyer sourcing)	**Partially implemented**
N4 sector to have VMS	**Implemented**
Species specific catch and discard information in logbooks	**Implemented**
Maintain measures	**Partially implemented**

Table 6. Northern Territory progress against TSSC recommendation

TSSC Recommendation	Status
Annual TACC of 50t for scalloped Hammerhead	**Implemented**
Once catch reaches 37.5t then harvest control rules implemented	**Implemented**
HCRs could include increased observer coverage, area closures, fishery closure, trip limits, gear restrictions and temporal closures	**Implemented**
Data validation techniques including:	
▪ VMS on all vessels	**Implemented**
▪ Electronic logbooks	**Partially implemented**
Product unloaded in Darwin & Gove only	**Partially implemented**
Sharks landed with fins naturally attached (with exemptions)	**Implemented**
Heads remain attached to body unless E-M operational	**Partially implemented**
Species specific recording in CDRs	**Implemented**
Random port inspections Increased monitoring to at least 20% where high risk of interactions exist	**Implemented**

Annual TACC of 50t for scalloped Hammerhead under the NTONLF management plan	**Implemented**
When 40t is reached then control rules are triggered including increased observer coverage	**Implemented**
Implementing data validation techniques under the MP	**Partially implemented**
Maintain all of the above measures	**Partially implemented**

In Queensland, 60% of the recommendations have been implemented, with the remaining recommendations have been partially implemented. In Northern Territory, 64% of the recommendations have been implemented, and the remaining recommendations have been partially implemented. Note that all these recommendations were required to be implemented, without alteration, prior to the listing of scalloped hammerheads as Conservation Dependent.

It is also noteworthy that the TSSC stated in its 2018 recommendations that: "The Committee recommends that 2014 Non-Detriment Finding be fully reviewed and updated in 2019, taking into consideration all relevant available data, including that collected between September 2014 and June 2019."

3.3.4 Amending the Great Barrier Reef Marine Park Act 1975

Species listed as a threatened under the EPBC Act, including those in the Conservation Dependent category, are protected under the *Great Barrier Reef Marine Park Act 1975* by virtue of such listed species being no-take species in the marine park. However, upon the Conservation Dependent listing of scalloped hammerhead in 2018, the Act was amended to allow catch and retention continue in the world heritage-listed area.

3.3.5 Queensland Shark Control Program Reform

In 2017, the Humane Society International (Australia) Inc. appealed the issuing of permits by the Great Barrier Reef Marine Park Authority (GBRMPA) to the Queensland Government to conduct a Shark Control Program and related research program.

In April 2019, the Administrative Appeals Tribunal handed down its determination which varied some of the permit conditions, including the non-lethal take of sharks, frequency of drum line attendance and tagging and relocation of sharks. The State of Queensland appealed the Tribunal decision but was dismissed by the Federal Court in September 2019 at which time the varied conditions of the Marine Park permit came into immediate effect.

Following this, the Queensland Government removed all shark control equipment from the Great Barrier Reef Marine Park area on the basis that it was deemed not possible to comply with tag and release requirements set by the Tribunal. Subsequently, QDAF re-installed the shark drumlines in parallel with the introduction of measures to meet the conditions set down by the Tribunal e.g. increasing surveillance and exploring modern 'complementary' technologies such as drones, barriers, SMART drumlines and tags.

In December 2019, the Great Barrier Reef Marine Park Authority granted a further variation to the permit which confirms that workplace health and safety obligations under the laws of Queensland are not negated by the permit conditions imposed by the Tribunal.

3.3.6 Revocation of the Wildlife Trade Operation for East Coast Inshore Finfish Fishery

On the 8th September 2020, the Federal Minister for Environment, announced the decision to revoke the WTO for the Queensland-managed East Coast Inshore Finfish Fishery (ECIFFF), effectively banning the export of shark, shark fin and all other seafood products from this fishery

from 30 September 2020[17]. The revocation was due to the fishery's inability to meet required sustainability conditions. This follows an extended period of the WTO conditions for this fishery, which were designed to manage the risk to marine species including the protected hammerhead sharks, not being met.

Amongst the unmet conditions were the requirements for an independent data collection and validation program, rules to better monitor shark catch, a plan to prevent ecological impacts, and harvest strategies that also included impacts on protected species.

The Queensland Fisheries Reform program contained plans to address some of these requirements, including a requirement to land sharks whole, however the regulation amendments intended to address these gaps stalled at the end of 2019 with little progress throughout 2020 (see **Section 3.3.7** on recent progress).

The decision to revoke the WTO represents a recognition by the Federal Minister for the Environment that Queensland was not adhering to sustainable management of the ECIFFF, one of the most significant Australian fisheries to impact on CITES, CMS, IUCN and EPBC Act listed hammerhead sharks.

3.3.7 Queensland Fisheries Regulation Amendments

Shortly after the September 2020 WTO revocation, Queensland passed a set of Regulation amendments which, among other things, introduced the requirement to land shark whole on the East coast. This is a welcome improvement, which comes 6 years following the NDF recommendation and 2 years after the TSSC recommended this occur. While the regulation now makes the removal of the head and fins illegal on the east coast, there remains no independent validation that this activity is not occurring, and shark processing at sea remains legal in the Gulf of Carpentaria.

FINDINGS

5. There has been no comprehensive review of the progress against the suite of recommendations included in the 2014 NDF, despite implementation of these being a condition of the positive NDF

6. Australia has not yet implemented specific management measures included in the NDF and made by the TSSC in relation to scalloped hammerhead sharks.

3.4 REVIEW OF FISHING RELATED MORTALITY LEVELS

In relation to fishing mortality, the positive NDF findings for the three hammerhead shark species were subject to[18]:

- no further increases in the average annual catch of the species
- no carryover of catch levels from year to year

This section reviews the annual catches of these species and any carryover of catch levels from year to year, compared to the harvest limits for each species (below), which were based on lower level of "normal take":

- Scalloped hammerheads – 200,000 kg
- Great hammerhead – 10,000 kg
- Smooth hammerhead – 70,000 kg

[17] https://www.legislation.gov.au/Details/F2020N00111

[18] https://www.environment.gov.au/system/files/resources/39c06695-8436-49c2-b24f-c647b4672ca2/files/cites-appendix-ii-shark-listing-ndf_1.pdf (page 48)

3.4.1 2017 Review of Catch Levels

As part of the 2017 NDF Analysis, jurisdictions provided updated catch figures for hammerheads sharks. The review reported that:

- Take of great and scalloped hammerheads substantially decreased over time since 2012 in the Northern Territory.
- Take of scalloped and unspecified hammerhead species in Queensland decreased from 2006/07 to 2010 and has remained at this level to date.
- Smooth hammerhead take in South Australia has remained at a very low level and had not changed significantly over time.
- The take of smooth hammerhead in WA has remained relatively stable from 2004/05 to 2014/15 avenging at 61, 500 kg per year.
- The national annual catch total of each species falls below the relevant limit set in the NDF.

In terms of performance against the NDF set harvest limits, the report noted that:

- National catch figures could not be completely attributed to the species level with an acceptable level of certainty as the data supplied by Queensland, Western Australia and Commonwealth managed fisheries included the category 'unspecified hammerhead species'[19]. The Northern Territory reported aggregate figures for great and smooth hammerhead sharks with a statement that the two species are estimated to be caught in equal abundance. South Australia reported all catch to species level (as only smooth hammerheads are known to occur in this jurisdiction).
- Catch figures are not directly comparable across jurisdictions as the Australian Fisheries Management Authority (AFMA) (Commonwealth fisheries) and Western Australia have reported by financial year while all other jurisdictions have reported by calendar year.

The review concluded that if the national unspecified hammerhead take is completely attributed to either scalloped or great hammerheads the take is still below the harvest limit set by the NDF for both species.

3.4.2 2020 Review of Mortality Level Data Sources

For this study, catch and other mortality data was gathered from the Australian CITES Scientific Authority, noting that harvest levels are required to be monitored **annually** by the Authority, as committed to in the NDF. The data provided included:

- Commercial retained, from all jurisdictions (QLD: weight and no.; Commonwealth: no. only; others: weight[20])
- Commercial discards, from QLD and Commonwealth (no. discarded)
- Beach protection device interactions, from NSW and QLD (no. caught, dead/alive)
- Charter boat retained catches, from NSW (no. caught) and QLD (weight, no. retained)
- Charter boat discarded catches, from QLD only (no. discarded)
- Threatened endangered species report, from NSW (no. caught)

Not included in the data provided, and explored in more depth **Section 3.4.3** were:

- Commercial fishing discard data, from WA
- Estimated illegal, unregulated or unreported (IUU) take

[19] Queensland, Western Australia and Commonwealth Fisheries reported to species level where possible with the rest of their catch data attributed to hammerheads as a group (unspecified hammerhead species).

[20] Tasmania and Victoria not included as Victoria reported only 10kg from 2014-2020 and Tasmania no reports

- Recreational fishing data, other than for the NSW and QLD charter sectors
- Indigenous harvest

3.4.3 Data Integrity

In considering the harvest data reported, there are a range of important factors that influence data integrity which need to be taken into account:

Lack of species-specific reporting. The need for species specific reporting was well recognised in the 2014 NDF owing to Simpfendorfer (2014) and Koopman and Knuckey (2014) highlighting that most reporting across fishing sectors, observers and shark control program was at the level of "hammerhead" thus making it difficult to determine mortalities and draw other conclusions at the level of the individual species. It is a welcomed notation that many of the jurisdictions have made progress on this requirement, with Western Australia yet to implement this requirement. However, given that many have not implemented this until recently, robust data over a significant enough timeframe does not yet exist to confidently draw conclusions.

Lack of reliable data on commercial discards. Most jurisdictions have not implemented the requirement to record discards, including to species level and record estimated weights and health condition, despite the recommendations of the NDF. Queensland is a notable exception and should be applauded for this recent progress. Without discard data from all fishing jurisdictions, there remains a significant degree of uncertainty regarding the total mortalities.

The Queensland data provides good insight into the variability of discards. The logbook data reports 21% discards in 2019 and 44% discards in 2018, double the amount between years. This illustrates how critical it is to record discards and how inaccurate presumption of mortality are if they don't take account bycatch and discarding.

It is equally important to understand the proportion of those that are dead vs alive, and also the sub-lethal affects that may occur to surviving specimens (i.e. reduced reproduction, reduced feeding capability, increased vulnerability to predation etc).

Dapp et al (2015) predicted the following mean total discard mortality (combined immediate and post-release mortality) percentages of obligate ram-ventilating elasmobranchs like hammerhead sharks by gear type: longline, 49.8%; gillnet and 79.0% and trawl gear 84.2%.

These results are consistent with the post capture mortality estimates by NT Fisheries (personal communication, July 2020) for hammerheads in Australian longline fisheries of 50% (with a 2 hr soak time). And somewhat lower than the NT Fisheries estimate for trawl fisheries of 100% discard mortality.

The results are not as high as the numbers reported by Morgan and Burgess (2007), which found for scalloped hammerhead a total at-vessel mortality of 91.4% (broken down into 70% for young, 95.2% for juveniles and 90.9% for adult). It found for great hammerhead at total at-vessel mortality of 93.8%, (broken down into 86.4% for young, 90.5% for juvenile and 87.3% for adults. By contrast McLoughlin and Eliason (2008), suggested reasonably high survival rates for sharks released following recreational catch.

Need for independent data validation. Almost all the data available is fishery-dependent data (i.e. collected and submitted by the fishers) with very little independent validation (i.e. data collected by human or electronic form which confirms the fisher reported data). Such a high level of reliance on unvalidated data is known to impact the quality of data, and specifically results in underestimates. Until a higher level of validation is introduced, all interaction, retention and discard data should conservatively be regarded as underestimates.

Lack of data for all harvest sectors. In order to undertake biological assessments of the impact of fishing on a species, mortality from harvest sector must be known or reliably estimated. However, currently there are significant absences in harvest information for the hammerhead species from non-commercial sectors. In particular, there is a limited understanding of mortality due retained and discarded recreational catch (other than some charter sector information) and indigenous harvest.

Lack of understanding of IUU extent. The requirement to investigate levels of IUU was strongly recommended in the 2014 NDF as a national level requirement, as well as directed to specific fisheries. Almost all jurisdictions reported that further investigations to determine the level of IUU in fisheries has not occurred.

Shark mortality due to beach protection. Queensland and New South Wales have significant beach protection programs involving captures of a large number of sharks. More recently (post 2014) the portion of sharks identified to species level has increased considerably which is good progress. Western Australia recorded no mortalities of any of the five species have been recorded in the drumline programs. NSW reports it shark protection program data (Dalton and Peddemors, 2019) and Queensland data is available online (https://qfish.fisheries.qld.gov.au/)

3.4.4 Assumptions to estimate harvest

In order to determine the total mortality attributed to the sources that were provided, the following assumption and analysis were performed:

- Average retained scalloped hammerhead weight was assumed to be 2.3 kg (Harry et al, 2011)
- Average discarded scalloped hammerhead weight was assumed to be 11 kg (based on Leigh, 2016 estimate of average weight of encountered scalloped hammerheads is 11kg)
- Average retained great hammerhead weight was assumed to be 15.7kg (based on Harry et al, 2011). Catch data provided from fishing jurisdictions for this report was also examined for additional insights on individual weight. There were only two data points, both from Queensland (2018, 2019) where the total weight and number of great hammerheads were reported. The average individual weight based on those data were 3.2kg in 2018 and 6.0kg in 2019. Given these weights were vastly different to those in the more comprehensive study by Harry et al (2011), latter estimate was the preferred to adopt here.
- Average discarded great hammerhead weight was assumed to be 15.7kg (based on Harry et al, 2011). Considerable uncertainty around this average weight is acknowledged. In particular, Leigh (2016) estimate of average weight of encountered great hammerheads of 84kg. The Harry *et al* estimate was favoured as 84kg seemed likely an overestimate and it would seem unusual that fishers would discard larger sharks. More reliable data collection and/or examination is required to enable better estimates.
- Smooth hammerhead caught in Commonwealth fisheries was reported as number retained only (with no estimated weight). Weight was assumed to be 8.3kg based on McAuley & Simpfendorfer (2003) data of mean annual catch from 1994/95 to 1998/99 of 5,593kg and mean number of individuals of 672 over the same period.
- Where there is no notation of fate or gear type, all individuals caught are assumed to be dead
- Where gear type was known, discard mortality (combined immediate and post-release mortality) percentages were assigned as per Dapp et al (2015) i.e. 70% for gillnets, 50% for line caught hammerhead sharks (see **Section 4.6.1**)
- All South Australian data was reported as "hammerhead"; however due to known species distributions, all were assigned to smooth hammerhead shark.
- Data was provided for "hammerhead" in the form of Sphyrnidae and *Sphyrna* sp. As all data listed as such was from WA, NSW and QLD, these were combined together for analysis.

- For non-specified hammerhead discards, 11kg individual weight was adopted. This was based on the knowledge that they are most unlikely to not be smooth hammerheads (given the jurisdictions reporting in this way) and given the uncertainty around great hammerhead individual specimen discard weights. It is acknowledged that there is a large degree of uncertainty around this, particularly due to the inherent issue that the specific species is unknown.

  A significant portion of catch from Queensland (from the period prior to mandatory species-specific reporting) and all of Western Australia's catch data, was reported as either Sphyrnidae or *Sphyrna* spp, i.e. unspecified hammerhead species. When Koopman & Knuckey encountered this issue in 2014, the "Hammerheads" data was able to be disaggregated into component species based on available observer data. This was done for each fishery separately and nearly 99% of "Hammerhead" catch from 2001–2012 was disaggregated in this way. Catches of "Hammerheads" from South Australia, Victoria and Tasmania were assumed to be 100% Smooth Hammerhead based on the geographical distribution of each species.

  Fishery specific and observer data was not examined as part of this review; hence it was not possible to perform a disaggregation of the unspecified hammerhead data. In lieu of this approach, 2 scenarios were modelled:

  a. Scenario 1, apportioned disaggregation. The average proportion of each species in the disaggregated catch for the period 2008-2012 was established using Table 5 in Koopman and Knuckey (2014) and these average proportions were applied to the 2014-2020 unspecific hammerhead reported catch (excluding the SA data which was apportioned 100% to smooth hammerhead sharks) – referred to hereafter as the "apportioned disaggregation scenario"

  b. Scenario 2, 100% allocation. All aggregated data (excluding the SA data) was assumed to be either all scalloped, all great or all smooth hammerhead shark – referred to hereafter as the "100% disaggregation scenario"

  In addition to the complexity around unspecified hammerhead reports, all Western Australian data was recorded against financial years, compared to all other State and Commonwealth data which was reported in calendar years. Therefore, Western Australia's catch data for each financial year was attributed equally across the two relevant calendar years. For example, catch assigned to 2016 included half of the reported catch from 2015/16 and half of the reported catch in 2017/17.

3.4.5 Annual harvest estimates

The **Figures 1** to **6** below show a summary of the retained and discarded data for each species, based on Scenario 1 and 2 above.

The review of these figures reveals:

- In Scenario 1, "apportioned disaggregation", none of the species harvest level exceeded the harvest limits set in the 2014 NDF.
- In Scenario 2, "100% allocation", scalloped hammerhead harvest remained below the harvest limit, however both great and smooth hammerheads exceeded the harvest limits of 100,000kg and 70,000kg respectively. For great hammerheads, the harvest limit was predicted to have been exceeded in 2014, 2015 and 2016. For smooth hammerheads, the harvest limit was estimated to have been exceeded in from 2014 to 2017. Again, it is acknowledged that this is the most extreme worst-case scenario and very unlikely to reflect reality.

Figure 1. Scalloped hammerhead sharks retained & discarded catch 2014-mid 2020, Scenario 1, apportioned disaggregation. Note: Scalloped hammerhead harvest limit = 200,000 kg

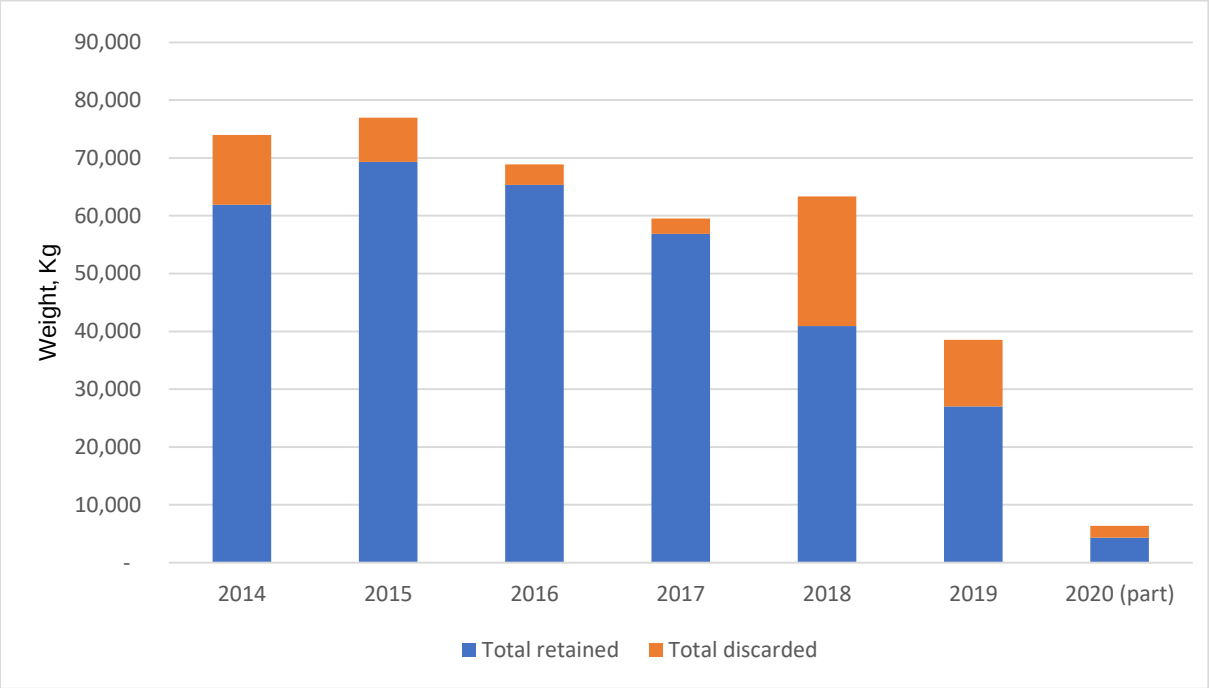


Figure 2. Scalloped hammerhead sharks retained & discarded catch 2014-mid 2020, Scenario 2, 100% allocation. Note: Scalloped hammerhead harvest limit = 200, 000 kg

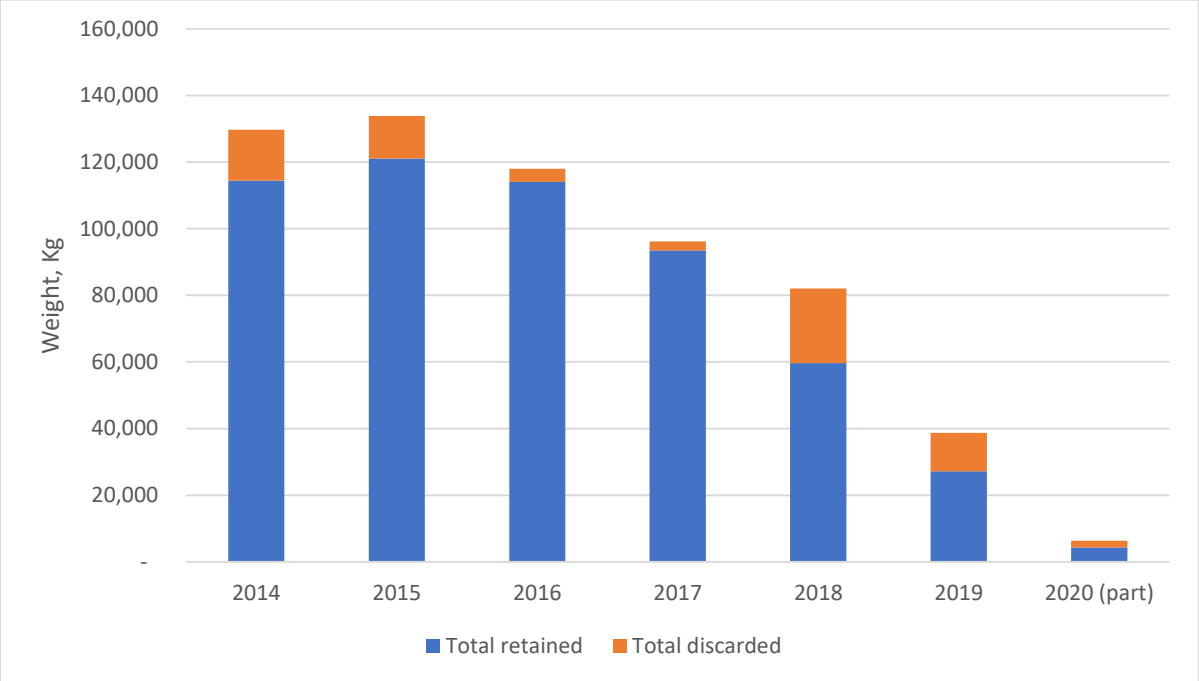


Figure 3. Great hammerhead sharks retained & discarded catch 2014-mid 2020, Scenario 1, apportioned disaggregation. Note: Great hammerhead harvest limit = 100, 000 kg

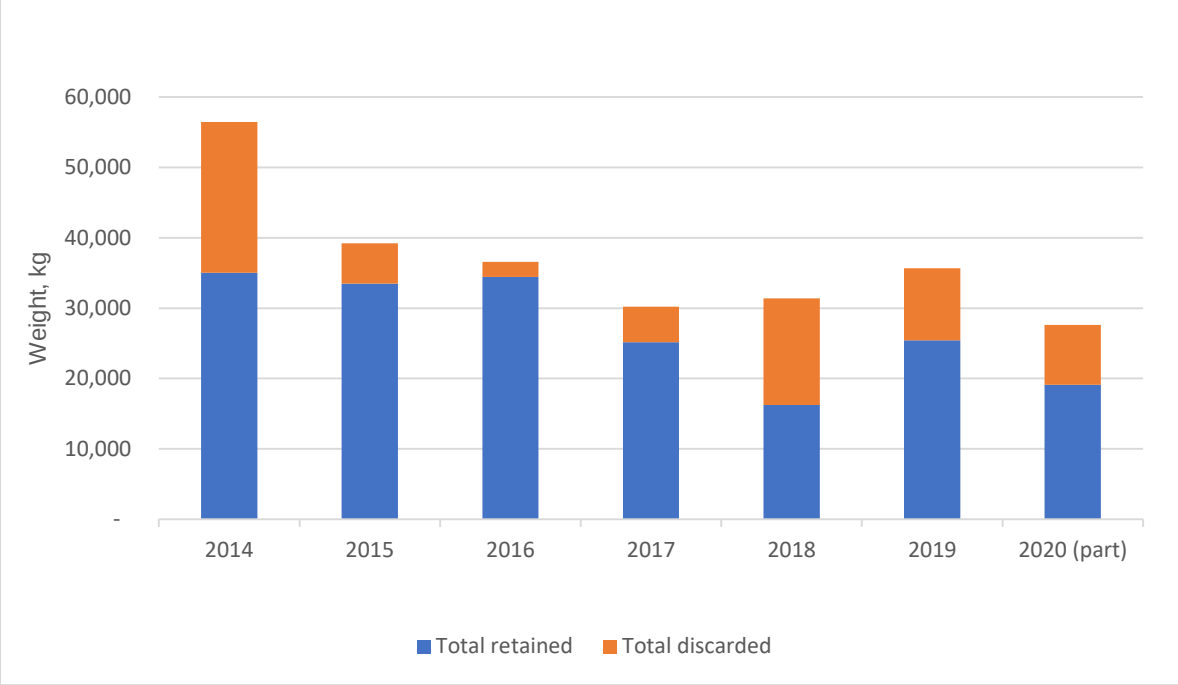


Figure 4. Great hammerhead sharks retained & discarded catch 2014-mid 2020, Scenario 2, 100% allocation. Note: Scalloped hammerhead harvest limit = 100, 000 kg

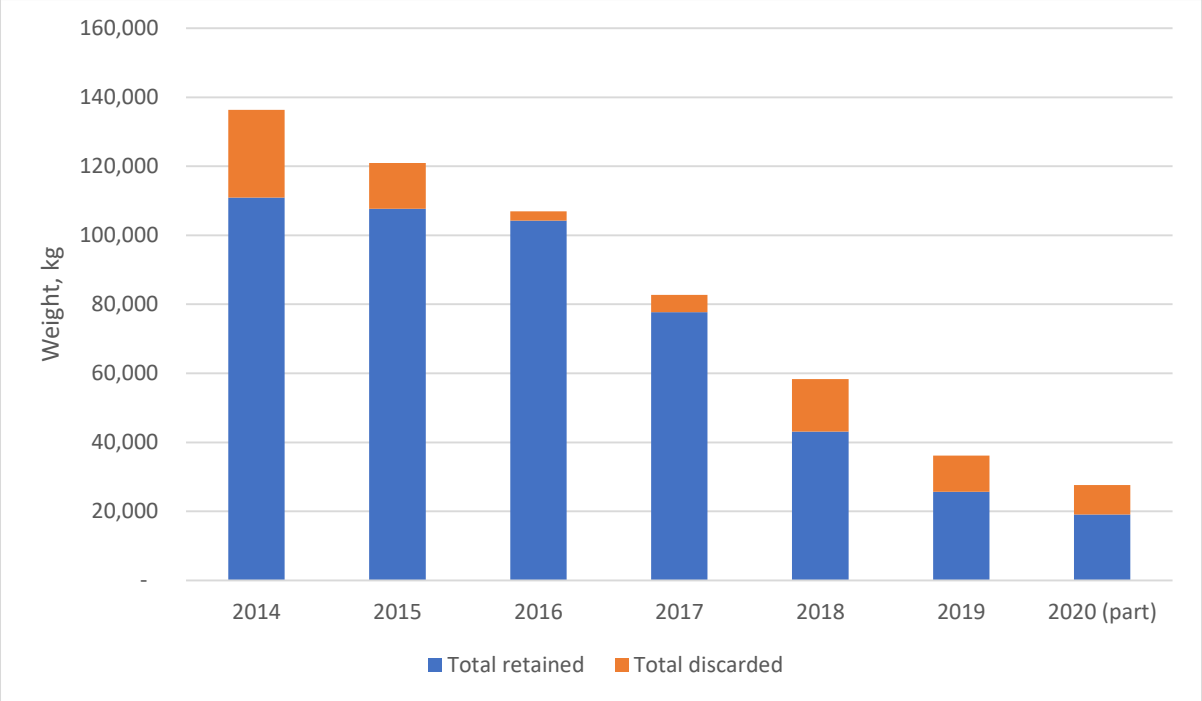


Figure 5. Smooth hammerhead sharks retained & discarded catch 2014-mid 2020, Scenario 1, apportioned disaggregation. Note: Scalloped hammerhead harvest limit = 70, 000 kg

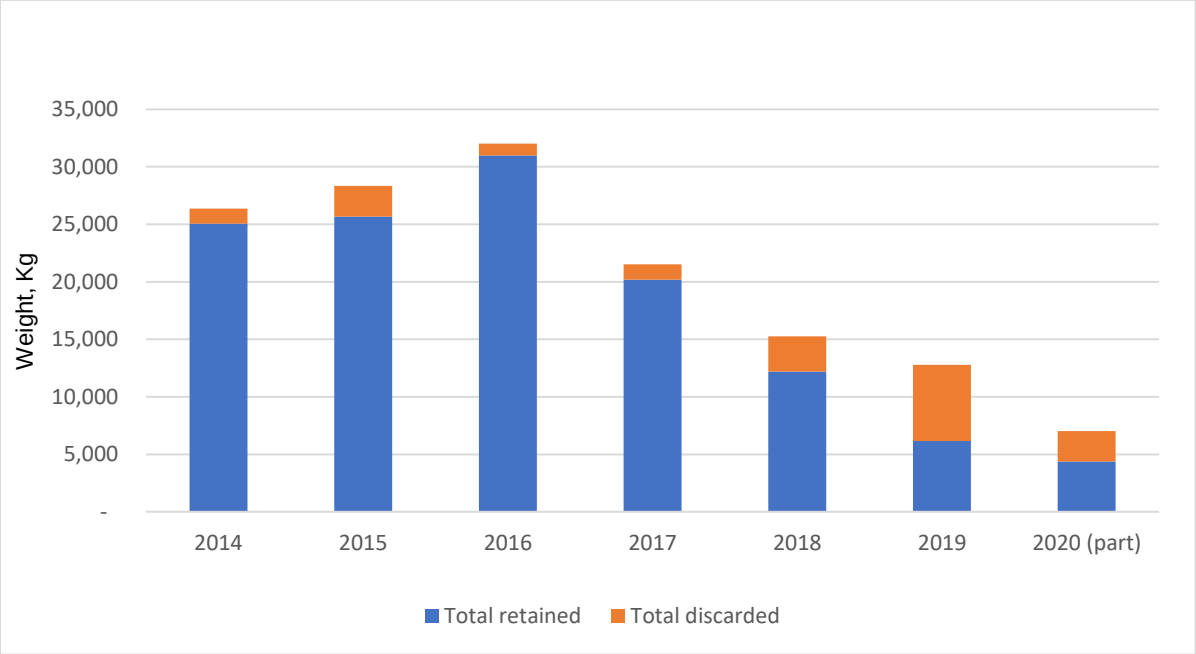
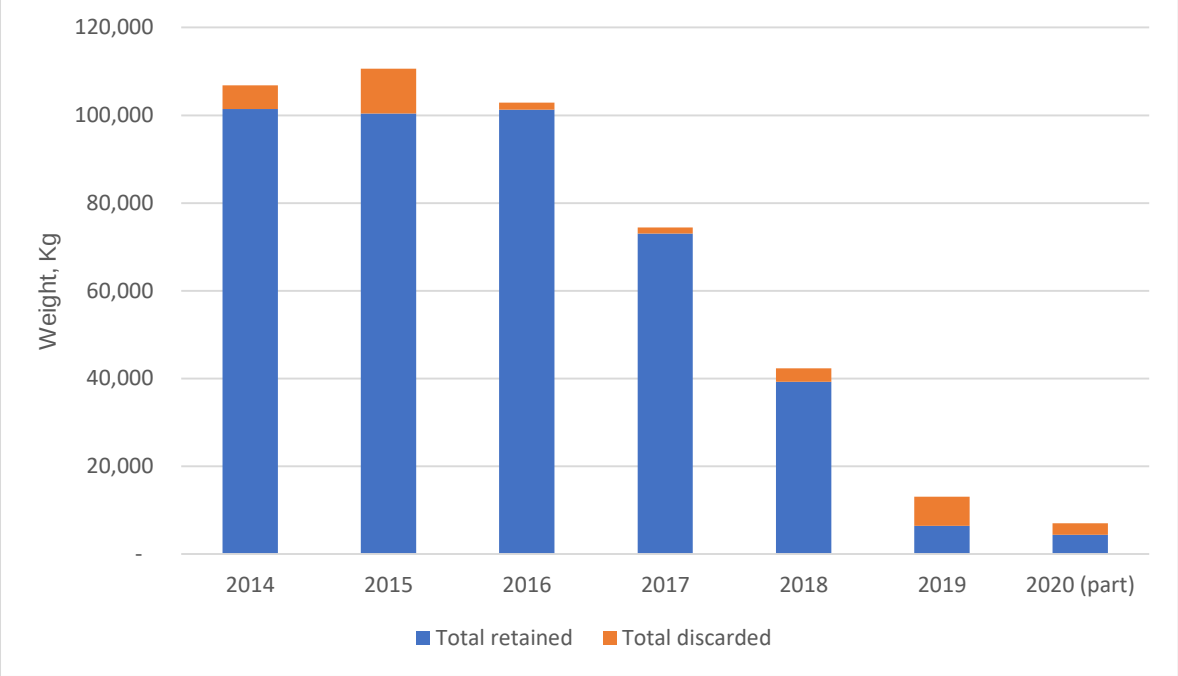


Figure 6. Smooth hammerhead sharks retained & discarded catch 2014-mid 2020, Scenario 2, 100% allocation. Note: Scalloped hammerhead harvest limit = 70, 000 kg



- The discarded proportion of each species is highly variable and also a significant amount in some years, across all species. It is noted that these numbers will be a significant underestimate given that discards from the commercial sector is currently only reported by Queensland and the Commonwealth.
- In addition to the uncertainty around discards, there are a range of other factors which influence the integrity of the data which are examined above in **4.4.3 Data Integrity**.

3.4.6 CITES requirement to annually monitor data

The 2014 NDF states that harvest levels will be monitored **annually** by the CITES Scientific Authority of Australia (Department of the Environment Australia, 2014). However, when a request for data on harvest levels was made in September 2020 (as input to this report), it appears that the Authority needed to collect the series of data from the jurisdictions. This raises concerns about the implementation of the annual monitoring requirement.

If annual monitoring were occurring, the Australian CITES Scientific Authority should have already reviewed, analysed and drawn conclusions in relation to data from 2014 through the 2019. There might be some delay in relation to 2019 data given the lag in data reporting in fisheries systems. However, by September the following year, it would be reasonable to expect that data for the prior year for these species would have been reviewed (in addition to all previous years) given the listed status of these species.

A published review of the NDF occurred in 2017 which included a review of mortality data and management arrangements. However, it is unclear what other monitoring and review has occurred since that time.

Section 3.3.1. of this report also notes that the 2017 review of management arrangements did not specifically review and draw conclusions about the specific comprehensive management recommendations set out in the 2014 NDF.

FINDINGS

7. There is insufficient data to determine harvest levels with sufficient certainty

3.5 REVIEW OF CITES TRADE DATA

CITES permits are required under the EPBC Act to internationally export or import any part or derivative (e.g. fillets, fins) of the three listed hammerhead shark species. In order for an exporter to be issued a permit they must provide evidence that the specimen(s) to be exported were sourced from a fishery which has been assessed as an approved WTO under the EPBC Act. Data on exports and imports are collected by CITES and published on its CITES trade database[21].

The CITES data makes it possible to cross reference trade and catch data to identify potential issues regarding accuracy of reporting.

3.5.1 2017 Review of CITES Trade Data

The 2017 NDF Analysis considered Australian export permit data for the three hammerhead species from September 2014 (the date of listing) to March 2017.

Exported product was reported to be almost entirely made up of fins of scalloped, great and smooth hammerhead shark. A small number (12 specimens) of live scalloped hammerhead shark

[21] https://trade.cites.org/

were exported from Australia to the United Arab Emirates during this period.

With the exception of the live export to the United Arab Emirates, trade data showed that all other hammerhead exports are fins shipped to Hong Kong. Total export of great hammerhead fin from 2014/15 to 2016/17 was reported as 1400kg. The exports of great hammerheads showed an increasing trend: 140kg in 2014/15, to 550 kg in 2015/16 and then 720kg in 2016/17. Total export of smooth hammerhead was around 70kg: 65kg exported in 2015/16 and only five kg exported in 2016/17. Scalloped hammerhead fins were only reported as exported in 2016/17; a total of 140 kg.

Interestingly, this summary does not align with the CITES data for the same time period, which was extracted during September/October 2020 for the purposes of this report.

3.5.2 2020 Review of CITES Trade Data

In November 2020, CITES trade data for the listed hammerhead shark species was gathered from the CITES portal https://trade.cites.org. and reviewed in order to:

- Identify trends revealed by the export data
- Identify any anomalies which would contribute to an understanding of the robustness of the data
- Compare catch data with trade data

The search parameters inputted into the CITES database were:

- Species: scalloped hammerhead, smooth hammerhead, great hammerhead sharks
- Time period: 2014 – 2020 (i.e. as far as data is available)
- Term (product type): all product types (i.e. fins, specimens, bone etc)
- Exporting country: all hammerhead products exported from Australia
- Importing country: all hammerhead products recorded as imported from Australia

The following export transactions were removed:

- Exports of products noted as "pre-convention" as by definition these are derived from sharks caught prior to listing
- Exports of products that had an origin other than Australia
- Products of source "X" taken from waters not under the jurisdiction of any state, as by that definition, these products have not been caught in Australian waters

The online CITES trade database did not provide data past 2018. By request, CITES Scientific Management Authority provided data for 2019 and 2020 to date. This data provided only included consignments reported as exported from Australia and weights of product recorded as exported. It did not include the importing country product weights.

As many of the products exported are not whole sharks and some products are recorded in number and not weight, it was necessary to apply conversions to estimate whole weight of sharks represented by the figures, as follows:

- *Fin weight* – Simpfendorfer (2014) reported that the reported fin weight in export data represent only 2-8% of the total shark weight. To account for the 2-8% range, the reported fin weight was multiplied by 50 (assuming 2% of whole shark), by 12.5 (assuming 8% of whole shark) and by 20 (a midway of 5%). These conversions were applied to the reported export and import numbers.
- *Specimens* & *Live* – Products listed as "specimens" and "live" were assumed to be whole sharks. For scalloped and smooth hammerhead sharks, the number of specimens was multiplied by 2.3kg, considered to be the average weight of harvested scalloped

hammerheads in Queensland fisheries (Leigh, 2016). For great hammerhead sharks, the number of specimens was multiplied by 15.7kg assumed to be the average weight of harvested great hammerheads (Harry et al, 2011). As referenced in **Section 3.4.4**, this may be an over-estimate but has been used in the absence of another more reliable estimate.

- *Bones, Derivatives* – Advice was sought from Australia's CITES Scientific Authority on its protocol for conversation of bones to whole shark weight. In response, the document *Guidance for Submission of Annual Report* was provided (CITES, 2019), however this document did not provide any further guidance on this matter. Hence, it was assumed that a singular bone or derivative was the equivalent of 1 whole shark, using the same weights assigned for products listed as "specimens" and "live". There is a possibility that the separate reporting of bones (and derivative) and fins could result in double counting of whole sharks, where fins and bones were yielded from the same individual shark. Given the lack of sufficient traceability processes in place, it is not possible to determine this. However, it is noteworthy that there were only two occasions where the export product recorded was "derivative" and no recorded "bones" relevant to this review.

The CITES data is presented below in **Table 7** for scalloped hammerhead, **Table 8** for great hammerhead and **Table 9** for smooth hammerheads.

Scalloped hammerhead export data

The data on scalloped hammerhead exports and imports shows:

- Since 2014, scalloped hammerheads have been exported to a number of countries, however the largest and most consistent importer of Australia hammerhead sharks is Hong Kong.
- Fins, specimens, derivatives and live shark have all been reported as exported, however fins represent the most significant volume.
- There has been a general decrease in the amount of scalloped hammerhead reported exported from 2015.
- Based on the various fin to whole shark ratio, the following total volume of scalloped hammerheads reported exported from Australian between 2014 and 2020 is:
  - Fins 2% whole weight - approximately 42, 000 kg
  - Fins 5% whole weight – approximately 17, 000 kg
  - Fins 8% whole weight – approximately 11, 000 kg
- Regardless of the ratio applied, there were no years in which the estimated annual whole weight equivalent exported exceeded the scalloped hammerhead harvest limit of 200 t.
- Regardless of the ratio applied, the estimated annual whole equivalent weight exported is well below the annual reported harvest on an annual basis.
- Total estimated whole weight equivalent exported from 2014 to 2020 (maximum prediction of approximately 42,064 kg is well below the total reported harvest over the same time period of 387,594 kg.
- Volume of scalloped hammerheads reported exported annually between 2017 and 2019 is markedly reduced compared to annual exports between 2015 and 2016.

While those are positive findings, there are also a number of anomalous observations when the database is examined on an individual consignment basis:

- Throughout 2016 to 2018, seven consignments (out of a total of 11 over that time) were received by importing nations with no record of these products being exported from Australia. These imports related to an estimated 9,000kg whole weight of scalloped hammerhead sharks, not recorded on export from Australia.
- Over the period 2014-2018, there were another four records of product being exported from Australia with no corresponding import records.

The 2019 and 2020 data provided directly by Australia's CITES Management Authority is not referenced in relation to this comparative analysis between export and import data, as data at import country was not provided for these years.

Great hammerhead export data

The data on great hammerhead exports and imports shows:

- All shipments were of fin to Hong Kong.
- Only six consignments of Great Hammerheads exports consignments were recorded between 2014 and 2016, with only one shipment in 2014, 2015 and 2017; and three shipments in 2016. In 2019, the number of consignments increased to eight in that year.
- The volumes per shipment were sizeable from 2016 to 2017 (i.e. whole weight equivalent of between 11t and 61t depending on the ratio used. A larger number of comparatively smaller shipments were reported in 2019.
- The amount of great hammerhead reported exported increased from 2014 to 2016 and then decreased from that point.
- Based on the various fin to whole shark ratios, the following whole weight equivalent of great hammerheads have been exported from Australian between 2014 and 2019 is (ranges are due to discrepancies between recorded export and import weights, see below):
  - Assuming fins 2% whole weight –between approximately 94,000 and 111,000 kg
  - Assuming fins 5% whole weight – between approximately 38,000 and 45,000 kg
  - Assuming fins 8% whole weight – between approximately 23,000 and 28,000 kg
- Regardless of the conversion ratio employed, in all years from 2014-2020 the estimated annual whole weight equivalent exported did not exceed the national harvest limit of 100t for great hammerhead sharks.
- Assuming fins 2% whole weight
  - In 2016, the total recorded whole weight of shark exported of 61,288 kg (recorded import to Hong Kong was 48,810 kg) exceeded the estimated annual harvest in 2016 using the "apportioned disaggregation" scenario of 35,565kg (see **Figure 3** and **Appendix 3**). It did not exceed the annual harvest using the "100% disaggregation" scenario of 106,947 kg.
  - In 2017, the total recorded whole weight of shark imported to Hong Kong of 45,299 kg (no record of export from Australia) exceeded the estimated annual harvest in 2017 using the "apportioned disaggregation" scenario of 30,202 kg (see **Figure 3** and **Appendix 3**). It did not exceed the annual harvest using the "100% disaggregation" scenario of 77,695 kg.
  - It is entirely possible that products of sharks legitimately harvested in previous years were exported in 2016 and 2017 accounting for the exports volume greater than annual harvest.
- The annual exports or imports did not exceed the annual harvest in any other year.
- The total estimated maximum whole weight equivalent exported from 2014 to 2020 of approximately 111,000kg is well below the total reported harvest estimated under the "apportioned disaggregation" scenario over the same time period of 257,135 kg.

There are also a number of anomalous observations with the database is examined on an individual consignment basis:

- There was significant inconsistency in the reports between import and export country for every consignment on record between 2014 and 2018. On two occasions, Australia recorded export, with no correspondence import recorded by the import country. On two occasions, an import was recorded by the importing country with no export reported by Australia, including a very sizeable import to Hong Kong of over 900kg of shark fin. On two occasions

the export and corresponding imports were recorded with significantly different volumes noted.

The 2019 and 2020 data provided directly by Australia's CITES Management Authority is not referenced in relation to this comparative analysis between export and import data, as data at import country was not provided for these years.

Smooth hammerhead export data

The data on smooth hammerhead exports and imports shows:

- Smooth Hammerheads exports were limited to one shipment for each of 2015, 2016, 2017 and 2019.
- All shipments of smooth hammerheads were in the form of fins and to Hong Kong
- Generally, the annual volumes of smooth hammerhead reported exported decreased from 2014 to 2020.
- Two of the shipments (in 2015 & 2016) showed significant consistency between export and import recording.
- The 2017 shipment was recorded by Hong Kong with no corresponding export record from Australia.
- Total volume, all fins, exported was approximately 73 kg which equates to whole weight equivalents of:
    - Assuming fins 2% whole weight – approximately 3,600 kg
    - Assuming fins 5% whole weight – approximately 1,400 kg
    - Assuming fins 8% whole weight – approximately 900 kg
- Regardless of the conversion ratio employed, in all years from 2014-2020 the estimated annual whole weight equivalent exported did not exceed the national harvest limit of 70, 000 kg for smooth hammerhead sharks.
- Regardless of the conversion ratio employed, the estimated annual whole equivalent weight exported is well below the annual reported harvest.

The total estimated whole weight equivalent exported from 2014 to 2019 (maximum prediction of 3,647 kg) is well below the minimum estimation of total harvest over the same time period of 143, 356 kg.

Table 7. CITES trade data (by individual consignment) for scalloped hammerhead sharks 2014-2020

					1:50 fin to whole weight conversion, Kg		1:20 fin to whole weight conversion, Kg		1:12.5 fin to whole weight conversion, Kg	
Year	Importer	Importer reported Qty (kg)	Exporter reported Qty (kg)	Term	Importer reported	Exporter reported	Importer reported Qty	Exporter reported	Importer reported	Exporter reported
2014	HK		23	fins	-	1,125	-	450	-	281
2015	HK	239	393	fins	11,971	19,651	4,788	7,860	2,993	4,913
2015	NL	18	15	live	72	60	72	60	72	60
2016	AE		6	derivatives		14		14		14
2016	FJ	36		specimens	83	-	83	-	83	-
2016	HK	328	337	fins	16,397	16,862	6,559	6,745	4,099	4,215
2016	HK		14	fins	-	678	-	271	-	169
2016	US		6	derivatives		14		14		14
2016	US	6		live	24	-	24	-	24	-
2017	HK	173		fins	8,661	-	3,464	-	2,165	-
2017	US	2		live	8	-	8	-	8	-
2018	AE	6		live	24	-	24	-	24	-
2018	CN	18		live	72	0	72	0	72	0
2018	US	2		live	8	0	8	0	8	0
2019	HK		10.9	fins	-	545	-	218	-	136
2019	HK		4.9	fins	-	245	-	98	-	61
2019	HK		2.85	fins	-	143	-	57	-	36
2019	HK		7.02	fins	-	351	-	140	-	88
2019	HK		21.84	fins	-	1,092	-	437	-	273
2019	HK		5.12	fins	-	256	-	102	-	64
2020	HK		4.3	fins	-	215	-	86	-	54
2020	HK		16.3	fins	-	815	-	326	-	204
				Total 2014	-	1,125	-	450	-	281
				Total 2015	12,043	19,711	4,860	7,920	3,065	4,973
				Total 2016	16,503	17,567	6,665	7,043	4,206	4,412
				Total 2017	8,669	-	3,472	-	2,173	-
				Total 2018	104	-	104	-	104	-
				Total 2019	-	2,632	-	1,053	-	658
				Total 2020		1,030		412		258
				Total	37,318	42,064	15,102	16,878	9,548	10,582

General comments about the CITES data

In no years did the whole shark equivalent of sharks exported exceed the harvest limit, in fact the amount was well below that limit. Also, the volume of fin exported was significantly less than the harvested volume of shark over these periods.

These relatively low export numbers could be a result of reported reduced market demand for shark fin in key markets like China and Hong Kong (Bloomberg et al, 2015; Evidence of declines in shark fin demand: China, 2014). However, given the limited traceability systems in place, the possibility of shark products from CITES listed shark species being exported outside of the CITES reported process should be considered.

Table 8. CITES trade data (by individual consignment) for great hammerhead sharks 2014- 2020

					1:50 fin to whole weight conversion, Kg		1:20 fin to whole weight conversion, Kg		1:12.5 fin to whole weight conversion, Kg	
Year	Importer	Importer reported Qty (kg)	Exporter reported Qty (kg)	Term	Importer reported	Exporter reported	Importer reported Qty	Exporter reported	Importer reported	Exporter reported
2014	HK		43.18	fins	0	2159	0	864	0	540
2015	HK	345.67	235.82	fins	17,284	11,791	6,913	4,716	4,321	2,948
2016	HK	976.2	1214.28	fins	48,810	60,714	19,524	24,286	12,203	15,179
2016	HK		11.47	fins	-	574	-	229	-	143
2017	HK	905.97		fins	45,299	-	18,119	-	11,325	-
2019	HK		16.67	fins	-	834	-	333	-	208
2019	HK		25.81	fins	-	1,291	-	516	-	323
2019	HK		57.2	fins	-	2,860	-	1,144	-	715
2019	HK		24.22	fins	-	2,860	-	1,144	-	715
2019	HK		88.82	fins	-	1,211	-	484	-	303
2019	HK		40.68	fins	-	4,441	-	1,776	-	1,110
2020	HK		47.8	fins	-	2,034	-	814	-	509
2020	HK		72.96	fins	-	3,648	-	1,459	-	912
			Total kgs 2014		-	2,159	-	864	-	540
			Total kgs 2015		17,284	11,791	6,913	4,716	4,321	2,948
			Total kgs 2016		48,810	61,288	19,524	24,515	12,203	15,322
			Total kgs 2017		45,299	-	18,119	-	11,325	-
			Total kgs 2018		no reports	no reports	no reports	no reports	no reports	no reports
			Total kgs 2019		-	13,496	-	5,398	-	3,374
			Total kgs 2020			5,682		2,273		1,421
			Total		111,392	94,416	44,557	37,766	27,848	23,604

Table 9. CITES trade data (by individual consignment) for smooth hammerhead sharks 2014- 2020

					1:50 fin to whole weight conversion, Kg		1:20 fin to whole weight conversion, Kg		1:12.5 fin to whole weight conversion, Kg	
Year	Importer	Importer reported Qty (kg)	Exporter reported Qty (kg)	Term	Importer reported	Exporter reported	Importer reported Qty	Exporter reported	Importer reported	Exporter reported
2015	HK	64.5	64.5	fins	3,225	3,225	1,290	1,290	806	806
2016	HK	6.72	6.72	fins	336	336	134	134	84	84
2017	HK	0.59		fins	30	-	12	-	7	-
2019	HK		1.72	fins	-	86	-	34	-	22
			Total kgs 2014		no reports	no reports	no reports	no reports	no reports	no reports
			Total kgs 2015		3,225	3,225	1,290	1,290	806	806
			Total kgs 2016		336	336	134	134	84	84
			Total kgs 2017		30	-	12	-	7	-
			Total kgs 2018		no reports	no reports	no reports	no reports	no reports	no reports
			Total kgs 2019		-	86	-	34	-	22
			Total		3,591	3,647	1,436	1,459	898	912

Australian ABARES data shows the following recent volumes of dried shark and rays products (in tonnes) exported from Australia:

	2011/2012	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18
Hong Kong	94	89	71	13	20	15	29
Japan	8	9	10	11	10	10	12
Singapore	11	9	6	0	0	-	-
Other	16	19	11	30	88	47	25
Total	128	126	97	55	118	72	66

While the volumes of dried shark and ray products have certainly reduced over the period of 2011/12 to 2017/18, the amount remains sizeable, particularly when considering these are not whole shark. If we presumed that only half of the 2017/18 exported product was fins, and assumed the midway fin-whole weight conversion ratio of 1:20, these would equate to 600,000 kg of shark and ray product. Until the existing limited traceability and verification measures in place for CITES and other exported product is resolved, uncertainty around the accuracy of this data will remain.

3.5.3 Issues with trade data and permit systems

The EPBC Act requires that, amongst other matters, an export permit for a CITES Appendix II listed species may only be issued by the Minister for the Environment if a positive NDF has been made by the Australian CITES Management Authority.

The current requirements for evidence of the legal sourcing of products from an approved WTO fishery is a copy of the current Commercial Fishing Licence which is authorised in accordance with the applicable licensing regime agreed to by the appropriate WTO (Australian CITES Management Authority *per comm*, 2020). Additional information such as licences from the Great Barrier Reef Marine Park Authority are required for certain WTOs. The validity of the licence is established "if required" by contacting the licensing agency described in the appropriate WTO.

In terms of monitoring of the system, the CITES Scientific Authority advises that:

- It conducts checks on permit compliance, to ensure so far as possible that permit applicants have been compliant with requirements and are acquitting regularly.
- Where useful, the CITES Scientific Authority has undertaken analysis of trade data as a component in the re-assessment fisheries for renewal of export approval (WTO) in order to cross check and highlight any discrepancies in reported take compared to exports. This is of variable usefulness, dependent on the nature of the products/derivatives exported, (for instance whether the whole specimen is exported), and the nature of the fisheries they are harvested from (whether they target listed species or catch small amounts as byproduct).
- This cross-checking has not been used extensively to-date in relation to the Appendix II listed shark species, but has been useful for other CITES listed species harvested in Australian fisheries to identify any concerning temporal trends in exports, and then examine whether these reflect reported harvesting patterns. For example, this has been used in relation to CITES listed corals where examinations led to more stringent adaptive management arrangements and improvements to harvest reporting requirements.
- To date in relation to the Appendix II shark species, the primary means employed by the Scientific Authority to monitor sustainability and identify issues of concern has been through the assessment of fisheries as approved WTO under the EPBC Act and subsequent periodic reporting by fisheries management agencies.

The 2017 NDF Analysis report noted that the current permit system does not allow reliable reporting on the fishery of origin of exported fins and made reference to the fact that the CITES Management Authority of Australia was considering mechanisms to improve the traceability of exported hammerhead shark fin. In October 2020, the CITES Management Authority of Australia advised that no additional mechanisms to improve traceability of exported hammerhead have been implemented or are under development.

CITES at the international level, has recognised the importance of traceability of shark products and has agreed on a Guidance on Traceability for Shark Products. Given the nature of the external information needs to ensure the robustness of the NDF, this could be achieved by implementing the traceability Guidance issued on the CITES website.

FINDINGS

8. There is no evidence of exported hammerhead shark product being in excess of the reported harvest limits or reported mortality of these species. Reported exported for all three species has generally declined since 2016.

9. Anomalies in the contents of the CITES trade database raises concerns as to the integrity of the CITES reported trade data

10. The limited requirements for traceability and validation of the source fishery at the point of export has been acknowledged by Government; however no improvements in the system have been made to date.

3.6 REVIEW OF RECENT SCIENTIFIC FINDINGS

The 2017 NDF Analysis concluded the 2014 NDF should be extended until such time as relevant additional information becomes available (or until it is otherwise decided to review the non-detriment finding") (Department of the Environment and Energy, 2017). Given this recommendation, a review of new scientific information has been undertaken, with a summary provided below. For each new scientific study, a summary is provided in addition to a notation on the specific value of this in terms of the management of the listed hammerhead species.

The new scientific studies are listed against the following categories:

- Studies related to discard mortality
- Studies related to species biological parameters
- Studies related to catch composition
- Studies related to stock status, structure and distribution
- Studies related to management

Note that additional information relating to stock status, conservation listings and management is provided in the proceeding sections of this report.

3.6.1 Studies related to discard mortality

- *Respiratory mode and gear type are important determinants of elasmobranch immediate and post-release mortality, Dapp et al (2015)*

Dapp et al (2015) reviewed the impact of respiratory mode and fishing gear on elasmobranch survival through the compilation of publicly available data sources on the immediate mortality percentages of 83 species and post-release mortality percentages of 40 species.

It was found that sharks and rays captured in longlines had significantly lower immediate mortality than those caught in trawls or gillnets. The models produced predicted the mean total

discard mortality (combined immediate and post-release mortality) percentages of obligate ram-ventilating elasmobranchs (which include the listed hammerhead species) by gear type: longline, 49.8%; gillnet 79.0%; trawl gear 84.2%.

In contrast, total discard mortality percentages of stationary-respiring species were significantly lower: longline 7.2%; gillnet 25.3%; trawl capture 41.9%

- *A review of capture and post-release mortality of elasmobranchs. Journal of fish biology, Ellis et al (2016)*

Ellis et al (2016) reviewed the various approaches that have been used to examine the discard survival of elasmobranchs, both in terms of at-vessel mortality and post-release mortality (PRM), with relevant findings summarized for both the main types of fishing gear used and by taxonomic group.

In general, demersal species with buccal-pump ventilation have a higher survival than obligate ram ventilators (including the listed hammerhead species). Several studies have indicated that females may have a higher survival than males. Certain taxa (including hammerhead sharks *Sphyrna* spp. and thresher sharks *Alopias* spp.) may be particularly prone to higher rates of mortality when caught.

- *Mitigating the discard mortality of non-target, threatened elasmobranchs in bather-protection gillnets, Broadhurst et al (2019)*

This study describes the immediate mortality of several threatened species discarded from gillnets deployed off eastern Australia . In total, 420 animals comprising at least 22 species were gillnetted with a total immediate mortality of 49 % and group-specific estimates of 100 % for dolphins (n = 8), 100 % for teleosts (n = 16), 86 % for sharks (n = 75), 45 % for turtles (n = 20) and 36 % for rays (n = 301).

Among elasmobranchs, species that were obligate ram-ventilating (e.g. great hammerhead, and common blacktip shark) had greater mortality (>95 %) than those species with spiracles, and likely capable of some stationary respiration (16–74 % mortality). The effect of soak time was further assessed to determine an optimal to maintain gillnet efficiency for target sharks, but minimise the absolute mortality of abundant rays and was estimated at up to three or four fishing nights (72–96h).

Relevance to the NDF –The models and estimates of total mortality provided by the above recent studies, provide additional basis for calculating the combined total mortality which results from discards (immediate and post-release mortality), and has determined these rates to be high (particularly for gillnets and trawls). Currently, the NDF harvest limit is based on retained volumes only. ***Section 3.4.3 of*** *this report has already shown that discards volumes are significant and also vary considerably. Collectively this information creates a sound basis to consider that at volume limit should be a limit on total mortality, not only retained harvest.*

Dapp et al's (2015) analysis provides the first quantified demonstration of the effect of breathing strategy and fishing gear type on survival and this finding should be used to develop appropriate mitigation measures.

3.6.2 Studies related to species biological parameters

- *Age, Growth and Maturity of the Pelagic Thresher Alopias pelagicus and the Scalloped Hammerhead Sphyrna lewini: Age and Growth of Two Large Shark Species, Drew et al (2015)*

In this study, age and growth parameters were estimated for the pelagic thresher and scalloped hammerhead shark from growth-band counts of thin-cut vertebral sections in Indonesia. This summary relates to the scalloped hammerhead sharks only.

Scalloped hammerhead shark (n = 157) vertebrae were collected from three Indonesian fish markets over a 5-year period. A multi-model analysis was used to estimate growth parameters. The samples of scalloped hammerhead shark were heavily biased towards females. Age at maturity was calculated to be 8·9 and 13·2 years for males and females, respectively.

Numerous age and growth studies have previously been undertaken on scalloped hammerhead shark, however few studies have been able to obtain adequate samples from all components of the population because adult females, adult males and juveniles often reside in different areas. For the first time, sex bias in this study was towards sexually mature females, which are commonly lacking in previous biological studies on scalloped hammerhead shark.

The data confirmed that scalloped hammerheads exhibit slow rates of growth and late age at maturity, highlighting the need for a re-assessment of the relative resilience of the scalloped hammerhead shark.

Relevance to the NDF – While slow growth rates and late age at maturity have always been recognised for scalloped hammerheads, this study suggests that current understanding of these parameters at 2014 could be an underestimate. If this were the case, this species would be even more vulnerable than previously acknowledged and suggests the need for more precautionary mortality limits and management arrangements.

3.6.3 Studies related to catch composition

- *Catch composition of a traditional Indonesian shark fishery operating in the MOU Box, Northwestern Australia: Results of shark fin identification from Operation Snapshot, Marshall et al (2016)*

This report characterises the shark catch of nine Indonesian fishing vessels operating in the eastern margin of the MOU Box1 during May 2015, based on the analysis of images and tissue samples of shark dorsal fins encountered on board. The sampled dorsal fins represented 152 individual sharks from 16 species belonging to the families Carcharhinidae (whaler sharks) and Sphyrnidae (hammerhead sharks).

Researchers identified, to species, 152 shark dorsal fins collected during Operation Snapshot (May 2015) using expert visual identification and DNA methods, and predicted the lengths, weights and estimated sexual maturity of the corresponding sharks. The researchers also further evaluated the success of two semi-automated methods that are currently under development for non-experts to identify the species of dorsal fins from photographs; a Morphometric method (Marshall 2011), and iSharkFin 1.0 © FAO 2014-2016.

Evaluated against the DNA results, 100% of the 145 identifications made by the Expert Visual identification method were correct. The Morphometric identification method achieved a success rate of 69.1%, while iSharkFin 1.0 identified only 29.2 % of viable dorsal fin photographs correctly.

- *QDAF validation of catch composition of shark species in net fisheries*

QDAF is currently undertaking research to "*…validate catch composition of shark species in net fisheries along the east coast as well as the Gulf of Carpentaria. This project aims to determine species catch composition of harvest by sampling at ports, processors or on-board/on-water. It also aims to develop a profile of discards, by including data gathered from random on-board observations*." This has been conducted as part of the QDAF monitoring program. The published results were due mid 2020 but now scheduled for end of 2020 (QDAF, pers. comm.).

Relevance to NDF - The Marshall et al study further reveals the significant challenges of shark identification based on fins alone by non-expert individuals. This underlines the need for the fins

*naturally attached to be implemented within all fisheries in Australian waters (with particular reference to Western Australia which is yet to introduce the policy) and further means to ensure the identify of shark fins through the supply chain ensure that products from listed sharks are not illegally exported without CITES export permits. This is considered a legitimate risk given that the traceability measures required even for CITES listed species are limited (see **Section 3.5.3**).*

3.6.4 Studies related to stock status, structure and distribution

- *Decline of coastal apex shark populations over the past half century, Roff et al (2018)*

Roff et al (2018) reconstructed fisheries-independent data from a shark control programme spanning 1,760 km of the Australian coastline over the past 55 years. Substantial declines of between 74–92% of catch per unit effort of hammerhead (Sphyrnidae), whaler (Carcharhinidae), tiger shark (*Galeocerdo cuvier*) and white sharks (*Carcharodon carcharias*) were reported indicating regional depletion of shark populations over the past half a century. Declines in body size and the probability of encountering mature individuals over the same period was also reporting indicating that apex shark populations are more vulnerable to exploitation than previously thought.

*Relevance to NDF – In the absence of a more traditional stock assessment, the 74-92% decline in catch per unit effort would be considered a sign of serious and significant impact and grounds for a review of the NDF to determine if the harvest limits and management actions laid out were sufficient to respond to the scale of decline reported by Ross et al 2018. No review was undertaken. Since this time, the North Australia Scalloped hammerhead stock assessment has commenced and will soon be reported. See **section 3.1.1**.*

- *Crossing lines: a multidisciplinary framework for assessing connectivity of hammerhead sharks across jurisdictional boundaries, Chin et al (2017)*

Chin et al (2017) undertook an assessment of scalloped and great hammerhead population structure and connectivity across northern Australia, Indonesia and Papua New Guinea (PNG) to inform management responses to CMS and CITES listings of these species.

An Integrated Assessment Framework (IAF) was devised to systematically incorporate data across jurisdictions and create a regional synopsis, and amalgamated a suite of data from the Australasian region. Scalloped hammerhead populations are segregated by sex and size, with Australian populations dominated by juveniles and small adult males, while Indonesian and PNG populations included large adult females. The IAF process introduced genetic and tagging data to produce conceptual models of stock structure and movement. Several hypotheses were produced to explain stock structure and movement patterns, but more data is needed to identify the most likely hypothesis. This study demonstrates a process for assessing migratory species connectivity and highlights priority areas for hammerhead management and research.

Relevance to NDF - This report is included for completed but considered superseded by Heupel et al (2020) which used multiple indicator methods to determine stock structure with more certainty.

- *National Environmental Science Program Hammerhead Shark Connectivity Project, Heupel et al (2020)*

The 2014 NDF recognised the considerable uncertainty regarding the population structure of scalloped hammerheads. The National Environmental Science Program Hammerhead Shark Connectivity Project led by the Australian Institute of Marine Science investigated these issues further. The study used tagging, parasite analysis and genetic sampling to see how hammerhead shark populations are connected in order to assess the potential stock structure and population status of hammerhead sharks in Australian waters.

Based on the results of the three approaches there were different conclusions regarding stock structure:

- Satellite tracking and parasite analysis showed little or no evidence of cross-jurisdictional movements (either domestically or internationally), indicating that in the short-term scalloped hammerhead shark move over relatively small spatial scales. Neither approach supported the hypothesis of a single well mixed Australian stock.
- In contrast, genetic analysis showed strong support for connectivity between scalloped hammerhead shark in northern and eastern Australia and both Papua New Guinea and Indonesia. The genetic data did not support the hypothesis of a single well-mixed Australian stock, with samples from Western Australia being significantly different from those from the rest of Australia, Indonesia and Papua New Guinea.
- Genetic samples also suggested that scalloped hammerhead shark from Fiji were significantly different from all Australian, Indonesian and Papua New Guinean samples.

Overall, these results suggest limited movements of scalloped hammerhead shark between Australia and its regional neighbours, but that there are sufficient movements to maintain genetic mixing. The exception being Western Australian samples which appear separate from the rest of the region. However, these results should be interpreted with caution due to the lack of large individuals in satellite tracking and parasite sampling.

Conclusions drawn from tracking and parasite approaches were limited by the size classes that were available to researchers. Both approaches were unable to sample the largest size classes, which have been shown to have the greatest likelihood of moving over long distances. As such, the project was not able to discount the hypothesis that larger size classes undertake regular movements between jurisdictions that support the genetic evidence of population connectivity. In contrast, the evolutionary time scales which genetic data represent combined with the nature of shark genetic structure can result in movement of a limited number of individuals producing a population level connection. Therefore, authors urged that conclusions about connectivity of Australian hammerheads with regional neighbours should be considered using a precautionary lens.

The authors recommended that future research should attempt to locate and sample the larger size classes, especially large mature females, and include areas such as Australian Marine Parks to identify potential benefits of use of these protected areas.

Relevance to the NDF – This report provides guidance to Australia about ownership of measures to protect hammerhead sharks in our waters. In particular, it suggests that while actions of international jurisdictions may have some effect on Australian stocks, it is likely that those effects are limited. Thus, it highlights the importance of Australia's own measures to sustainably manage this species.

3.6.5 Studies related to management

- *Performance of bycatch reduction devices varies for chondrichthyan, reptile, and cetacean mitigation in demersal fish trawls: Assimilating subsurface interactions and unaccounted mortality, Wakefield, et al (2017)*

Wakefield et al (2017) examined species-specific responses of chondrichthyans, reptiles and cetaceans to trawl bycatch reduction devices using both in situ subsurface electronic monitoring and onboard observations undertaken in June to December 2012. It found that 26.9% of day trawls had no megafauna interactions and 38.3% of the 1826 interactions escaped, with most in rapid time (91.4% in ≤ 5 min). The upward inclined exclusion grid significantly improved the escape proportions for most chondrichthyans by 20–30%. The researchers concluded that the relatively cost-effective method of electronic monitoring achieved very high levels of subsurface

observer coverage (60% of day trawls or 56% of day trawl hours), and provided evidence that the subsurface expulsion of megafauna in poor condition is negligible. Furthermore, this study provides species-specific improvements toward bycatch mitigation strategies for demersal fish trawling.

Relevance to NDF – This study found significant success in the use of upward inclined exclusion grids in terms of proportions escape and the condition at escape. This is encouraging and combined with the Dapp et al (2015) finding of mean total discard mortality of 84.2% in trawl gear, suggests there should be strong consideration on ensuring grids are mandatory on all trawl fisheries which significantly interact with listed shark species.

FINDINGS

11. Since 2014, a number of new scientific finding have been presented which are relevant to the understanding of the vulnerability and threats faced by scalloped, great and smooth hammerhead sharks

4 SUMMARY OF FINDINGS

Below are the summary of findings resulting from the exploration of issues of conservation status, stock status, management, harvests, CITES export data and new scientific research. Recommendations which flow from these findings are in **Section 5**.

1. Despite numerous recommendations to improve the understanding of stock status of the three hammerhead species, to date there has been little publicly available progress

In 2014, there were no stock assessments available to robustly guide understanding and decision making regarding the three hammerhead species, leading Simpfendorfer (2014) to conclude that for all species it was impossible to provide a science-based estimate of sustainable catch. Numerous recommendations have been made to improve the knowledge base to enable robust stock assessments, however six years on there are no completed robust stock assessments for scalloped, great or smooth hammerheads (although the stock assessment for scalloped hammerheads is nearing finalisation).

QDAF completed a species complex level assessment in 2016 for whaler and hammerhead sharks however it was flawed by the quality and quantity of data on which the analysis could be made.

The scalloped hammerhead shark stock assessment is in process and is expected to be finalised early 2021 however to date there is no publicly available information available on the results of the assessment. The attempt to conduct a stock assessment is welcomed. The availability of the stock assessment would in itself trigger a review of the NDF, based on the directive of the NDF itself that: "if further information on individual species abundance, distribution and harvest becomes available …the harvest levels contained in this NDF may be reviewed."

2. Significant recommendations from expert peer reviewer of the Queensland hammerhead sharks have not been implemented.

In his independent review of the 2016 QDAF stock assessment of hammerhead (and whaler) sharks, Cortes (year?) provided specific advice on steps to improve the understanding of stock status which included the resurrection of the fisheries observer program, conducting a fishery-independent survey and the implementation of fin-clipping of captured sharks to perform genetic identification and compare with logbooks reports

3. The global conservation status of all three hammerhead species has declined since 2014. The need for additional international scale management of these migratory species has also been formally recognised.

The recognised global and national status of all three hammerhead shark species has markedly declined since 2014. The scalloped and great hammerhead sharks have declined from a global status of Endangered to Critically Endangered. While these are global listings, not national, it is noteworthy that in Australia, apart from the recent progression of a scalloped hammerhead stock assessment, there has been very little work to determine with any more certainty the stock status in this region.

In addition, the need for international level management of all three species has since been recognised in their listing on CMS Appendix II.

Scalloped hammerheads have also been found to be eligible for Endangered listing but ultimately listed as Conservation Dependent under Australia's national threatened species list.

4. In taking out a reservation to the Convention for Migratory Species (CMS) listing of the three hammerhead sharks, the Australian Government reported that it will fulfill its requirements under the CMS by participating in the Shark MOU. However, the tangible impact of the Shark MOU on the management or protection of these species in Australia has not been articulated, and the process to review the CMS reservation decision over time is also not communicated.

The Australian Government submitted reservations against the CMS listing of all three hammerhead species and promoted the significance of the Shark MOU in lieu of the impact the CMS would have had. However, the tangible impact of the Shark MOU on the management or protection of the three hammerhead species in Australia has not been articulated.

There is no public information regarding a subsequent review of the CMS listing reservations of the three hammerhead species. It would be reasonable and responsible to review a reservation decision over time, much like the 2014 NDF was required to be reviewed initially after 3 years.

5. There has been no comprehensive review of the progress against the suite of recommendations included in the 2014 NDF, despite implementation of these being a condition of the positive NDF

The initial NDF was required to be reviewed after three years, which it was. The 2017 NDF Analysis only sought to consider information on any new management practices put in place relevant to hammerhead shark stocks. This review did not contain a review of progress against comprehensive suite of generic and fisheries-specific recommendations that were specifically established in relation to the 2014 NDF. This is despite the fact that the 2014 NDF itself states that the positive NDF for the species *were subject to Australian State and Commonwealth management agencies seeking to implement improved management arrangements to minimise the ongoing catch of these species*.

In addition, the 2017 NDF Analysis included no new timeframe for future review. This report has raised numerous materials changes to issues relevant to the three hammerheads species, many of which were available some time ago. Such new insights have yet to be formally considered.

6. Australia has not yet implemented specific management measures included in the NDF and made by the TSSC in relation to scalloped hammerhead sharks.

Australia has not implemented management measures specific defined and required in the NDF. Overall Australia has fully implemented 41% of the generic recommendations. Partially implemented or recommendations "in progress" of implementation represent a further 18%. 41% of recommendations have not been implemented/presumed not implemented in any form.

Regarding the fishery-specific recommendations, across all jurisdiction, 27% of recommendations have been fully implemented. Partially implemented or recommendations "in progress" of implementation represent a further 10%, and 55% of recommendations have not been implemented/presumed not implemented in any form.

Some TSSC recommendations remain unimplemented despite the requirement for full and unaltered implementation of all recommendations by 2018.

Over this same period of time, Australia made at least two proactive management decisions which undermined the protection of hammerhead species:

- The Government proactively amended legislation which effected allowed targeting of scalloped hammerheads in the Great Barrier Reef Marine Park and
- The WTO for the Queensland ECIFF fishery was permitted to remain in force from 2014 to September 2020 despite recognised necessary measures not being in place for several years.

For the most part, since 2014 there has been little disincentive to slow progress on implemented the NDF recommendations. In fact, exports have been unhindered despite this. Only in 2020, after a long period of non-compliance with WTO conditions to Queensland's East Coast Inshore Finfish Fishery have its export approval revoked. The revocation was followed by swift movement by Queensland to implement required changes; highlighting the necessity of a stronger position on implementation of NDF requirements regarding management and data collection.

While many of these management recommendations are yet to be implemented, new and additional management recommendations have been formally made by TSSC including the requirement for a formal management plan for scalloped hammerhead sharks to assist in this species' recovery.

In addition, a thorough review of all the recommendations from a relevance to each species and jurisdiction would be of much value. There are many recommendations assigned to fisheries which would likely be identified as irrelevant or not critical.

7. There is insufficient data to determine harvest levels with sufficient certainty

Despite the clear recommendation to regulatory authorities to implement a range of measures to address the uncertainty around mortality of hammerhead sharks, this has either not occurred or has only recently occurred, meaning that a significant dataset of species-specific data is not yet available. In addition, there remains a lack of observer data, lack of catch validation, an absence of an appropriate understanding of discards, post release mortality and mortality due to IUU fishing. There is also an absence of recreational and indigenous harvest data in all states, although the take by these sectors is acknowledged to be negligible.

Where unspecified hammerhead catch is allocated all to either great to smooth hammerhead sharks, each of these species exceed their harvest limits of 100,000kg (in 2014, 2015, 2016 and 2018) and 70,000kg (in 2014 to 2017) respectively.

While the assignment of all unspecific hammerhead catch data to one species may be an unreasonable assumption to make, there are equally numerous factors to support a claim that all

reported catches and discards are an under-estimation of the true mortality of these species. Ultimately, there is insufficient data to determine with certainty that harvest levels are not exceeding set harvest limits.

8. There is no evidence of exported hammerhead shark product being in excess of the reported harvested catches. There is no evidence of exported hammerhead shark product being in excess of the reported harvest limits or reported mortality of these species. Reported exported for all three species has generally declined since 2016.

When comparing the reported exported product on the CITES database and the total catches for the period 2014 – 2020, there is no evidence that unreported catches are being formally traded. There were two years in which great hammerhead exports were in excess of the annual reported harvest for that year, however that would be legitimately possible by storing harvested product and exporting it in later years. Reported exports appear to be declining for all three species.

9. Anomalies in the contents of the CITES trade database raises concerns as to the integrity of the CITES reported trade data

There are numerous issues and questions that are raised in examining the CITES data including discrepancies between the export and import records, most particularly for scalloped and great hammerhead sharks. This included evidence of consignments received by importing countries, but not recorded on export records from Australia and vis versa.

This could suggest that CITES listed hammerheads are leaving Australia illegally, without the appropriate recording and potentially permits not being obtained. This could also suggest deficiencies in importing country systems also, upon which Australia and all trading countries rely in order to ensure the integrity of the CITES system.

10. The limited requirements for traceability and validation of the source fishery at the point of export has been acknowledged by Government however no improvements in the system have been made to date.

The 2017 NDF Analysis identified that the current permit system does not allow reliable reporting on the fishery of origin of exported fins and made reference to the fact that the CITES Management Authority of Australia was considering mechanisms to improve the traceability of exported hammerhead shark fin; however no such improvements have been made.

11. Since 2014, a number of new scientific finding have been presented which are relevant to the understanding of the vulnerability and threats faced by scalloped, great and smooth hammerhead sharks

Important new findings have been published and available to improve the understanding of impact and improve management of the list hammerhead shark species, including as examples:

- Estimates of immediate and post-release mortality of hammerhead sharks (Dapp et al, 2015; Ellis et al, 2016)
- New data on age at maturity and growth rates which suggest a greater vulnerability of hammerheads species (Drew et al, 2015);
- An improved understanding of scalloped hammerhead stock structure which highlighted the importance of the Australia's own domestic fisheries management (Chin et al, 2017; Heupel et al, 2020);
- A documented decline in catch rates in Queensland's shark control program indicating a corresponding decline in population size (Roff et al, 2018)

- Finding regarding the difficulties in relying on shark identification by non-experts (Marshall et al, 2016)
- Findings regarding the fate of megafauna expelled from bycatch reduction devices (Wakefield et al, 2017)

The 2017 NDF analysis concluded the 2014 NDF should be extended until such time as "relevant additional information" becomes available (or until it is otherwise decided to review the non-detriment finding") (Department of the Environment and Energy, 2017). The above summary of relevant new information is evident that "relevant additional information has become available" has become available, hence the NDF should be reviewed in the light of this information.

For clarity, in addition to the new research data summarised here, significant additional information relating to stock status, conservation listings and management has also become available, as outlined in the proceeding sections of this report.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

The 2014 positive NDF for hammerhead shark species was subject to (a) no further increase in the average annual catch of the species; (b) no carryover of catch levels from year to year, and (c) State and Commonwealth management agencies seeking to implement improved management arrangements to minimise the ongoing catch of these species.

The NDF also included that *"… if further information on individual species abundance, distribution and harvest becomes available through a review of trade data, ecological risk assessment or through research projects, the harvest levels contained in this NDF may be reviewed. Through the improvement of reporting (down to species level) and research, the information basis for future NDFs will improve over time."*

As at November 2020, the following can be reported against each of those conditions for a positive NDF and triggers for a review of harvest levels.

a) No further increase in the average annual catch of the species

In order to make any commentary regarding the trend in catches of the three hammerhead species, there must first be confidence in reliable catch and discard data.

However, despite the NDF clear recommendation to implement measures to address the uncertainty around retained and discarded commercial catch of hammerhead sharks, this has either not occurred in some jurisdictions, or has only recently occurred, meaning that a sufficient dataset of species-specific data is not yet available.

In addition, there is a lack of observer data and/or other forms of fisheries independent data which would serve to validate the data which is available. There is also a lack of data for other forms of mortality including recreational and indigenous sectors and IUU take.

While available data does not suggest that there has been further increases in annual catch of these species, there is significant uncertainty around the actual level of mortality.

b) No carryover of catch levels from year to year

There is no evidence of catch level carry over from year to year.

c) Management agencies implement improved management arrangement, as specified

While some progress has been made, 41% of 2014 NDF generic recommendations have not been implemented in any form. Of the fishery specific recommendations, 55% have not been implemented in any form. Also, TSSC some recommendations relating to the listing of scalloped hammerheads as threatened under the EPBC Act remain unimplemented despite the requirement for full and unaltered implementation of all recommendations by 2018.

In addition to these management recommendations not being implemented, the WTO for the East Coast Fin Fish Fishery was permitted to remain in force despite recognised necessary measures not being in place for several years (until October 2020). In a further layer of mismanagement, the then Minister for the Environment, proactively amended regulations to allow targeting of scalloped hammerheads in the Great Barrier Reef Marine Park during this same period.

Meanwhile, in 2018 the TSSC's recommended that "the 2014 Non-Detriment Finding be fully reviewed and updated in 2019, taking into consideration all relevant available data, including that collected between September 2014 and June 2019." This recommendation from Australia's expert authority on threatened species has not been actioned.

While some barriers to implementation of recommendations relevant to fisheries across Australia are expected, this very low level of implementation and no progress of new and pertinent recommendations by the TSSC, results in the statement "Management agencies implement improved management arrangement" not being met.

It is noteworthy also that no comprehensive review of management recommendations has been completed since the NDF was initiated 2014. While the 2017 review asked fishing authorities to offer up information of new management arrangements, this was not compared to the specific recommendations. If it were, it would have revealed extremely limited progress.

d) further information on individual species abundance, distribution and harvest becomes available through a review of trade data, ecological risk assessment or through research projects

Further relevant information and/adjustments which have occurred since 2014 include:

- **Conservation Status.** There has been a significant worsening of the conservation status. In 2018, scalloped hammerheads were listed as Conservation Dependent under the EPBC Act and in 2019 the scalloped and great hammerhead sharks were upgraded on the IUCN Red List to Critically Endangered, with the recommendation all retention and landings be prohibited at least as long as the global population remains in a Critically Endangered status. All three species have been listed on the CMS since 2014.

- **Stock status.** The Department of the Environment and Energy's 2017 NDF analysis was that insufficient new data was still yet to be produced to have confidence in hammerhead shark population models or stock assessments, but still no progress has been made regarding this for great or smooth hammerheads. A scalloped hammerhead stock assessment is currently in progress.

- **CITES Trade data and management.** The CITES trade data does not reveal any concerning trends in its own right. However, there the discrepancies between recorded exports and imports per consignment raise questions about the integrity of the system which is designed to provide assurances of species and volumes traded. In addition, the adequacy of the traceability requirements to ensure that only product originating from WTO fisheries is exported has been highlighted as needing improvement, yet no improvements have been made.

- **New scientific findings.** A number of new scientific findings of relevance have become available since 2014. These include new information of post release mortality, important life history parameters, stock structure, shark identification, and more.

The above list represents a significant amount of further and highly relevant information which is now available with regards to the three listed hammerhead shark species.

In summary, this review finds the performance against conditions (a) and (c) of the NDF has been very limited; and that the directive which requires that the NDF be reviewed if new scientific findings become available has not yet been followed.

5.2 RECOMMENDATIONS

It is recommended that the NDF for the three hammerhead species be reviewed immediately, on the basis that:

- It cannot be verified that no further increase in the average annual catch of the species has occurred;
- Limited progress has been made on implementing the specific recommendations outlined in the NDF (and mandatory condition set by the TSSC also remain unmet); and
- New scientific data is now available to relevant to assessing the status and risks to the hammerhead species.

Any new consideration of an NDF should:

1. Take into account the significant worsening of the global and national conservation status of these species.
2. Introduce the setting of a mortality limit expressed as whole live weight, as opposed to the current harvest limit. This would be a more appropriate indicator of impact and health, and incentivise regulators and industry to invest in gathering data on the total mortality at a species-specific level.
3. Revise the harvest limits to reflect the need for further precaution on the basis that significant improvement quality of data has not been delivered as was expected from the 2014 NDF.
4. Re-examine the NDF recommendations and identify new recommendations based on recent findings, including but not limited to the recommendation by the TSSC to develop a management plan for scalloped hammerhead sharks. This should include honing recommendations to ensure that each are explicitly relevant to each fishery and jurisdiction.
5. Require the incorporation of specific implementation timeframes on all recommendations, including recommendations that must be implemented prior to exporting being permitted (in addition to formal and robust stock assessments being completed).
6. Require that all these time-bound recommendations are immediately (in light of very slow progress on improvement to date) included, in fully, as conditions of WTOs for all relevant fisheries.
7. Implement Cortes (2016) recommendations for achieving stock assessments which included fishery observer programs to gather crucial fisheries data and biological information; or the undertaking of a fisheries independent survey program and fin clipping to ensure accurate species identification.
8. Require improvements to the traceability system supporting CITES export permits to validate that products from the listed hammerhead species have been harvested in WTO fisheries. In particular the CITES Guidance on this matter should be a considered a significant asset in actioning this requirement.

9. Address the need to improve compliance around the CITES export permit system including clear protocols around triggers for further checks, requirements for random spot checks and other methods which provide surety as to compliance with CITES requirements and Australian export permits. This should be extended also exports of non-CITES listed species to ensure that listed species are not being exported with a permit.

10. Investigate the cause on anomalies in CITES data and implement improvements that will address the incompatibility between the export and import data. If anomalies are due to administrative/systems errors, these should be resolved as a priority to ensure that any illegal activity is clear and apparent with no ability for them to be justified as administrative issues.

11. Include a requirement to publish an annual report on the progress against the NDF conditions including mortality related limits and recommendations and any other prescribed conditions (consideration should also be given to adopting this transparency for all CITES listed species).

12. Take into account the new scientific findings laid out in the report and new findings which will subsequently emerge.

In addition, it is recommended that:

13. The CMS reservation of the three hammerhead shark species be reviewed in the light of the progress against Commonwealth and scientific recommendations; and in the light of uncertainty of stock status due to inadequacies in the quality and quantity of data.

14. A policy be implemented which require a review of CMS reservation decisions at appropriate frequency, suggesting at least every three years.

In 2014, TRAFFIC, together with (German) Federal Agency for Nature Conservation produced a CITES Non-detriment Findings Guidance for Shark Species, A Framework to assist Authorities in making Non-detriment Findings (NDFs) for species listed in CITES Appendix II (updated version 2) (Mundy et al, 2014). This guidance document, provided as a resource on the CITES website, would be a sound basis to approach the consideration of the a new NDF.

REFERENCES

Bloom Association (Hong Kong) in collaboration with the Social Sciences Research Centre of The University of Hong Kong (2015). SURVEY ON SHARK CONSUMPTION HABITS AND ATTITUDES IN HONG KONG. Shark-Sociological-Survey-2015-Press-Kit.pdf (bloomassociation.org)

Braccini, M., Molony, B., and Blay, N. (2019). Patterns in abundance and size of sharks in northwestern Australia: cause for optimism. ICES Journal of Marine Science *77*, 72-82.

Bradshaw, C. J. A., Field, I. C., McMahon, C. R., Johnson, G. J., Meekan, M. G. and Buckworth, R. C. (2013). More analytical bite in estimating targets for shark harvest. Marine Ecology Progress Series 488: 221-232

Broadhurst, Matt & Cullis, Brian. (2019). Mitigating the discard mortality of non-target, threatened elasmobranchs in bather-protection gillnets. Fisheries Research. 222. 105435. 10.1016/j.fishres.2019.105435

Chin, A., Simpfendorfer, C. A., White, W. T., Johnson, G. J., McAuley, R. B., and Heupel, M. R. (2017). Crossing lines: a multidisciplinary framework for assessing connectivity of hammerhead sharks across jurisdictional boundaries. Scientific Reports 7, 46061

CITES (2019) Guidelines for the preparation and submission of CITES annual reports, December 2019. https://www.cites.org/sites/default/files/notif/E-Notif-2019-072-A1.pdf

Cortes (2016) Desk Review of Queensland shark stock assessment for Fisheries Queensland. Self published.

Dalton and Peddemors (2020). Shark Meshing (Bather Protection) Program 2019/20 Annual Performance Report Prepared in accordance with the 2017 Joint Management Agreement and associated Management Plan. Published by NSW Department of Primary Industries. ISSN 1839-0900

Dapp D, Walker T, Huveneers, C and Reina R (2016) "Respiratory mode and gear type are important determinants of elasmobranch immediate and post-release mortality" Fish and Fisheries; Vol 17, Issue:2 pp 507-524.

Denham, J., Stevens, J., Simpfendorfer, C. A., Heupel, M. R., Cliff, G., Morgan, A., Graham, R., Ducrocq, M., Dulvy, N. D, Seisay, M., Asber, M., Valenti, S. V., Litvinov, F., Martins, P., Lemine Ould Sidi, M., Tous, P. and

Department of the Environment Australia (2014). Non-Detriment Finding for the export of shark species listed in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and harvested from Australian waters: Sphyrna lewini - scalloped hammerhead shark; Sphyrna mokarran - great hammerhead shark; Sphyrna zygaena - smooth hammerhead shark; Lamna nasus - porbeagle shark; Carcharhinus longimanus - oceanic whitetip shark.

Department of the Environment and Energy (2017). Analysis of data on Hammerhead Abundance, Distribution and Harvest in Australian Fisheries since Implementation of the 2014 Hammerhead Shark Non-Detriment Finding.

Drew, M., W. T. White, Dharmadi, A. V. Harry, and C. Huveneers. (2015) Age, Growth and Maturity of the Pelagic Thresher Alopias pelagicus and the Scalloped Hammerhead Sphyrna lewini: Age and Growth of Two Large Shark Species. Journal of Fish Biology 86, no. 1 (2015): 333–54.

Ellis, Jim & Phillips, S & Poisson, Francois (2016). A review of capture and post-release mortality of elasmobranchs. Journal of fish biology. 90. 10.1111/jfb.13197

Field, I. C., Buckworth, R. C., Yang, G. J., Meekan, M. G., Johnson, G., Stevens, J. D., Pillans, R. D., McMahon, C. R. and Bradshaw, C. J. A (2012). Changes in size distributions of commercially exploited sharks over 25 years in northern Australia using a Bayesian approach. Fisheries Research 125-126: 262-271

Harry, A.V., Tobin, A.J., Simpfendorfer, C.A., Welch, D.J., Mapleston, A., White, J., Williams, A.J., and Stapley, J. (2011). Evaluating catch and mitigating risk in a multispecies, tropical, inshore shark fishery within the Great Barrier Reef World Heritage Area. Marine and Freshwater Research 62, 710-721.

Heupel, M. R, McAuley, R. B. (2007). Sharks and Rays (Chondrichthyans) in the North-west Marine Region, Final Report to Department of the Environment and Water Resources, National Oceans Office Branch.

Koopman M and Knuckey I (2014). Advice on CITES Appendix II Shark Listings. Department of Sustainability, Environment, Water, Population and Communities.

Leigh, G. M. (2016). 'Stock assessment of whaler and hammerhead sharks (Carcharhinidae and Sphyrnidae) in Queensland. Fisheries Resource Assessment Report, Department of Agriculture and Fisheries, Queensland Government'.

Marshall, L.J., Giles, J.L, and Johnson, G. (2016). Catch composition of a traditional Indonesian shark fishery operating in the MOU Box, northwestern Australia: Results of shark fin identification from Operation Snapshot, May 2015. Report number: 2016 / 001375. Affiliation: Australian Fisheries Management Authority.

McAuley, R. and Simpfendorfer, C. (2003). Catch composition of the Western Australian temperate demersal gillnet and demersal longline fisheries, 1994 to 1999. Fisheries Research Report No. 146, 2003. Published by Department of Fisheries, Perth, Western Australia. November 2003. ISSN: 1035 - 4549 ISBN: 1 877098 36 1

McLoughlin and Eliason (2008). Review of information on cryptic mortality and the survival of sharks and rays released by recreational fishers. Bureau of Rural Sciences, Australian Government. http://data.daff.gov.au/brs/brsShop/data/shark_review_final.pdf

Morgan, A. and G. H. Burgess. 2007. At-Vessel Fishing Mortality for Six Species of Sharks Caught in the Northwest Atlantic and Gulf of Mexico. Gulf and Caribbean Research 19 (2): 123-129. Retrieved from https://aquila.usm.edu/gcr/vol19/iss2/15 DOI: https://doi.org/10.18785/gcr.1902.15

Mundy-Taylor, V., Crook. V., Foster, S., Fowler, S., Sant, G. and Rice, J. (2014). CITES Nondetriment Findings Guidance for Shark Species (2nd, Revised Version). A Framework to assist Authorities in making Non-detriment Findings (NDFs) for species listed in CITES Appendix II. Report prepared for the Germany Federal Agency for Nature Conservation

Rayns, N. (2019). Review of management arrangements that support the Conservation Dependent listing of Scalloped Hammerhead shark (Sphyrna lewini) under the EPBC Act. FutureCatch Consulting

Roff G, Brown C, Priest M and Mumby P (2018) Decline of coastal apex shark populations over the past half century. Communications Biology 1:223. Simpfendorfer C, Chin A, Kyne P, Rigby C, Sherman S and White W (2019) A Report Card for Australia's Sharks.

Simpfendorfer, C, A., de Jong, S, K. and Sumpton, W. (2011). Long-term trends in large shark populations from inshore areas of the Great Barrier Reef World Heritage Area: results from the Queensland Shark Control Program. MTSRF Transition Program Project Report.

Simpfendorfer, C, A. (2014) Information for the development of Non-Detriment Findings for CITES listed. Report to Department of the Environment.

Wakefield, C.B., Santana-Garcon, J., Dorman, S.R., Blight, S., Denham, A., Wakeford, J., Molony, B.W., Newman, S.J. (2017). Performance of bycatch reduction devices varies for chondrichthyan, reptile, and cetacean mitigation in demersal fish trawls: Assimilating subsurface interactions and unaccounted mortality. ICES Journal of Marine Science 74:343–358.

Welch, D.J. (2020). Review of management arrangements that support the Conservation Dependent listing of Scalloped Hammerhead shark (Sphyrna lewini) under the EPBC Act Update report to the Threatened Species Scientific Committee.

WildAid (2014). Evidence of declines in shark fin demand: China. Technical Report. https://www.researchgate.net/publication/282568010_Evidence_of_declines_in_shark_fin_demand_China/link/5612319008ae4833751bd70e/download

APPENDIX 1 - GENERIC RECOMMENDATIONS OF THE NDF & RESPONSES RECEIVED FROM FISHERIES AGENCIES

Recommendation	Comment
Determine the extent of Illegal, Unregulated and Unreported (IUU) catch	COMWLTH – **Not implemented.** See fishery specific responses. QLD – **Not implemented.** QDAF do not collate specific data on illegal catch of shark species subject to the NDF. None of the species in the NDF have any significant domestic commercial value so it is unlikely that any significant illegal take is occurring in Queensland waters. NT – **Implemented.** Information provided at: - Marshall L, Giles J, Johnson G. (2016). Catch composition of a traditional Indonesian shark fishery operating in the MOU Box, northwestern Australia: Results of shark fin identification from Operation Snapshot. - Salini, J., Edgar, S., Jarrett, R., Xunguo, L., Pillans, R., Toscas, P., You-Gan, W. (2007). Estimating reliable foreign fishing vessel fishing effort from coastwatch surveillance and apprehension data. AFMA Project Number 2006/819. WA - **Not implemented.** DPIRD scientists are working on reconstructed catch estimates for IUU fishing of shark species in WA, due for publishing in 2021. NSW – **Not implemented.** VIC - **Presume not implemented.** VIC provided information on all measures and this was not included. JM: Low level take. SA - **Presume not implemented.** SA provided information on all measures and this was not included. JM: Low level take. TAS - **Presume not implemented.** TAS provided information on all measures and this was not included. JM: Low level take.
Require fins naturally attached	COMWLTH – **Implemented.** QLD – **Partially implemented**. Implemented for the east coast, not for the Gulf of Carpentaria. NT – **Implemented.** WA – **Not implemented.** NSW – **Implemented**. Requirements to prohibit finning and land sharks with fins attached are set out in Section 20B of the Fisheries Management Act 1994 and Clause 90 of the Fisheries Management (General) Regulation 2019. VIC – **Implemented.** It is mandatory to land any shark with the fins attached. SA – **Implemented.** Regulation 18 of the Fisheries Management (General) Regulations 2017 TAS – **Implemented.** All shark must have the fins attached to the body of the shark when landed. This applies to both commercial and recreational fishers.
Require some level of species-specific reporting	COMWLTH – **Implemented.** QLD – **Implemented.** NT – **Implemented.** WA – **Not implemented.** Hammerheads are currently grouped under a general reference in the logbooks. DPIRD is trialling an e-logbook system in selected fisheries, with a plan to roll the system out across the broader suite of fisheries. NSW – **Implemented.** Species specific reporting is available for the Shark Meshing Program and for commercial harvest and interactions with protected (TEPS) species in commercial logbooks and online reporting systems. VIC – **Not implemented.** Vic fisheries mostly deals with school and gummy shark. The catch data shows the catch for other species is minimal. Don't identify by species lower than 'Hammerhead'. SA – **Implemented.** The Smooth hammerhead (Sphyrna zygaena) is the only species from the Family Sphyrnidae found in South Australian waters. Hence, any fishery data on 'hammerheads' are assumed to represent catches of this species. TAS - **Implemented.** Commercially caught and retained shark (bycatch) must be recorded in the Commercial Catch, Effort and Disposal book. All catch is recorded at a species level using standard fish names.

Fisheries that target shark species and catch these sharks as bycatch/byproduct should consider implementing the recording of sex and total lengths once trigger points are reached	COMWLTH – **Presumed not implemented.** QLD – **Not implemented.** NT – **Not implemented.** WA – **Not implemented.** NSW – Mostly **Implemented.** Implemented in the Shark Meshing Program. Catches are monitored against the TACC associated with conditions of approved wildlife trade operation for the fishery (currently 110t for specified species, including species other than CITES species). The current weekly trip limit closure provides a trigger of 70t (all defined species) for further action. Catches have not reached the trigger or TACC over time. Reported catches of CITES species are negligible . CITES species are not targeted catch in other fisheries. Implemented in the Shark Meshing Fishery. Not implemented in charter. VIC - **Presume not implemented.** VIC provided information on all measures and this was not included. JM: Low level take. SA - **Presume not implemented.** SA provided information on all measures and this was not included. JM: Low level take. TAS - **Presume not implemented.** TAS provided information on all measures and this was not included. JM: Low level take.
Require identification to species level required for exporting businesses	COMWLTH – Presumed n**ot implemented.** QLD – **Presumed not implemented.** NT – **Presumed not implemented.** WA – **Not implemented.** NSW – **Implemented.** Species specific reporting is required for commercial harvest through commercial logbooks and online reporting systems. Records of sale must identify species and quantity of fish sold, providing supply chain identification through exporting businesses. NSW – **Implemented.** Species specific reporting is required for commercial harvest through commercial logbooks and online reporting systems. Records of sale must identify species and quantity of fish sold, providing supply chain identification through exporting businesses. Not applicable to the Shark Meshing Program VIC - **Presume not implemented.** VIC provided information on all measures and this was not included. JM: Low level take. SA - **Presume not implemented.** SA provided information on all measures and this was not included. JM: Low level take. TAS – **Implemented.** Commercially caught and retained shark (bycatch) must be recorded in the Commercial Catch, Effort and Disposal book. All catch is recorded at a species level using standard fish names.
Require recording of bycatch, discards and health status	COMWLTH - **Partially implemented.** Discards recorded, health status not. QLD - **Implemented.** Commercial operators are required to report all shark interactions through a dedicated Shark & Ray logbook. This requirement has been in effect since commenced in July 2009. A more recent version of the logbook, implemented from 1 January 2018 includes avenues for fishers to report shark discards. NT – **Partially implemented.** Discards recorded, health status not. WA – **Not implemented.** Data on discarded commercial catch estimates of sharks are not currently available. As discussed above, reconstructed catch estimates of discarded commercial catch of sharks will be published in 2021. NSW - **Partially implemented.** Retained bycatch is reported through Catch and Effort reporting system. Interactions with protected species (Great & Scalloped Hammerhead) required to be reported through TEPS reports available in commercial logbooks and online reporting systems. Implemented in Shark Meshing Program. Retained bycatch is reported through Catch and Effort reporting system. Interactions with protected species (Great & scalloped Hammerhead) required to be reported through TEPS reports available in commercial logbooks and online reporting systems. VIC - **Presume not implemented.** VIC provided information on all measures and this was not included. JM: Low level take. Protected species reporting in Vic only covers great white, grey nurse and mako sharks. SA – **Not implemented.** There are no fishery discard data available for the period between 2013 and 2019. TAS – **Not implemented.** Data collection meets minimum national data collection standards. Catch and effort returns are currently under review to facilitate move to electronic reporting. This may potentially include discard reporting for the Scalefish Fishery.

Implement individual catch limits for each of the listed species	COMWLTH – **Not implemented.** No change – catch of these sharks is minimal (one scalloped hammerhead reported for the period 2014-2020). QLD – **Partially implemented.** The take Hammerhead sharks on the Queensland east coast managed under quotas and trigger rules based on the NDF. Trip possession limits apply for commercial line and net fishers who do not hold an "S" symbol. NT – **Implemented**. Trip limits in place for Hammerhead shark refer to Management Framework https://dpir.nt.gov.au/__data/assets/pdf_file/0017/620432/mgt-arranagements-offshore-netline-fishery.pdf WA **- Not implemented.** No trip limits have been implemented for the five species in the TDGDLF. With the level of catch of the five species in WA considered low/non-existent, trip limits for specific species within the individual fisheries are unlikely to provide any material benefit. NSW - **Partially implemented.** Harvest of Scalloped and Great Hammerhead sharks is prohibited under the Fisheries Management Act 1994. Harvest of Smooth hammerhead, Porbeagle and Oceanic Whitetip sharks is restricted by weekly trip limits: https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/639778/Section-8-Notification-Conditions-for-taking-certain-shark-species-harvested-in-the-Ocean-Trap-and-Line-Fishery-February-2017.pdf. Not applicable to the SHARK MESHING PROGRAM VIC – **Implemented.** For all species of shark other than gummy and school there is catch limit of 1 per trip and this is for all shark other than gummy/school. SA – **Not implemented.** Given the low level of catch (below), implementation of a trip limits and a maximum size limit have not been investigated. TAS – **Implemented.** Strict bycatch regulations limit the amount of shark (all species including rays) that can be taken in State waters by commercial fishers who do not hold a Commonwealth shark net and/or shark hook authority and a Tasmanian Coastal Waters Permit. The commercial trip limit is five (5) shark (species combined).
Maximum size limits for retained sharks	COMWLTH – **Not implemented.** No change – catch of these sharks is minimal (one scalloped hammerhead reported for the period 2014-2020). QLD - **Implemented** (http://era.daf.qld.gov.au/id/eprint/6969/1/ERA%20-%20ECIFFF%20Level%201%20[2019].pdf) NT – **Not implemented.** No maximum size limits have been introduced into the fishery as there are very few mature animals caught. The majority of Hammerhead sharks caught in the gillnet component of the fishery are likely mainly juvenile with some mature males. Hammerhead sharks have very high post release mortality and the implementation of rules which would require fishers to release any mature sharks would be largely ineffectual and a poor management tool for Hammerhead sharks. WA - **Presume not implemented.** WA provided information on measures and this was not included. NSW - **Not implemented.** Weekly trip limits are established to provide further protection to sharks and monitoring is conducted against conditions of approved wildlife trade operations and the trip limit closure. Implementing maximum size limits may be considered in the future, noting current negligible reported catch of CITES species. VIC - **Presume not implemented.** VIC provided information on all measures and this was not included. JM: Low level take. SA - **Not implemented.** Given the low level of catch (below), implementation of a trip limits and a maximum size limit have not been investigated. TAS – **Not implemented.** As Tasmania does not have a dedicated shark fishery and report zero (0) catch of the above species, therefore it is unlikely that a maximum size limit would be introduced.
Where bycatch exceeds trip limits, implement further measures to protect sharks such as banning of wire traces and safe handling practices	COMWLTH – **Not implemented.** No change – catch of these sharks is minimal (one scalloped hammerhead reported for the period 2014-2020). QLD – **Partially implemented.** NT – **Implemented.** While no further specific measures are in place, there are no permitted exceptions to the trip limit. WA – **Presume not implemented.** WA provided information on measures and this was not included. NSW – **Implemented.** Exceeding established trip limits is prohibited, and further measures are established to protect sharks. Restrictions on the number of hooks and/or setlines are in place in the Ocean Trap and Line Fishery, with respective limits applied to waters inside and outside 3nm. Wire traces are banned on bottom set lines used in waters inside 3nm. Setline hooks must be circle hooks and non-offset in waters >3nm to minimise discard mortality. Handling practices prohibit use of knives, spikes, clubs or similar implements to injure non-retained catch. Not applicable to the Shark Monitoring Program. VIC - **Presume not implemented.** VIC provided information on all measures and this was not included. JM: Low level take.

	SA – **Implemented.** Measures include: Prohibited from using wire trace with a gauge of 2 mm or greater in conjunction with fishing hooks greater than a size 12/0 at any time. Restricted on the usage and length of mesh nets. Limited on the number of hooks that can be used on long lines. TAS – **Implemented.** The Scalefish Fishery Management Plan—which came into force on 1 November 2015 contained legislation that: Introduced new and/or extended existing "no gillnetting" areas; Introduced a reduction of hook numbers on recreational set lines from 30 hooks to 15 hooks; Prevent the use of burley for any purpose other than fishing; Reduced recreational catch limits for mako and blue shark were also implemented. The possession limit of 2 remains, however the boat limit is now 2 — where previously up to 5 mako shark could be possessed in a boat. There has been no further change to the management of this fishery. Tasmania continues to support research/stock assessments that will allow for the review of the effectiveness of current management measures.

APPENDIX 2 - DETAILED RESPONSES TO FISHERY SPECIFIC 2014 NDF RECOMMENDATIONS

Content included in the "Recommendation" column is that included in the original 2014 NDF document.
Content include in the "Progress & Comment" column is that provided from the management authorities and CITES Australian Scientific Authority
The coloured categories of progress have been assigned by the author, based on a review of reported implemented against the recommendations, according to the following categories

- **Implemented** – the recommendation has been implemented
- **Not implemented** – the recommendation has not been implemented
- **Presumed not implemented** – the management authority has not specifically advised of any activity against the recommendation; presumption is that no action has occurred.
- **Partially implemented** – some progress has been made, but the recommendation is not fully implemented, with no indication of plans to fully implement
- **In progress** – the recommendation is being actively implemented and there is a stated intention and/or plan to complete its implementation
- **Not applicable** – the fishery has been closed since the 2014 NDF, or the management action is not possible due to the species' being no take, hence the recommendation is not currently applicable

Table A.1 Commonwealth Fisheries

Recommendation	Progress & Comments
Commonwealth Western Tuna and Billfish Fishery	
2.10 An estimate of the annual catch of each of the five species of interest by IUU fishing is required. This was done across all of northern Australia (Marshall 2011) but needs to be disaggregated to fishery level. 2.19 Only slight improve needed in reporting to species level in commercial logbooks. 2.20 Improve reporting of shark to species level and shark weight in observer records	**Presumed not implemented.** **Implemented.** Species ID through e-monitoring has improved following implementation. Species ID for sharks that remain in the water is difficult and leaving sharks in the water to release them is best practice for survivability. **Presumed partially implemented.** No comment from AFMA on weights in observer data.
Commonwealth –Western Deepwater Trawl Fishery	

2.14 Implement trigger limits for the five shark species of interest.	**Not implemented.** No change – catch of these sharks is minimal, if at all (no interactions reported for the period 2014-2020).
2.26 Implement catch limits or trip limits for the listed shark species and potentially implement maximum size limits to ensure stricter protection of a portion of the mature shark population.	**Not implemented.** As above.
Commonwealth North West Slope Trawl Fishery	
2.10 An estimate of the annual catch of each of the five species of interest by IUU fishing is required. This was done across all of northern Australia (Marshall 2011) but needs to be disaggregated to fishery level.	**Not implemented.** No change – catch of these sharks is minimal, if at all (no interactions reported for the period 2014-2020).
2.14 Implement trigger limits for the five shark species of interest.	**Not implemented.** As above.
2.20 Improve reporting of shark to species level in observer records.	**Not implemented.** As above.
2.26 Implement catch limits or trip limits for the listed shark species and potentially implement maximum size limits to ensure stricter protection of a portion of the mature shark population.	**Not implemented.** As above.
Commonwealth – Torres Strait Prawn Fishery	
2.10 An estimate of the annual catch of each of the five species of interest by IUU fishing is required. This was done across all of northern Australia (Marshall 2011) but needs to be disaggregated to fishery level	**Not implemented.** No change – catch of these sharks is minimal, if at all (no interactions reported for the period 2014-2020). Compulsory Turtle Exclusion devices so all large specimens are excluded. No juveniles have been recorded in observer samples.
2.20 Improve reporting of shark to species level in observer records, and require reporting of discards of sharks in commercial logbooks.	**Not implemented.** As above.
Commonwealth Southern and Eastern Scalefish and Shark Fishery (multiple sectors)	
2.14 Implement catch or trip limits for the five shark species of interest.	**Not implemented.** No catch or trip limits have been implemented for the five shark species of interest as catches are not considered to be significant: - Scalloped Hammerhead (Sphyrna lewini) – minimal quantities of this species were reported in the gillnet and otter board trawl (CTS) sectors in 2015, 2019 and 2020. - Great Hammerhead (S. mokarran) – nil. - Smooth Hammerhead (S. zygaena) – small amounts have been caught between 2014 to the present. The majority was caught in the gillnet sector. - Porbeagle (Lamna nasus) – catch of this species have remained low since 2014. The majority was caught in the automatic longline sector.

2.20 Improve reporting of shark to species level in observer records. Check on the correct identification of shark species in commercial logbook data	- Oceanic Whitetip (Carcharhinus longimanus) – minimal quantities of this species was reported in the Danish seine and otter board trawl (CTS) sectors in 2019 and 2020. **Presumed not implemented.** Revised Ecological Risk Assessments (ERAs) have been conducted for the otter board trawl (CTS and GABTS), Danish seine, gillnet sectors of the SESSF in 2019: - Scalloped Hammerhead was assessed as low risk in the otter board trawl (CTS). This species was not assessed in the gillnet sector due to nil catch in the period assessed (2012-2016). - Great Hammerhead were not assessed due to nil catch in the period assessed (2012-2016). - Smooth Hammerhead was assessed as low risk in the Danish seine, otter board trawl (CTS) and gillnet sectors. - Porbeagle was assessed as low risk in the otter board trawl (CTS) and gillnet sectors. - Oceanic Whitetip were not assessed due to nil catch in the period assessed (2012-2016). - Revised ERAs for the manual and automatic longline sectors are currently being undertaken, the most recent ERA (2014) did not assess any of the five species of interest. AFMA are currently updating Bycatch and Discarding Workplans (the Workplans) for the otter board trawl, Danish seine and gillnet sectors of the SESSF. While these species have not been identified as high risk in the respective ERAs, AFMA has committed to referencing the five species in the Workplans and will include actions to ensure species identification by observers and in commercial logbooks is accurate.
2.26 Implement catch limits or trip limits for the listed shark species and potentially implement maximum size limits to ensure stricter protection of a portion of the mature shark population.	**Presumed not implemented.** While there is no catch or trip limits for these shark species, in accordance with the SESSF Management Plan, an operator must return any live shark listed as migratory under the EPBC Act to the water unharmed – this currently applies to Porbeagle and Oceanic Whitetip sharks.
Commonwealth – Northern Prawn Fishery	
2.10 An estimate of the annual IUU catch of each of the five species of interest by IUU fishing is required. This was done across all of northern Australia (Marshall 2011) but may require a specific project to identify species (mostly by fins) on seized vessels.	**Not implemented.**

2.20 Improve reporting of shark to species level in observer records, and require reporting of discards of sharks in commercial logbooks.	**Not implemented.** No change – catch of these sharks is minimal, if at all (no interactions reported for the period 2014-2020). Compulsory Turtle Exclusion devices so all large specimens are excluded. No juveniles have been recorded in observer samples.
Commonwealth – Eastern Tuna and Billfish Fishery	
2.20 Improve reporting of hammerhead shark to species level in observer records	**Implemented.** Species ID through e-monitoring has improved following implementation. Species ID for sharks that remain in the water is difficult and leaving sharks in the water to release them is best practice for survivability.
Commonwealth Coral Sea (multi-sector)	
2.10 An estimate of the annual catch of each of the 5 species of interest by IUU fishing is required. This was done across all of northern Australia (Marshall 2011) but needs to be disaggregated to fishery level.	**Not implemented.** No change – catch of these sharks is minimal (one scalloped hammerhead reported for the period 2014-2020).
2.14 Quotas are not appropriate for infrequently caught byproduct/ bycatch species, but trip limits or catch triggers for the five listed shark species could be implemented.	**Not implemented.** As above.
2.20 Observer data on retained and discarded shark species should be identified down the species level. Commercial logbook data is generally identified to species level for hammerheads but whalers and weasel sharks are often grouped but any Oceanic Whitetip Sharks should be specifically identified (there was none apparent in the observer data).	**Not implemented.** As above.
2.26 A maximum size limit could be implemented to ensure stricter protection of a portion of the mature population	**Not implemented.** As above.
Commonwealth Australian High Seas Fisheries	
2.10 An estimate of the annual catch of each of the five species of interest by IUU fishing is required.	**Not implemented.** No change - catch of these sharks is minimal or nil: - Scalloped Hammerhead (Sphyrna lewini) – nil. - Great Hammerhead (S. mokarran) - nil. - Smooth Hammerhead (S. zygaena) - minimal quantities of this species was reported as discarded in logbooks in 2016 and 2017. - Porbeagle (Lamna nasus) – nil. - Oceanic Whitetip (Carcharhinus longimanus) - minimal quantities of this species was reported as retained in logbooks in 2018 (SIOFA and SPRFMO area of waters). Given the weights of the individual animals, and gear used (demersal longline), these records are

	believed to be a coding error (likely to be Whitetip Reef Sharks, based on logbook and landings data for the trips in question) – AFMA is undertaking further verification.
2.14 Quotas are not appropriate for infrequently caught byproduct/ bycatch species, but trip limits or catch triggers for the five listed shark species could be implemented.	**Not implemented.** As above.
2.26 A maximum size limit could be implemented for the non-trawl sector to ensure stricter protection of a portion of the mature population.	**Not implemented.** As above.

Table A.2 Queensland Fisheries

Recommendation	Progress & Comment
Queensland – River and Inshore Beam Trawl Fishery	
2.10 Estimate IUU catch	**Not implemented.** QDAF do not collate specific data on illegal catch of shark species subject to the NDF. None of the species in the NDF have any significant domestic commercial value so it is unlikely that any significant illegal take is occurring in Queensland waters.
2.19 Provide facility to report discards in commercial logbooks.	**Implemented.** Commercial operators are required to report all shark interactions through a dedicated Shark & Ray logbook. This requirement has been in effect since commenced in July 2009. A more recent version of the logbook, implemented from 1 January 2018 includes avenues for fishers to report shark discards.
2.20 Improve species identification of observers. Required estimation of weight in observer records.	**In progress.** No on-board observer program is in place in Queensland. Various programs to improve data validation across fisheries are being developed and implemented as part of the Queensland Sustainable Fisheries Strategy 2017 – 2027
Queensland Gulf of Carpentaria Inshore Fin Fish Fishery	
2.10 An estimate of the annual catch of each of the five species of interest by IUU fishing is required. This was done across all of northern Australia (Marshall 2011) but needs to be disaggregated to fishery level.	**Not implemented.** QDAF do not collate specific data on illegal catch of shark species subject to the NDF. None of the species in the NDF have any significant domestic commercial value so it is unlikely that any significant illegal take is occurring in Queensland waters. Licenced commercial operators in Queensland are required to report all shark interactions through a dedicated Shark & Ray logbook. This requirement has been in effect since commenced in July 2009. A more recent version of the logbook, implemented from 1 January 2018 includes avenues for fishers to report shark discards.

2.14 Quotas are not appropriate for infrequently caught byproduct/ bycatch species, but trip limits or catch triggers for the five listed shark species could be implemented.	**Implemented.** The take Hammerhead sharks in the Gulf of Carpentaria is managed under quotas and trigger rules based on the NDF.
2.19 Provide facility to report discards in commercial logbooks.	**Implemented.** Commercial operators are required to report all shark interactions through a dedicated Shark & Ray logbook. This requirement has been in effect since commenced in July 2009. A more recent version of the logbook, implemented from 1 January 2018 includes avenues for fishers to report shark discards.
2.20 Improve reporting of shark weight in observer records.	**Not implemented.** No on-board observer program is in place in Queensland. Various programs to improve data validation across fisheries are being developed and implemented as part of the Queensland Sustainable Fisheries Strategy 2017 – 2027.
Queensland Gulf of Carpentaria Developmental Fin Fish Trawl Fishery	
2.10 An estimate of the annual catch of each of the five species of interest by IUU fishing is required. This was done across all of northern Australia (Marshall 2011) but needs to be disaggregated to fishery level.	**Not implemented.** QDAF do not collate specific data on illegal catch of shark species subject to the NDF. None of the species in the NDF have any significant domestic commercial value so it is unlikely that any significant illegal take is occurring in Queensland waters.
2.20 Improve reporting of shark weight in observer records.	**Not implemented.** No on-board observer program is in place in Queensland. Various programs to improve data validation across fisheries are being developed and implemented as part of the Queensland Sustainable Fisheries Strategy 2017 – 2027
Queensland Fin Fish (Stout Whiting) Trawl Fishery	
2.19 Provide facility to report discards in commercial logbooks.	**Implemented.** Commercial operators are required to report all shark interactions through a dedicated Shark & Ray logbook. This requirement has been in effect since commenced in July 2009. A more recent version of the logbook, implemented from 1 January 2018 includes avenues for fishers to report shark discards.
2.20 Improve reporting of shark weight in observer records	**Not implemented.** No on-board observer program is in place in Queensland. Various programs to improve data validation across fisheries are being developed and implemented as part of the Queensland Sustainable Fisheries Strategy 2017 – 2027
Queensland East Coast Spanish Mackerel Fishery	
2.10 An estimate of the annual catch of each of the five species of interest by IUU fishing is required. This was done across all of northern Australia (Marshall 2011) but needs to be disaggregated to fishery level.	**Not implemented.** QDAF do not collate specific data on illegal catch of shark species subject to the NDF. None of the species in the NDF have any significant domestic commercial value so it is unlikely that any significant illegal take is occurring in Queensland waters. AFMA and or the Australian border forces may be able to provide

	further information regarding any Illegal foreign fishing vessels operating in northern Australian waters.
2.14 Quotas are not appropriate for infrequently caught byproduct/ bycatch species, but trip limits or catch triggers for the five listed shark species could be implemented.	**Not applicable.** Sharks are no-take species in this fishery.
2.19 Provide facility to report shark species and discards in commercial logbooks.	**Implemented.** Commercial operators are required to report all shark interactions through a dedicated Shark & Ray logbook. This requirement has been in effect since commenced in July 2009. A more recent version of the logbook, implemented from 1 January 2018 includes avenues for fishers to report shark discards.
Queensland East Coast Otter Trawl Fishery	
2.10 An estimate of the annual catch of each of the five species of interest by IUU fishing is required. This was done across all of northern Australia (Marshall 2011) but needs to be disaggregated to fishery level.	**Not implemented.** QDAF do not collate specific data on illegal catch of shark species subject to the NDF. None of the species in the NDF have any significant domestic commercial value so it is unlikely that any significant illegal take is occurring in Queensland waters.
2.19 Provide facility to report discards in commercial logbooks.	**Implemented.** Commercial operators are required to report all shark interactions through a dedicated Shark & Ray logbook. This requirement has been in effect since commenced in July 2009. A more recent version of the logbook, implemented from 1 January 2018 includes avenues for fishers to report shark discards.
2.20 Improve reporting of shark weight in observer records	**Not implemented.** No on-board observer program is in place in Queensland. Various programs to improve data validation across fisheries are being developed and implemented as part of the Queensland Sustainable Fisheries Strategy 2017 – 2027
Queensland East Coast Inshore Fin Fish Fishery	
2.10 An estimate of the annual catch of each of the five species of interest by IUU fishing is required. This was done across all of northern Australia (Marshall 2011) but needs to be disaggregated to fishery level.	**Not implemented.** QDAF do not collate specific data on illegal catch of shark species subject to the NDF. None of the species in the NDF have any significant domestic commercial value so it is unlikely that any significant illegal take is occurring in Queensland waters.
2.14 Implement trip limits for the listed shark species by licence with an S symbol.	**Implemented.** The take Hammerhead sharks on the Queensland east coast managed under quotas and trigger rules based on the NDF. Trip possession limits apply for commercial line and net fishers who do not hold an "S" symbol
2.19 Improve reporting to species level and provide facility to report discards in commercial logbooks.	**Implemented.** Commercial operators are required to report all shark interactions through a dedicated Shark & Ray logbook. This requirement has been in effect since

2.20 Improve reporting of shark weight in observer records	commenced in July 2009. A more recent version of the logbook, implemented from 1 January 2018 includes avenues for fishers to report shark discards. **Not implemented.** No on-board observer program is in place in Queensland. Various programs to improve data validation across fisheries are being developed and implemented as part of the Queensland Sustainable Fisheries Strategy 2017 – 2027
Queensland Coral Reef Fin Fish Fishery	
2.10 An estimate of the annual catch of each of the five species of interest by IUU fishing is required. This was done across all of northern Australia (Marshall 2011) but needs to be disaggregated to fishery level.	**Not implemented.** QDAF do not collate specific data on illegal catch of shark species subject to the NDF. None of the species in the NDF have any significant domestic commercial value so it is unlikely that any significant illegal take is occurring in Queensland waters.
2.14 Quotas are not appropriate for infrequently caught byproduct/ bycatch species, but trip limits or catch triggers for the five listed shark species could be implemented.	**Not applicable.** Sharks are no-take species in this fishery. Shark product retained on the Queensland east coast is managed as part of the ECIFFF
2.19 Improve reporting to species level and provide facility to report discards in commercial logbooks.	**Implemented.** Commercial operators are required to report all shark interactions through a dedicated Shark & Ray logbook. This requirement has been in effect since commenced in July 2009. A more recent version of the logbook, implemented from 1 January 2018 includes avenues for fishers to report shark discards.
2.20 Improve reporting of shark to species level and shark weight in observer records.	**Not implemented.** No on-board observer program is in place in Queensland. Various programs to improve data validation across fisheries are being developed and implemented as part of the Queensland Sustainable Fisheries Strategy 2017 – 2027
2.26 Implement trip limits for the listed shark species and potentially implement maximum size limits to ensure stricter protection of a portion of the mature shark population.	**Not applicable.** N/A as sharks are no-take species in this fishery.

Table A.3 Northern Territory Fisheries

Recommendation	Progress & Comment
Barramundi Fishery	
2.19 Improve reporting to species level in commercial logbooks and include discard weights.	**Presumed not implemented.** **Implemented.** Required estimation of weight in observer records

2.20 Improve reporting of shark to species level and shark weight in observer records. 2.26 Potentially implement maximum size limit for Smooth Hammerhead, Oceanic Whitetip Shark or Porbeagle Shark.	**Presumed not implemented.**
Northern Territory Demersal Fishery (DF) – multi sector that now includes the original Finfish Trawl and Demersal Fisheries	
2.10 Estimate IUU catch	**Implemented.** Estimated to be near zero levels in recent years. More information at: ● Marshall L, Giles J, Johnson G. (2016). Catch composition of a traditional Indonesian shark fishery operating in the MOU Box, northwestern Australia: Results of shark fin identification from Operation Snapshot. ● Salini, J., Edgar, S., Jarrett, R., Xunguo, L., Pillans, R., Toscas, P., You-Gan, W. (2007). Estimating reliable foreign fishing vessel fishing effort from coastwatch surveillance and apprehension data. AFMA Project Number 2006/819.
2.20 Improve reporting to species level in both logbooks and by observers.	**Implemented.** Onboard observer program complemented by: ● Implementation of electronic monitoring program (cameras) which reviews 100% of TEPS Interactions and identifies Hammerhead sharks to species level. ● Development of Identification sheets and a Threatened, Endangered and Protected Species Guide for the Northern Territory to support fishers to more accurately identify Hammerhead shark species.
Northern Territory Offshore Net and Line Fishery	
Develop performance measures for Hammerheads. 2.10 An estimate of the annual catch of each of the five species of interest by IUU fishing is required. This was done across all of northern Australia (Marshall 2011) but needs to be disaggregated to fishery level. 2.14 and 2.18 Implement trip limits for the listed shark species	**Implemented.** New Management Framework Introduced in December 2018 • The ONLF Management Framework introduced the objective to maintain catches of large sharks (which includes Hammerhead sharks) at sustainable levels and to ensure fishing impacts do not result in serious or irreversible harm to TEPS populations • The performance indicators in the Harvest Strategy include: - Target TACC- Cease all fishing activity within one month of notification **Implemented.** Estimated to be near zero levels in recent years. More information at: ● Marshall L, Giles J, Johnson G. (2016). Catch composition of a traditional Indonesian shark fishery operating in the MOU Box, northwestern Australia: Results of shark fin identification from Operation Snapshot. ● Salini, J., Edgar, S., Jarrett, R., Xunguo, L., Pillans, R., Toscas, P., You-Gan, W. (2007). Estimating reliable foreign fishing vessel fishing effort from coastwatch surveillance and apprehension data. AFMA Project Number 2006/819.

2.18 Require landing with of sharks with fins naturally attached 2.19 Remove generic group reference and improve reporting to species level in commercial logbooks. 2.20 Improve reporting of shark to species level and shark weight in observer records. 2.26 Implement trip limits for the listed shark species. and potentially implement maximum size limits to ensure stricter protection of a portion of the mature shark population.	**Implemented.** Trip limits implemented, refer to Management Framework - https://dpir.nt.gov.au/__data/assets/pdf_file/0017/620432/mgt-arranagements-offshore-netline-fishery.pdf **Implemented.** Requirement implemented, refer to Management Framework – https://dpir.nt.gov.au/__data/assets/pdf_file/0017/620432/mgt-arranagements-offshore-netline-fishery.pdf **Implemented.** Electronic and paper logbooks require Hammerhead sharks to be reported to the species level. Individual species reporting of Scalloped and Great Hammerhead sharks is mandatory on all ONLF Catch Disposal Records (CDR). refer to Management Framework - https://dpir.nt.gov.au/__data/assets/pdf_file/0017/620432/mgt-arranagements-offshore-netline-fishery.pdf **Implemented.** Onboard observer program complemented by: o Implementation of electronic monitoring program (cameras) which reviews 100% of TEPS Interactions and identifies Hammerhead sharks to species level. o Development of Identification sheets and a Threatened, Endangered and Protected Species Guide for the Northern Territory to support fishers to more accurately identify Hammerhead shark species. **Implemented.** Trip limits in place for Hammerhead shark refer to Management Framework https://dpir.nt.gov.au/__data/assets/pdf_file/0017/620432/mgt-arranagements-offshore-netline-fishery.pdf **Not implemented.** No maximum size limits have been introduced into the fishery as there are very few mature animals caught. The majority of Hammerhead sharks caught in the gillnet component of the fishery are likely mainly juvenile with some mature males. Hammerhead sharks have very high post release mortality and the implementation of rules which would require fishers to release any mature sharks would be largely ineffectual and a poor management tool for Hammerhead sharks.

Table A.4 Western Australian Fisheries

Recommendation	Progress & Comments
Kimberley gillnet and barramundi fishery (KGBF)	

2.10 An estimate of the annual IUU catch of Great Hammerhead, Scalloped Hammerhead and Ocean Whitetip Shark within the boundary of this fishery is required.	**In progress.** DPIRD scientists are currently working on reconstructed catch estimates for IUU fishing of shark species in WA. This work is due to be published in 2021.
2.14 Implement trip limits for the five shark species of interest.	**Not implemented.** No trip limits have been implemented for the five species in the KGBF. With the level of catch of the five species in WA considered low/non-existent, trip limits for specific species within the individual fisheries are unlikely to provide any material benefit.
2.19 Provide facility to report discards in commercial logbook data.	**Not implemented.** Currently there are no specific requirements to report discarded catch in the logbooks. However, operators are required to record all protected species interactions including if the animal was released. DPIRD is currently trialling an e-logbook system in selected fisheries, with a plan to roll the system out across the broader suite of fisheries following the successful completion of this pilot project. The e-logbook system has the capacity for more refined reporting of discarded catch and protected species interactions. DPIRD scientists are currently working on reconstructed catch estimates of discarded commercial catches of shark species in WA. This work is due to be published in 2021.
2.20 Collect more recent observer data to describe species composition of the catch and discards.	**Implemented.** DPIRD recently ran an observer program (2017-2019) in the KGBF. Observer data was primarily collected for stock assessment purposes and to identify potential bycatch of protected species. The data analysis showed that hammerhead sharks are a negligible component of catch in the KGBF. Operators are required to record all protected species interactions in the KGBF logbooks including if the animal was released, the species, location of incident and health post interaction. DPIRD developed a Field identification guide to Western Australian Sharks and Shark-like Rays to assist with better species identification including guidelines for each of the great hammerhead, scalloped hammerhead and winged hammerhead shark species. The

	guide can be found: https://www.fish.wa.gov.au/Documents/occasional_publications/fop001.pdf
Ensure any catch of the five species of interest is reported at species level in the logbooks.	**Implemented-** Operators are required to record all protected species interactions in the KGBF logbooks including if the animal was released, the species, location of incident and health post-interaction. DPIRD developed a *Field identification guide to Western Australian Sharks and Shark-like Rays* to assist with better species identification including guidelines for each of the great hammerhead, scalloped hammerhead and winged hammerhead shark species. The guide can be found: https://www.fish.wa.gov.au/Documents/occasional_publications/fop001.pdf
2.26 Implement trip limits for the five shark species of interest, as well as maximum size limits.	**Not implemented.**
Northern shark fishery (NSF)	
2.10 An estimate of the annual catch of each of the five species of interest by IUU fishing is required. This was done across all of northern Australia (Marshall 2011) but needs to be disaggregated to fishery level.	**Not applicable.** No recent updates against the recommendations for the NSF because: (1) No fishing has occurred in the Joint Authority Northern Shark Fishery since 2008 when the WTO was revoked. (2) No fishing in the WA North Coast Shark Fishery since 2009 when the WTO lapsed. (3) The waters of the WA North Coast Shark Fishery are currently closed with the expiration of the instrument of exemption (permitting fishing by prescribed persons/entities) in May 2018. (4) DPIRD scientists are currently working on reconstructed catch estimates for IUU fishing of shark species in WA. This work is due to be published in 2021.
2.14 Implement trigger limits for the five shark species of interest.	**Not applicable.** As above.
2.19 Remove generic shark references in logbooks and improve species identification in logbook data.	**Not applicable.** As above.
2.20 Collect more recent observer data to describe species composition.	**Not applicable.** As above.
Pilbara fish trawl fishery	

2.10 An estimate of the annual catch of each of the five species of interest by IUU fishing is required. This was done across all of northern Australia (Marshall 2011) but needs to be disaggregated to fishery level.	**In progress -** DPIRD scientists are currently working on reconstructed catch estimates for IUU fishing of shark species in WA. This work is due to be published in 2021.
2.19 Allow for reporting of discarded shark in the logbooks and/or use observer program to estimate total annual discard of sharks of interest.	**Implemented.** The Pilbara Fish Trawl Fishery logbooks includes specific protected species (number and alive or dead) reporting, as well as the capacity for other species to be recorded in the comments section. DPIRD recently completed a study that examined the levels of uncertainty associated with extrapolated estimates of total bycatch for rarely-encountered species (including EPBC Act protected species) and how this varies with observer coverage levels. The study provided information on the minimum levels of observer coverage required for statutory logbook validation. Study results can be found: https://www.environment.gov.au/system/files/consultations/c26df15f-cc49-4e31-ab0e-f738af6cfbef/files/application-2018-appendix.pdf Analysis of data from trial observer programs in 2012 and 2016 determined that total bycatch of protected species were within the range reported through logbooks annually, from 2007 to 2017. As discussed in the assessment of the last WTO application: https://www.environment.gov.au/system/files/pages/a95da5cb-4d11-4760-a53d-ad10a77a2873/files/wa-pilbara-trawl-assessment-2018.pdf DPIRD is currently trialling an e-logbook system in selected fisheries, with a plan to roll the system out across the broader suite of fisheries following the successful completion of this pilot project. The e-logbook system has the capacity for more refined reporting of discarded catch and protected species interactions. DPIRD scientists are currently working on reconstructed catch estimates of discarded commercial catches of shark species in WA. This work is due to be published in 2021.
Temperate demersal gillnet and demersal longline fisheries	
2.14 Implement trip limits for the five listed shark species.	**Not implemented.** No trip limits have been implemented for the five species in the TDGDLF. With the level of catch of the five species in WA considered low/non-existent, trip limits for specific species within the individual fisheries are unlikely to provide any material benefit.

2.19 Remove generic shark references in logbooks and provide facility to report discards in commercial logbooks.	**Not implemented.** DPIRD developed a *Field identification guide to Western Australian Sharks and Shark-like Rays* to assist with better species identification including guidelines for each of the great hammerhead, scalloped hammerhead and winged hammerhead shark species. The guide can be found: https://www.fish.wa.gov.au/Documents/occasional_publications/fop001.pdf Hammerheads are currently grouped under a general reference in the logbooks. DPIRD is currently trialling an e-logbook system in selected fisheries, with a plan to roll the system out across the broader suite of fisheries (including the TDGDLF) following the successful completion of this pilot project. The e-logbook system has the capacity for more refined reporting of discarded catch and protected species interactions. Requirement to record all protected species interactions in the logbooks and their health (alive or dead) post-interaction. DPIRD scientists are currently working on reconstructed catch estimates of discarded commercial catches of shark species in WA. This work is due to be published in 2021.
2.20 Collect more recent observer data to describe species composition of the catch and quantify discards. Ensure any catch of the five species of interest is reported at species level in the logbooks.	**Partially implemented.** DPIRD is currently conducting a research project (funded through the Parks Australia Marine Parks grants program) aiming to better understand fishing gear impacts in the temperate shark fisheries. This project involves having DPIRD staff on board while they trial various gear configurations and will provide valuable data (in person observations and on-board cameras) on catch compositions and any interactions with TEP species. Past targeted on-board research programs were conducted until 2013. During 1994 to 1999, observer rates of protected species (captures) were considered low throughout the fisheries. As discussed in the last WTO application: https://www.environment.gov.au/system/files/pages/ad594b82-7fc1-4de2-a43b-be56dd6df129/files/wa-temperate-shark-2018-assessment-report.pdf **Not implemented**

2.26 Implement trip limits for the five listed shark species, and potentially implement maximum size limits to ensure stricter protection of a portion of the mature shark population.	**Not implemented**

Table A.5 New South Wales Fisheries

Recommendations	Progress & Comments
NSW Ocean Trawl Fishery	
2.14 Implement trip limits for the listed shark species other than scalloped and great hammerhead 2.19 Provide facility to report discards in commercial logbooks. 2.20 Collect more recent observer data to describe species composition of the catch and quantify discards. Ensure any catch of the five species of interest is reported at species level in the logbooks. 2.26 Implement trip limits for the listed shark species other scalloped and great hammerhead, and potentially implement maximum size limits to ensure stricter protection of a portion of the mature shark population	**Not implemented.** Reported catch is monitored and negligible (Table 5), trip limits are not currently proposed. **Partially implemented.** Interactions with protected species (great & scalloped Hammerhead) required to be reported through TEPS reports available in commercial logbooks and online reporting systems. **Implemented.** Observer data is collected in the Ocean Trawl Fishery. Retained bycatch is reported through Catch and Effort reporting system. Interactions with protected species (great & scalloped Hammerhead) required to be reported through TEPS reports available in commercial logbooks and online reporting systems. **Not implemented.** Reported catch is monitored and negligible (Table 5), trip limits or maximum size limits are not currently proposed.
NSW Ocean Hauling Fishery	
2.14 Quotas are not appropriate for infrequently caught byproduct/ bycatch species, but trip limits or catch triggers could be implemented for the listed shark species other scalloped and Great Hammerhead. 2.19 Provide facility to report discards in commercial logbooks.	**Not implemented.** Reported catch is monitored and negligible (Table 5), trip limits are not currently proposed. **Partially implemented.** Interactions with protected species (Great & scalloped Hammerhead) required to be reported through TEPS reports available in commercial logbooks and online reporting systems. **Partially implemented.** Observer programs have been conducted in this fishery.

2.20 Collect more recent observer data to describe species composition of the catch and quantify discards. Ensure any catch of the five species of interest is reported at species level in the logbooks. 2.26 Implement trip limits for the listed shark species other scalloped and Great Hammerhead, and potentially implement maximum size limits to ensure stricter protection of a portion of the mature shark population.	**Implemented.** Retained bycatch is reported through Catch and Effort reporting system. Interactions with protected species (Great & scalloped Hammerhead) required to be reported through TEPS reports available in commercial logbooks and online reporting systems. **Not implemented.** Reported catch is monitored and negligible (Table 5), trip limits or maximum size limits are not currently proposed.
NSW Ocean Trap & Line Fishery	
2.14 There are reasonably strong controls on shark captures in this fishery. If they were to be strengthened at all, separate trip limits and maximum size limits for the listed shark species other scalloped and Great Hammerhead could be introduced. 2.19 Provide facility to report discards in commercial logbooks.	**Partially implemented.** Harvest of scalloped and Great Hammerhead sharks is prohibited under the Fisheries Management Act 1994. Harvest of Smooth hammerhead, Porbeagle and Oceanic Whitetip sharks is restricted by weekly trip limits: https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/639778/Section-8-Notification-Conditions-for-taking-certain-shark-species-harvested-in-the-Ocean-Trap-and-Line-Fishery-February-2017.pdf **Partially implemented.** Interactions with protected species (Great & scalloped Hammerhead) required to be reported through TEPS reports available in commercial logbooks and online reporting systems.

Table A.6 Victorian Australian Fisheries

Recommendation	Progress & Comments
Victorian Ocean Access Fishery	
2.14 Quotas are not appropriate for infrequently caught byproduct/ bycatch species, but trip limits or catch triggers for Smooth Hammerhead and Porbeagle Shark could be implemented. 2.19 Improve identification of shark catches in commercial logbooks. 2.20 An observer program should be implemented and data on retained and discarded shark species should be identified down the species level.	**Implemented.** For all species of shark other than gummy and school there is catch limit of 1 per trip and this is for all shark other than gummy/school. **Not implemented.** Reporting required to hammerhead **Not implemented.**

2.26 A maximum size limit could be implemented to ensure stricter protection of a portion of the mature shark population.	**Presumed not implemented.**

Table A.7 South Australian Fisheries

Recommendations	Progress & Comments
South Australia Marine Scalefish Fishery	
2.14 Quotas are not appropriate for infrequently caught byproduct/ bycatch species, but trip limits or catch triggers for Smooth Hammerhead and Porbeagle Shark could be implemented.	**Not implemented.** Given the low level of catch (below), implementation of a trip limits and a maximum size limit have not been investigated.
2.19 Improve reporting of sharks to species level in commercial logbooks	**Implemented (by virtue of only smooth hammerheads occurring in SA waters).** The Smooth hammerhead (*Sphyrna zygaena*) is the only species from the Family Sphyrnidae found in South Australian waters. Hence, any fishery data on 'hammerheads' are assumed to represent catches of this species.
…..and record any discards.	**Not Implemented.** There are no fishery discard data available for the period between 2013 and 2019.
2.26 A maximum size limit could be implemented to ensure stricter protection of a portion of the mature population.	**Not implemented.** Given the low level of catch (below), implementation of a trip limits and a maximum size limit have not been investigated.

Table A.8 Tasmanian Fisheries

Recommendation	Progress & Comment
Tasmanian Scalefish Fishery	
2.19 Improve identification of shark catches in commercial logbooks.	**Implemented.** Commercially caught and retained shark (bycatch) must be recorded in the Commercial Catch, Effort and Disposal book. All catch is recorded at a species level using standard fish names.

2.20 An observer program should be implemented and data on retained and discarded shark species should be identified down the species level. 2.26 A maximum size limit could be implemented to ensure stricter protection of a portion of the mature shark population.	Data collection meets minimum national data collection standards. Catch and effort returns are currently under review to facilitate move to electronic reporting. This may potentially include discard reporting for the Scalefish Fishery. **Presumed not implemented.** There has been zero (0) catch of smooth hammerhead or porbeagle shark reported in the Tasmanian Scalefish Fishery—these are the species whose range includes Tasmanian State waters. **Not implemented.** As Tasmania does not have a dedicated shark fishery and report zero (0) catch of the above species, therefore it is unlikely that a maximum size limit would be introduced. Strict bycatch regulations limit the amount of shark (all species including rays) that can be taken in State waters by commercial fishers who do not hold a Commonwealth shark net and/or shark hook authority and a Tasmanian Coastal Waters Permit. The commercial trip limit is five (5) shark (species combined).

APPENDIX 3 - CALCULATING TOTAL FISHING MORTALIES

SCALLOPED HAMMERHEAD

	Species Specific			Disaggregation Scenario 1. Koopman & Knuckey ratios			Species Specific + Dissaggregated		TOTALS
Year	Retained (kg)	Discarded (kg)	Total estimated mortality (kg)	Retained (kg)	Discarded (kg)	Total estimated mortality (kg)	Total retained	Total discarded	
2014	14,008.92	9,543.00	23,551.92	47,879.15	2,554.60	50,433.75	61,888	12,098	73,986
2015	22,395.93	2,926.00	25,321.93	46,824.63	4,733.07	51,557.70	69,221	7,659	76,880
2016	21,257.92	3,215.00	24,472.92	44,066.36	339.57	44,405.92	65,324	3,555	68,879
2017	23,721.31	2,641.00	26,362.31	33,146.90	15.67	33,162.58	56,868	2,657	59,525
2018	24,009.21	22,342.03	46,351.24	16,933.16	47.02	16,980.17	40,942	22,389	63,331
2019	26,866.64	11,499.98	38,366.62	134.16	151.50	285.66	27,001	11,651	38,652
2020 (part)	4,300.00	2,041.00	6,341.00				4,300	2,041	6,341
Total	136,559.93	54,208.01	190,767.94	188,984.36	7,841.43	196,825.78	325,544.29	62,049.44	387,594

	Species Specific			Disaggregation Scenario 2. ASSUME 100% Scalloped HH			Species Specific + Dissaggregated		TOTALS
Year	Retained (kg)	Discarded (kg)	Total estimated mortality (kg)	Retained (kg)	Discarded (kg)	Total estimated mortality (kg)	Total retained	Total discarded	
2014	14,008.92	9,543.00	23,551.92	100,814.90	5,379.00	106,193.90	114,824	14,922	129,746
2015	22,395.93	2,926.00	25,321.93	98,594.50	9,966.00	108,560.50	120,990	12,892	133,882
2016	21,257.92	3,215.00	24,472.92	92,786.64	715.00	93,501.64	114,045	3,930	117,975
2017	23,721.31	2,641.00	26,362.31	69,794.51	33.00	69,827.51	93,516	2,674	96,190
2018	24,009.21	22,342.03	46,351.24	35,654.65	99.00	35,753.65	59,664	22,441	82,105
2019	26,866.64	11,499.98	38,366.62	282.49	319.00	601.49	27,149	11,819	38,968
2020 (part)	4,300.00	2,041.00	6,341.00				4,300	2,041	6,341
Total	136,559.93	54,208.01	190,767.94	397,927.68	16,511.00	414,438.68	534,487.61	70,719.01	605,207

GREAT HAMMERHEAD

	Species Specific			Disaggregation Scenario 1. Koopman & Knuckey ratios			Species Specific + Dissaggregated		
Year	Retained (kg)	Discarded (kg)	Total estimated mortality (kg)	Retained (kg)	Discarded (kg)	Total estimated mortality (kg)	Total retained	Total discarded	TOTALS
2014	10100	20082.6	30469.6	24928.3	1330.05	26,258	35,028	21,413	56441
2015	9100	3282.6	12463.6	24379.3	2464.27	26,844	33,479	5,747	39226
2016	11500	1945.4	13445.4	22943.2	176.80	23,120	34,443	2,122	36565
2017	7900	5035.5	12935.5	17257.9	8.16	17,266	25,158	5,044	30202
2018	7416	15144.027	22559.897	8816.3	24.48	8,841	16,232	15,169	31401
2019	25367	10169.485	35536.255	69.9	78.88	149	25,437	10,248	35685
)20 (part)	19100	8515.7	27615.7			-	19,100	8,516	27616
Total	90483	64175	155026	98395	4083	102477	188877	68258	257135

	Species Specific			Disaggregation Scenario 2. ASSUME 100% Great HH			Species Specific + Dissaggregated		
Year	Retained (kg)	Discarded (kg)	Total estimated mortality (kg)	Retained (kg)	Discarded (kg)	Total estimated mortality (kg)	Total retained	Total discarded	TOTALS
2014	10100	20082.6	30469.6	100,814.90	5,379.00	106,193.90	110,915	25462	136376
2015	9100	3282.6	12463.6	98,594.50	9,966.00	108,560.50	107,694	13249	120943
2016	11500	1945.4	13445.4	92,786.64	715.00	93,501.64	104,287	2660	106947
2017	7900	5035.5	12935.5	69,794.51	33.00	69,827.51	77,695	5069	82763
2018	7416	15144.027	22559.897	35,654.65	99.00	35,753.65	43,071	15243	58314
2019	25367	10169.485	35536.255	282.49	319.00	601.49	25,649	10488	36138
)20 (part)	19100	8515.7	27615.7				19,100	8516	27616
Total	90483	64175	155026	397928	16511	414439	488410	80686	569097

SMOOTH HAMMERHEAD

Year	Species Specific			Disaggregation Scenario 1. Koopman & Knuckey ratios			Species Specific + Dissaggregated		TOTALS
	Retained (kg)	Discarded (kg)	Total estimated mortality (kg)	Retained (kg)	Discarded (kg)	Total estimated mortality (kg)	Total retained	Total discarded	
2014	630	0	630	24420.1	1302.94	25,723	25,050	1303	26353
2015	1796	253	2049	23882.3	2414.04	26,296	25,678	2667	28345
2016	8501.2	869	9370.2	22475.5	173.19	22,649	30,977	1042	32019
2017	3271.2	1331	4602.2	16906.1	7.99	16,914	20,177	1339	21516
2018	3566	3025	6591	8636.5	23.98	8,661	12,203	3049	15252
2019	6094	6619.8	12713.6	68.4	77.27	146	6,162	6697	12859
2020 (part)	4385.66	2625.81	7011.47			-	4,386	2626	7011
Total	**968**	**836**	**42967**	**96389**	**3999**	**100388**	**124633**	**18723**	**143356**

Year	Species Specific			Disaggregation Scenario 2. ASSUME 100% Smooth HH			Species Specific + Dissaggregated		TOTALS
	Retained (kg)	Discarded (kg)	Total estimated mortality (kg)	Retained (kg)	Discarded (kg)	Total estimated mortality (kg)	Total retained	Total discarded	
2014	630	0	630	100,814.90	5,379.00	106,193.90	101,445	5379	106824
2015	1796	253	2049	98,594.50	9,966.00	108,560.50	100,390	10219	110609
2016	8501.2	869	9370.2	92,786.64	715.00	93,501.64	101,288	1584	102872
2017	3271.2	1331	4602.2	69,794.51	33.00	69,827.51	73,066	1364	74430
2018	3566	3025	6591	35,654.65	99.00	35,753.65	39,221	3124	42345
2019	6094	6619.8	12713.6	282.49	319.00	601.49	6,376	6939	13315
2020 (part)	4385.66	2625.81	7011.47				4,386	2626	7011
Total	968	836	42967	397928	16511	414439	426172	31235	457406

Determining average proportion of each hammerhead species from Koopman and Knuckey, 2014

	Scalloped Hammerhead Weight, t	Scalloped Hammerhead Proportion (%)	Smooth Hammerhead Weight, t	Smooth Hammerhead Proportion (%)	Great Hammerhead Weight, t	Great Hammerhead Proportion (%)	TOTAL
2008	214.51	57.75	62.94	16.94	79.77	21.47	371.46
2009	159.45	48.39	68.17	20.69	85.07	25.82	329.52
2010	112.42	43.28	75.83	29.19	59.00	22.71	259.76
2011	124.86	44.87	68.62	24.66	77.02	27.68	278.27
2012	88.26	43.18	60.57	29.63	53.05	25.95	204.42
Average %		47.49		24.22		24.73	