



REPORT ON THE

SHARK CONSERVATION SUMMIT

SYDNEY 2019

DISCLAIMER

This report is based upon the discussions and recommendations of the HSI/AMCS Sharks Conservation Summit 2019. While the authors have endeavoured to reflect the outcomes and recommendations of the summit participants, any opinions, findings, conclusions and recommendations do not necessarily reflect the views of all participants of the Shark Summit or of the reviewer. The species segments were reviewed by the presenters themselves, while the remainder of the report was reviewed by Prof Colin Simpfendorfer.



HUMANE SOCIETY INTERNATIONAL (HSI)

Humane Society International (HSI) is the world's largest animal protection NGO specialising in the application of national and international laws to protect threatened species. The Australian office was established in 1994 and its mission is to build an ecologically sustainable and humane world for all animals. HSI has successfully nominated over 70 species for threatened species protection and recovery under Australian law, including a number of the shark species discussed in this report.



AUSTRALIAN MARINE CONSERVATION SOCIETY (AMCS)

The Australian Marine Conservation Society (AMCS) is the voice for Australia's oceans.

AMCS is Australia's only national charity dedicated solely to protecting our precious ocean wildlife – a community of ocean lovers across the nation working for healthy seas. AMCS is an independent charity, staffed by a committed group of scientists, educators and passionate advocates who have defended Australia's oceans for over 50 years.

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ABOUT THE SHARK CONSERVATION SUMMIT

The Shark Conservation Summit was a first of its kind event in Australia on 21 and 22 February, 2019 that brought together shark researchers, government and conservation NGOs. Organised by the Humane Society International (HSI) and the Australian Marine Conservation Society (AMCS), the summit sought to address challenges and seek opportunities for shark and ray conservation in Australia. Experts from across Australia were invited with attendees from all states and territories and including representatives from research institutions, state and federal governments, non-government organisations, and the public.

The overall aim of the shark summit was to provide key recommendations to assist policy makers, researchers and conservation organisations to make informed decisions on the management and conservation of Australia's sharks and rays. Throughout the summit, presenters were asked to provide their key recommendations which were also discussed with the broader audience in two special sessions on the second day of the summit.






Key topics that were addressed at the summit included:

-  The importance of shark and ray diversity within Australian waters;
-  Summaries of the current state of research and recovery efforts for shark and ray species that are listed as threatened under the Environmental Protection and Biodiversity Act 1999 (EPBC Act);
-  Global efforts to protect sharks and rays through international treaties;
-  Exploring how NGOs and scientists can better work together to best drive positive conservation outcomes for sharks and rays;
-  The status of sharks and rays that are not included on the EPBC Act threatened species list;
-  Improved traceability and species labelling in the trade of shark products;
-  An update on the latest non-lethal shark controls methods;
-  A discussion of the role the media plays in attitudes to shark conservation.

SHARK AND RAY BIODIVERSITY IN AUSTRALIA

Professor Simpfendorfer highlighted the efforts that Australia has made in the management of cross jurisdictional species and that Australia is seen as a lifeboat for many sharks and rays that have declined significantly in other areas of their range. The number of chondrichthyan species in Australia is currently estimated to be at least 322 species including 182 sharks, 125 rays and 15 chimaeras. Australian waters contain a quarter of the world's shark and ray diversity, and have a high degree of endemism with at least 164 of these species found only in Australian waters.

One of the main messages of the keynote address was identifying that the global challenge for sharks and rays is almost all about fishing mortality (f). In this context, Professor Simpfendorfer summarised the findings of the recently released FRDC Shark Report Card (2019) which assessed 194 stocks of sharks and rays in Australian waters and found:

-  124 are being fished at a sustainable level;
-  9 stocks with historical declines are recovering, mostly due to changes in fisheries regulations;
-  6 stocks are considered to be depleted but not below levels that they can be sustained;
-  18 stocks were assessed as "overfished" with the majority having conservation efforts in place:
 - 10 stocks are protected (federal and/or state)
 - 4 stocks are Conservation Dependant and have rebuilding plans
 - 2 stocks have fishery rules
 - 2 stocks have no measures in place (Colclough's shark and the whitefin swellshark); and
-  42 species did not have sufficient data to be defined.

Conservation efforts for these species is particularly difficult due to the diversity of shark and ray communities and the myriad life histories. One of the major global challenges for shark conservation is the fact that many species of sharks pass through multiple jurisdictions and are subject to different management regimes in each jurisdiction (Dulvy *et al.* 2017). Professor Simpfendorfer highlighted the efforts that Australia has made in the management of cross-jurisdictional species and the fact that Australia is seen as a lifeboat for many sharks and rays that have been declined significantly in other areas of their range.

The 'Australia as a lifeboat' paradigm can be seen as a foundation upon which Australia builds certain shark and ray conservation initiatives. While threats still occur within Australian jurisdictions, in most cases they are less pervasive, and therefore local populations of these species are relatively healthier than in other parts of the world. For example, the four species of sawfish which call Australia home, are extinct through half of their former ranges but are

surviving in small populations in Australia. As 'last bastions' for these species, protection of the Australian populations is of the utmost importance. Australian populations could even seed former range states where the local populations have become critically diminished.

In addition, considering the sheer diversity of sharks and rays living in Australia's waters, we have a uniquely vital responsibility in protecting diversity and evolutionary lineage for the world's sharks and rays.

The main takeaway messages of the keynote address were:

- 🐟 Overall, Australia is doing an adequate job of managing its sharks and rays relative to a global standard that has seen acute declines in shark and ray populations.
- 🐟 Australia has a globally important role to address the global crisis for sharks and rays as a chondrichthyan biodiversity hotspot, and as a lifeboat for imperilled species.
- 🐟 Science-based management should be at the core of conservation efforts, especially in places like Australia, where capacity is high.
- 🐟 Improved fisheries management is the key to global conservation efforts for sharks and rays:
 - it's almost all about fishing mortality.
- 🐟 Addressing issues related to incidental catch will be important
- 🐟 Given the complexity of issues globally, we need to prioritise efforts.

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Tiger shark (*Galeocerdo cuvier*)



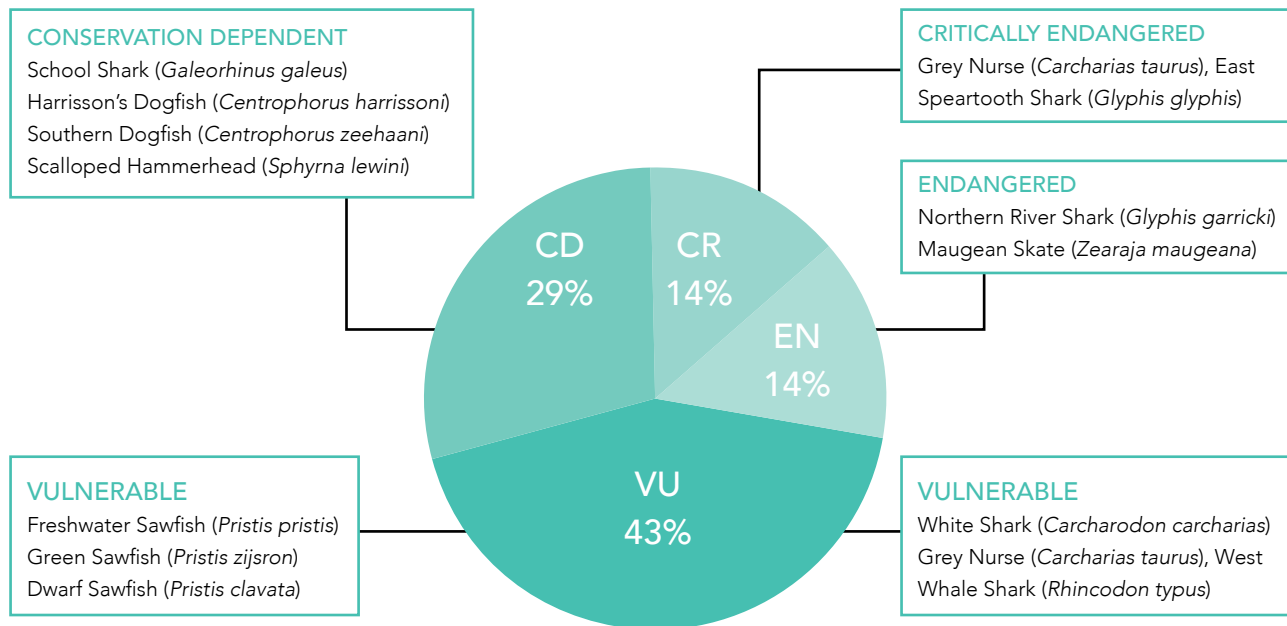
FRAMEWORK FOR THREATENED SPECIES PROTECTION IN AUSTRALIA

The primary piece of legislation that directs the conservation of threatened species in Australia is the Commonwealth Environmental Protection and Biodiversity Act 1999 (EPBC Act). The EPBC Act is currently under a 10-year review. One of the functions of the EPBC Act is to provide the mechanisms for the assessment, listing and recovery of threatened native species. Under the EPBC Act, species are included on the threatened species list in one of six categories; extinct, extinct in the wild, critically endangered (CR), endangered (EN), vulnerable (VU), or conservation dependent (CD). Inclusion in the CD category is only available where a management plan is currently in place and where the cessation of the plan would adversely affect the conservation status of the species. Additionally, consideration for CD is only applicable to species that are not “Matters of National Environmental Significance.” Under the EPBC Act species of fish that are commercially exploited may be listed as CD even if they qualify for listing in a threat category. The Department of Environment & Energy (DEE) is responsible for the administration of the EPBC Act. The Threatened Species Scientific Committee (TSSC) is assembled by the Minister for the Environment to assess nominations and provide recommendations to the Minister on the listing, threat abatement and recovery of threatened species. Three sessions on day one of the Shark Conservation Summit were dedicated to reviewing the status and current research on EPBC Act listed sharks and rays.

At the Summit, Dr Matthew Heard presented on the status of species not listed for federal protection, and Dr Michelle Heupel provided an update on Australia’s Shark Action Plan.

It is worth noting a Fisheries Research and Development Corporation (FRDC) document published in 2019 called [Shark futures: A report card for Australia’s sharks and rays](#) that will potentially have implications for future EPBC nominations and listings. Certain species listed as ‘overfished’ or ‘depleted’ in the report are not listed under the EPBC Act including Colclough’s shark (*Brachaelurus colcloughi*) and whitefin swellshark (*Cephaloscyllium albipinum*). Additional species were assessed at levels not yet threatened but were cause for concern including, Eastern angelshark (*Squatina albipunctata*) and tiger shark (*Galeocerdo cuvier*). Lastly, there are also those that are listed, but require uplisting (e.g. from VU to EN) such as the sawfishes.

Figure 1. Percentage of threatened sharks and ray species listed within each EPBC Act category. Includes both the East Coast and West Coast populations of grey nurse sharks.



Though not published at the time of the Shark Conservation Summit, the recent (December 2019) report *Review of Recovery Planning for Threatened Sharks: Status, Analysis & Future Directions*, by Dr Nick Rayns, revealed that no species of shark or ray listed under the EPBC Act has experienced any measurable improvements in population status. Australian universities and government institutions are proficient at shark research and funding that research. In addition, Australia performs well in identifying when a species requires listing due to population declines, however, much improvement needs to be made in investing in conservation and recovery actions.

Table 1. Additional shark and ray EPBC listings in progress from HSI and AMCS. FPAL stands for the Final Priority Assessment List, formulated by the Minister for the Environment of nominated species that will be assessed for EPBC listing.

Species	IUCN Category	Basis for nomination	Nominated as	Progress
Whitefin Swellshark (<i>Cephaloscyllium albiginum</i>)	CR	Catch reduction of >50% over three generations where causes of reduction have not ceased, actual levels of exploitation	CR	Submitted March 2019, FPAL, slated for CD
Grey Skate (<i>Dipturus canutus</i>)	EN	Catch reduction of >50% over three generations where causes of reduction have not ceased, continuing levels of exploitation	EN	Submitted March 2019, FPAL, slated for CD
Longnose Skate (<i>Dentiraja confusus</i>)	CR	Significant decline in standardised catch rates (>99.9%)	CR	Submitted March 2019, FPAL, slated for CD
Narrow Sawfish (<i>Anoxypristis cuspidata</i>)	EN	The only Australian species of sawfish not currently included on the EPBC, declines of 50 and 70%	VU	Submitted March 2019, not for FPAL, termed 'data deficient'
Colclough's Shark (<i>Brachaelutus colcloughi</i>)	VU	IUCN listing, population decline, range-limited, significant and pervasive fishing threat	VU	Drafting, to be submitted March 2020
Greeneye Spurdog (<i>Squalus chloroculus</i>)	EN	IUCN listing, population decline, significant and pervasive fishing threat	EN	Drafting, to be submitted March 2020
Sydney Skate (<i>Dipturus australis</i>)	VU	IUCN listing, population decline, range-limited, significant and pervasive fishing threat	VU	Drafting, to be submitted March 2020
Eastern Angelshark (<i>Squatina albipunctata</i>)	VU	IUCN listing, population decline, significant and pervasive fishing threat	CR	Drafting, to be submitted March 2020

RESEARCH AND RECOVERY OF EPBC ACT LISTED SPECIES



GREAT WHITE SHARK (*CARCHARODON CARCHARIAS*)

The great white shark was listed as Vulnerable on the precursor to the EPBC Act, the *Cth Endangered Species Protection Act, 1992* in 1997 following a nomination from Humane Society International. It was included in the EPBC Act threatened species list at its enactment on July 16th, 2000. The first recovery plan for this species came into effect in 2002 and was reviewed in 2008. The current recovery plan was released in 2013 and is due for review.

At the summit, Dr Richard Hillary from the CSIRO presented the latest research on the population estimates for great white sharks in eastern Australia and New Zealand based on cutting edge genetic relatedness techniques. Close-kin genetics have shown that the total population size is estimated to be small, and, while the survival of adults and juveniles is high, the trend in population growth for adult white sharks is estimated to be near zero since the early 2000's (Bruce *et al.*, 2018; Hillary *et al.*, 2018).



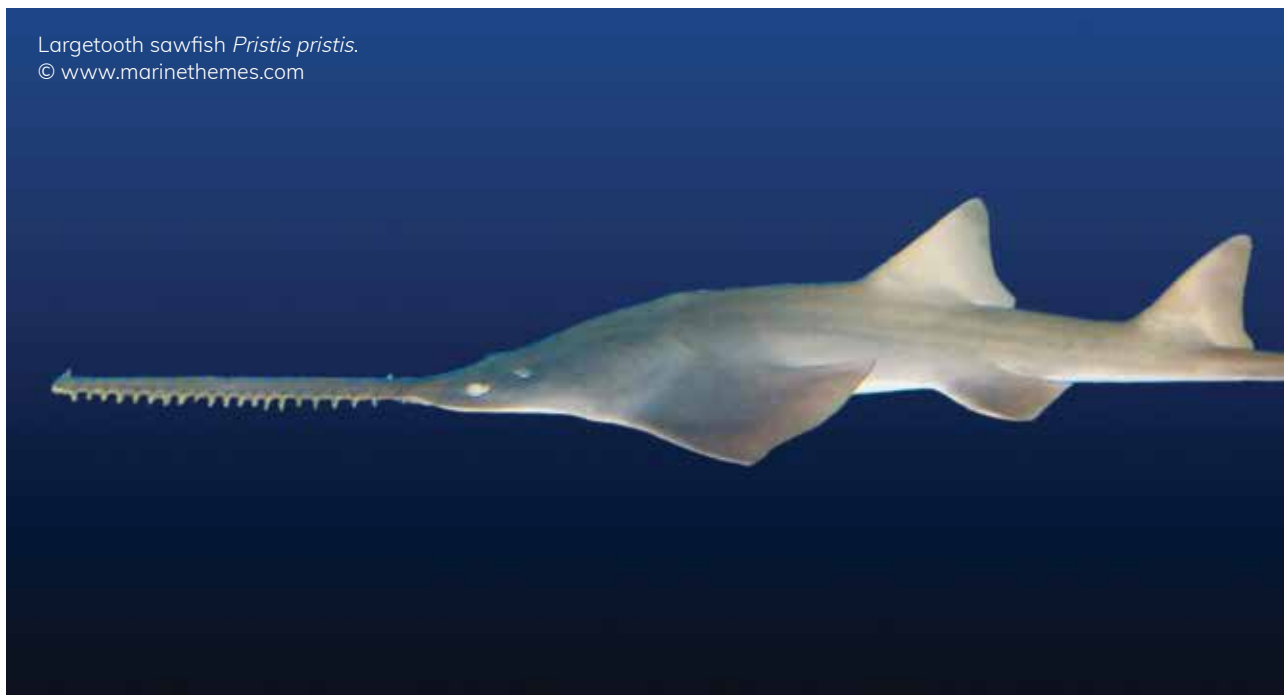
Critically endangered (east coast) grey nurse shark, *Carcharias taurus*, swimming at South West Rocks, New South Wales. © South West Rocks Dive Centre.

GREY NURSE SHARK (*CARCHARIAS TAURUS*)

Like the great white shark, the grey nurse shark was listed as threatened under the *Cth Endangered Species Protection Act, 1992* as the result of a nomination from HSI. Two separate populations of the grey nurse shark are now listed on the EPBC Act threatened species list with the eastern population assessed as Critically Endangered and the western population assessed as Vulnerable. The first recovery plan for the grey nurse shark came into force in June 2002 (EA, 2002). This recovery plan was reviewed in 2008 and updated in 2014 and is due for review again in 2019.

The Recovery Plan identified a number of critical habitats for the grey nurse shark protected by Commonwealth, New South Wales and Queensland governments in an effort to mitigate the impact of recreational and commercial fishing. However, incidental hooking remains the key threat to the east coast population. Dr Nick Otway from the NSW Department of Primary Industries presented on the current state of the population and knowledge on the post release mortality of grey nurse sharks following hooking by recreational and commercial fishers. The threat of post release mortality and significant sub-lethal impacts (bacterial infection and disease, cessation of reproduction, and reduced rates of growth) of hooking is much more serious than previously thought. One solution suggested by Dr Otway was the development of biodegradable hooks although the difficulty of adoption of a new hook type, particularly by recreational fishers, was recognised. Of important note was that genetically-based sampling cannot identify diseased and cachectic individuals, and therefore would yield an overestimation of the reproductive potential and size of the population.

Largetooth sawfish *Pristis pristis*.
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SAWFISH (*PRISTIS SPP.*)

Of the four sawfish species present in Australian waters three are listed as vulnerable, and one as migratory on the EPBC Act threatened species list. The largetooth sawfish (*Pristis pristis*) was listed as Vulnerable in 2000 while the green sawfish (*P. zijsron*) and dwarf sawfish (*P. clavata*) were listed as Vulnerable in 2008 and 2009 respectively. Due to its listing on Appendix I of Conservation of Migratory Species (CMS), the narrow sawfish (*Anoxypristis cuspidata*) joins the other species listed as migratory in 2015 - though this does not require a recovery plan, listing or conservation advice. The Sawfish and River Shark Multispecies Recovery Plan was implemented in 2015 (DoE, 2015).

Dr Barbara Wueringer, founder and director of Sharks and Rays Australia (SARA) presented on the current state of knowledge and research on sawfish in northern Australia. Dr Wueringer highlighted the importance of considering range contractions when determining the risk of sawfish species to extinction. This issue is being further investigated through several studies that combine habitat modelling, tagging and investigation of reports of sawfish from grey literature and citizen science.

One of the principal threats to sawfish in Australian waters has been identified as incidental capture in commercial fisheries with mortality caused by harming animals during release. Capable of buccal respiration, sawfish are generally resilient to capture in nets, however post-release mortality results from maiming (e.g. rostrums removed) in order to remove them from nets. There is also a lack of species-specific datasets, and if we are to rely on fishery dependent data, we need to ensure that fishers can tell the difference between species. Dr Wueringer outlined the efforts that SARA are currently investing in educating commercial fishers on sawfish identification and to ensure that they are releasing sawfish from gillnets safely and unharmed.

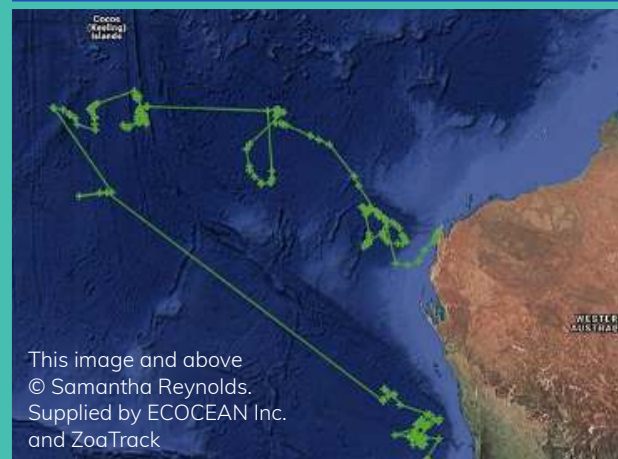
RIVER SHARKS (*GLYPHIS SPP.*)

Dr Toby Patterson from the CSIRO presented the current status for the spear tooth shark (*G. glyphis*) and the northern river shark (*G. garricki*) which are listed as Critically Endangered and Endangered, respectively under the EPBC Act. There are some major gaps in our knowledge of these species, particularly about their demography (age, growth and reproduction). Preliminary research has demonstrated restricted juvenile range within particular river systems, and genetically isolated populations across their range. Estimates of adult population size using close kin mark recapture suggest that even the largest known populations comprise no more than a few thousand adults. Research into juvenile mortality indicates very high natural mortality of sharks in their first two years of life. Habitat modification, water extraction, low levels of adult abundance and high levels of juvenile mortality are challenges for the survival of these species. Continued collection of tissue samples and incorporation of juvenile mortality in existing population models will facilitate more precise estimates of adult and total population size, enabling population trajectory to be estimated.

COMMUNITY ENGAGEMENT

ECOCEAN WHALE SHARK RACE AROUND THE WORLD

In 2015 and 2017, the ECOCEAN Whale Shark Race Around the World engaged with primary and secondary schools to sponsor a satellite tagging program for whale sharks off the coast of Western Australia. Each school contributed to costs to enable satellite tags to be deployed on whale sharks by researchers from ECOCEAN. The race was timed to start during National Science Week with tracks displayed publicly on the ZoaTrack website to allow schools to follow the journey of the whale shark carrying their tag. ZoaTrack visualisation and analysis tools were used by students to study the movements of their sharks which increased their engagement and improved the educational outcomes of the program. Interactive webinars were run by ECOCEAN scientists through the Saba interface and allowed students to directly engage with the researchers. While the Race officially finished during Science Week, access to the tagging data for schools is ongoing. This program engaged school children to become familiar with the whale shark and broader marine conservation; increased their STEM capabilities; and aimed to inspire students during National Science Week 2015 and 2017. The Race Around the World is a great example of how researchers can think outside the box to increase awareness and engagement around threatened sharks while also increasing our knowledge of the ecology of this cryptic species.



This image and above
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Supplied by ECOCEAN Inc.
and ZoaTrack



Whale Shark, *Rhincodon typus*.

WHALE SHARK (*RHINCODON TYPUS*)

The whale shark was listed as Vulnerable under the EPBC Act in 2001. A Whale Shark Recovery Plan was developed and came into effect in 2005 and ceased to be in effect from October 2015. The Australian Government undertook a review of the Plan in 2014 and found that the major ongoing threat was from intentional and unintentional capture of whale sharks in international waters through fishing operations.

Dr Brad Norman from ECOCEAN Inc. and The University of Queensland was responsible for the original EPBC Act nomination for the whale shark and presented at the summit on some of the research and community outreach programs that have been conducted since its listing. Dr Norman discussed the low level of knowledge around this cryptic and mysterious species. While the majority of the threats to whale sharks occur outside Australian waters, Australia plays a key role in research and conservation of whale sharks, with community engagement a key to furthering the recovery of this species. Dr Norman outlined his highly successful community outreach project which engaged schools to invest in satellite tagging and improves community awareness engagement for this species.



MAUGEAN SKATE (*ZEARAJA MAUGEANA*)

The Maugean skate was listed as Endangered under the EPBC Act in 2004 based on its small population size and restricted geographic distribution, being reported from only two remote western Tasmania estuaries. Macquarie Harbour is the main stronghold for the species; threats to the Maugean skate include pollution from historic mining activities, incidental fishing mortality, changed river flows associated with hydro-electricity generation and environmental impacts linked to salmonid aquaculture operations. By contrast, the current status of the population in Bathurst Harbour is uncertain, no individuals have been observed in surveys of that system for more than twenty years.

The majority of the research on the Maugean skate has been conducted through the Institute for Marine and Antarctic Studies (IMAS) at the University of Tasmania. Recent research highlighted the potential impacts of human activities on the range of the Maugean skate and the importance of dissolved oxygen levels in the harbour (Bell *et al.*, 2016). Recent management measures have been introduced to reduce the likelihood of fishery interactions with the Maugean skate, marine farming operations have also been temporarily scaled back and an extensive environmental monitoring program has been implemented to assess environmental conditions in Macquarie Harbour.

Associate Professor Jeremy Lyle from IMAS presented the findings of the latest research on the habitat preference and movement patterns of Maugean skates in Macquarie Harbour. Maugean skates show a preference for areas of high dissolved oxygen and are largely site attached. Given these results, Professor Lyle highlighted the importance of managing aquaculture activities to ensure that dissolved oxygen levels and other environmental impacts were minimised.

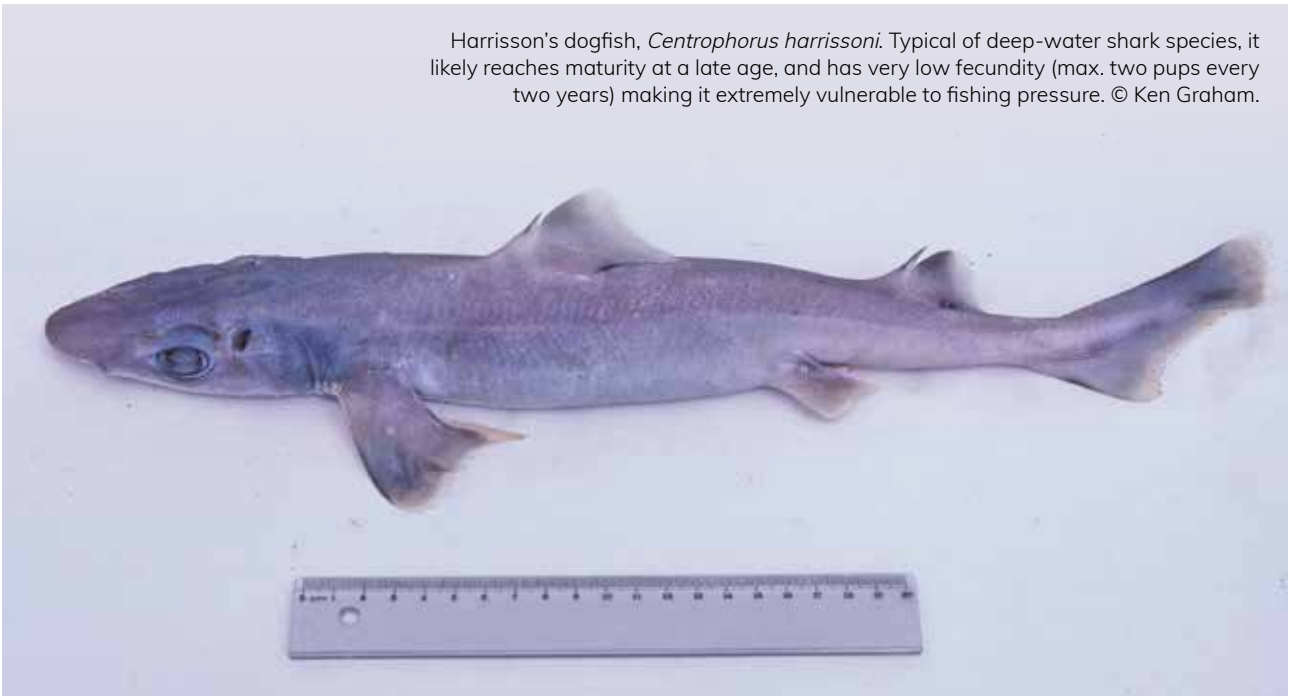


SCHOOL SHARK (*GALEORHINUS GALEUS*)

The school shark (*Galeorhinus galeus*) was listed as Conservation Dependent on the EPBC Act threatened species list in 2009 as a result of a HSI nomination. The main threats identified for school sharks is mortality mostly from incidental catch taken in gillnets targeting the gummy shark (*Mustelus antarcticus*) in the fisheries of south-eastern Australia (AFMA, 2015). As a Conservation Dependent species, a rebuilding strategy was developed for the school shark by AFMA in 2008 (AFMA, 2008) and has since been reviewed and revised (AFMA, 2015).

Dr Terry Walker presented on the current status of the school shark stock in southern Australia. Preliminary analysis of demersal trawl school shark catch per unit effort data indicates a very slight increasing population trend, and the current population is around 10% of the virgin biomass. One of the questions that remains over the Australian stock is the level of connectivity between Australia and New Zealand with the potential that the NZ stock is 'topping up' the Australian stock over time. Devloo-Delva *et al.* (2019) identified fine-scale reproductive connectivity between these stocks. Given the multi-national range of the Australia and New Zealand population of school shark, it is important that management is developed to factor in the cross jurisdictional status of the species. Management measures, such as adoption of a narrow range of mid-sized gillnet mesh sizes and closed areas off South Australia for the protection of sea lions have led to a reduction in the fishing mortality for large, mature sharks. There is recent anecdotal evidence of population increase in nursery areas, as well as in trawl catches.

Harrison's dogfish, *Centrophorus harrissoni*. Typical of deep-water shark species, it likely reaches maturity at a late age, and has very low fecundity (max. two pups every two years) making it extremely vulnerable to fishing pressure. © Ken Graham.



DOGFISH (*CENTROPHORUS SPP.*)

Harrison's dogfish (*Centrophorus harrissoni*) and Southern dogfish (*C. zeehaani*) were listed Conservation Dependent under the EPBC Act in 2013. The upper-slope dogfish management strategy was developed by AFMA in 2010 and revised in 2012 based on a review of the original measures (AFMA, 2012).

Dr Terry Walker presented on the current state of stocks of dogfish in southern Australia. The main threat to these species is mortality from capture within the Southern and Eastern Shark and Scalefish Fishery (SESSF), Commonwealth Trawl Fishery and some NSW fisheries (AFMA, 2012 ; NSW-DPI, 2012). Active measures implemented under the Upper-Slope Dogfish Management Strategy have led to declines in the numbers of these species caught across these fisheries with the 700 m closure having the greatest impact according to Dr Walker. Despite these measures both of these species are still considered overfished in Australian waters according to the most recent assessment from ABARES (Helidoniotis *et al.*, 2019). Populations remain below the 20% limited reference point of the Commonwealth Harvest Strategy policy and fishing mortality remains uncertain despite low landed catch and protection provide by taxa-specific closures (Helidoniotis *et al.*, 2018).

AUSTRALIA'S ROLE IN SHARK CONSERVATION

In addition to having high capacity and output in terms of shark and ray research, Australia has also played a leading role in shark conservation at a global level. Nicola Beynon, HSI Head of Campaigns in Australia presented on the role the Australian Government has played in global shark conservation. Australia was one of the key countries that instigated the Memorandum of Understanding (MOU) on the Conservation of Migratory Sharks under the CMS and is a member of the Shark MOU Advisory Council. Australia nominated the great white shark for protection under CMS and the Convention on International Trade in Endangered Species for Flora and Fauna (CITES) which was among the first sharks to be listed under these international conventions. Australian institutions have also contributed to capacity building by leading workshops, such as for the Pacific CITES Shark Project in 2016.

Australia has an ability to conserve its sharks and rays well and if able to do so, they will be a “lifeboat” for threatened species with diminished global ranges. Due to cultural, social, and economic circumstances, Australia exerts relatively less pressure on populations of sharks and rays within its Economic Exclusivity Zone, than do other Pacific and Indian Ocean countries. Despite historical population declines of some species in Australia, populations of wide-ranging species are generally healthier than other range states (Simpfendorfer *et al.* 2019).

The resources available to Australian state and federal fisheries management organisations allows for the progressive evolution and improvement of management and research over time in the context of shark and ray conservation. Research can identify measures through which the environmental impact of fisheries can be mitigated. Improvements in input and output controls can lead to better management through spatio-temporal closures, quota management, and other methods of control. Whether these measures actually lessen impacts depends on implementation by regional fisheries management organisations and compliance of fishers. In Australia, bycatch is one of the most pervasive issues, and imperative to improve populations. Research into bycatch has shown that improvement could be achieved through gear modifications, handling and release practices, and spatial closures to manage interactions.

As mentioned earlier, the independent report *Review of Recovery Planning for Threatened Sharks: Status, Analysis & Future Directions*, by Dr Nick Rayns, revealed that no species of shark or ray listed under the EPBC Act has experienced any measurable improvements in population status. Though Australia excels at shark research, funding and in identifying when a species requires listing, there is much room for improvement in investing in conservation and recovery actions.

Summit attendees looked forward to Australia continuing a strong leadership role in international shark conservation.

NOVEL GENETIC TECHNIQUES

ENVIRONMENTAL DNA - EDNA

Ecologists are increasingly relying on DNA shed by organisms into the environment, known as environmental DNA (eDNA), for their research. Instead of having to physically collect and detect individuals, scientists are tapping sources such as shed skin cells, urine, faeces, blood and saliva for details on rare and endangered species.

Early eDNA surveys used the polymerase chain reaction (PCR) to amplify DNA from an individual species. But newer techniques, such as the one used by David Morgan in northern Australia, can detect sawfish in remote areas without the need to physically capture individual sawfish. The latest methods use DNA sequencing to detect organismal signatures within water samples.

CLOSE KIN GENETICS

Close-kin genetics involves identifying the proportion of a sampled population that is closely related, parent-offspring or sibling relationship. Population estimates are based on the principal that in a small population the proportion of closely related animals will be higher than in a large population.

By identifying the proportion of the population that is an offspring pairing, researchers are also able to estimate the size of a population and mortality rates. This has recently been used to provide a population estimate for white shark populations off the eastern Australia and New Zealand. (Hillary *et al.* 2018). This population is estimated to be fairly small (2500 – 6750 individuals) while adult and juvenile survival were high (90% and 73% respectively).

Great white shark (*Carcharodon carcharias*)



TRADE IN SHARK PRODUCTS

Dr Adam Stow presented the latest research on the trade in shark products globally and in Australia. Genetic research has revealed that, globally, a high proportion of traded fins and gills come from species of conservation concern including many species that listed under CITES appendices (Steinke, 2017). In Australia, there are still large amounts of shark being imported with little regulation around the labelling of this imported product and it is often mislabelled. Exacerbating the problem is the ambiguity in trade codes and re-exporting of product. Traceability is another major issue. This has led to frequent mislabelling or a complete lack of labelling, leaving consumers unaware or uninformed as to the species and origin of the products for sale. Australia must accept its mantle as a global leader in shark and ray conservation, (for the reasons described previously) and must draft and enact effective seafood labelling legislation, allowing Australian consumers to make informed choices.

NON-LETHAL SHARK CONTROL MEASURES

A range of experts (Assoc Prof Charlie Huveneers - Flinders University, Lindsay Lyon – Ocean Guardian, Dr Vic Peddemors – NSW Department of Primary Industries, and Senator Peter Whish-Wilson – Chair of the Senate Enquiry into Shark Control) provided insight into the latest developments and testing of non-lethal shark bite mitigation measures in Australia. This is a highly emotive topic with the public because of the tragic impacts of fatal shark bites. Unfortunately, this situation is more politically charged through the, often misleading and sensationalised, portrayal of sharks by politicians and the media. The overwhelming message from experts at the summit was that there is no silver bullet for shark control, it requires a range of non-lethal approaches, specific to the situation.

Dr Vic Peddemors from the NSW Department of Primary Industries outlined the 'Three Key Pillars' of the non-lethal component of the shark control program:

 **DETECTION:** drones, sonar, VR4's, helicopters/aerial surveys.

 **DETERRENT:** barriers, SMART (Shark Management Alert in Real-Time) drumlines, personal deterrents

 **EDUCATION:** Shark Smart public awareness campaign, Shark Smart app

Recent technological developments in the NSW shark control program, particularly in conducting research on non-lethal alternatives to shark nets and drumlines have shown the efficacy of some of these control measures. One of the key findings of this research is that, following capture and

translocation, great white sharks that were caught on SMART drumlines did not return to the area of capture and often returned to the coast, an average of 74 days later, hundreds of kilometres away.

Associate Professor Charlie Huveneers from Flinders University presented on the latest research on personal shark deterrents. Recent testing of the effectiveness of a range of personal deterrent devices on deterring white sharks from taking bait at the Neptune Islands (South Australia) has shown that one (Ocean Guardian's Shark Shield) significantly reduced the likelihood of a shark biting a bait, though none of those tested were 100% effective. One of the major challenges with personal deterrents is that the public is not well informed on the range of devices available and the effectiveness of each device. At one end of the spectrum, this lack of clarity reduces the public confidence in effective deterrents while at the other end of the spectrum, there may be a false sense of security (encouraging greater risk taking) created by less effective deterrents.

A recent Federal Senate Enquiry was conducted by the Environment and Communications References Committee into shark mitigation and deterrent measures. The chair of this committee, Senator Peter Whish-Wilson presented some of the recommendations of the enquiry to the Shark Conservation Summit. This included the recommendation that the NSW and QLD governments should immediately replace lethal drumlines with SMART drumlines and phase out shark meshing programs while increasing the funding for non-lethal control measures and deterrents. Similar to one of Dr Huveneers recommendations on deterrents, Senator Whish-Wilson emphasised the importance of information to allow the public to assess the risks posed by sharks.

Humpback whale calf caught in shark nets on Gold Coast



PORTRAYAL OF SHARKS IN THE MEDIA

The national news media greatly influences the way the Australian public views sharks. For a long time in Australia, large sharks have been maligned, misunderstood, and actively hunted. Additionally, outside of larger, more iconic species of sharks and rays, the awareness of the majority of Australia's species, particularly endemic species, is largely non-existent. A discussion of shark and ray conservation issues in Australia is incomplete without addressing the way the media portrays this group of animals. Only large, iconic species make the news and when they do, it is after the rare and potentially tragic incidents when sharks interact negatively with humans. The language media outlets commonly use to describe such events are usually sensationalist and meant to evoke fear, and therefore interest expressed through clicks, purchases and subscriptions. The majority of the public receive their shark information from these types of sources, and so this type of attention, and the attitudes it engenders, breed public fear and aversion. Thus, a critical step in improving the public's perception of sharks lies with modifying the language the media uses in their portrayal of sharks.

To address such concerns, a panel was convened to assess the role of the media as it pertains to sharks. The panel was presented and chaired by Wendy Harmer, author, comedian and host of ABC Radio Sydney's Morning radio program. The panel consisted of Allison Langdon (60 Minutes presenter and Today host), Dr Christopher Pepin-Neff (Senior Lecturer in Public Policy at the University of Sydney and author of *Flaws: Shark Bites and Emotional Public Policymaking*), and Dr Blake Chapman (Sharks Editor at Large at Australian Geographic and author of *Shark Attacks: Myths, Misunderstandings and Human Fear*).

The panel conversations focused around public attitudes towards sharks and the influence of Australian media outlets. Members of the panel agreed that shark communicators need to adjust their message to serve differences in audiences while the media must differentiate between provoking interest and stoking fear. Changing the rhetoric around sharks in Australia is a monumental challenge, and any hope of success depends on cooperation from science and media.

KEY RECOMMENDATIONS

Create greater public and political engagement and pride in Australia's shark and ray biodiversity.

- Australian media, policymakers, and public need to understand the importance of sharks and rays to healthy ocean ecosystems, and that Australia's seas are a hotspot of shark and ray biodiversity and should be a source of national pride.
- There needs to be recognition in Australian culture of the ecological importance of sharks and rays.
- The media needs to be enlisted to raise awareness about the importance of sharks and discouraged from focusing on our human fear of them.

Continually improve Australia's leadership in global shark conservation.

- Australia is a member of international conservation treaties and must be a leading global voice for shark and ray conservation within them.
- Australia is the pre-eminent economic power in the South Pacific and Southern Indian Oceans and can contribute scientifically and economically in capacity building through consulting, materials and workshops to promote implementation of good conservation management.
- Australian influence needs to promote shark and ray conservation throughout the region by supporting development of sustainable fishing practices. Australia can showcase fisheries and conservation success stories as they lead by example.

Cooperate with range states so management of migratory sharks is better integrated. Investigate and utilise existing legal mechanisms to protect migratory and endemic, threatened and non-threatened species.

- Consolidate protections for imperilled, wide-ranging coastal species in Australia such as sawfish (*Anoxypristis cuspidata* and *Pristis spp.*), wedgefish (*Rhinidae*), giant guitarfish (*Glaucostegidae*), and more pelagic species such as tiger sharks (*Galeocerdo cuvier*) and mako sharks (*Isurus spp.*).

Conduct research into population trends and any recovery of threatened and listed species in order to evaluate the efficacy of conservation measures.

- Monitor threatened species in an effective and ongoing way to ensure population trends are accurately tracked.
- Recognise the importance and utility of novel genetic approaches (i.e. environmental DNA and close-kin genetics) to population assessments, and how they can add value to traditional monitoring techniques. These techniques can be used to identify critical habitats, monitor population trajectories, and determine if greater conservation interventions are needed.
- Recognise the value of citizen science to enhancing the sampling power of researchers and institutions but will also stimulate engagement and awareness.

Prioritise research based on critical conservation needs.

- Recognise that identification and protection of critical habitat is the priority for range or habitat limited species such as sawfish (*A. cuspidata* and *Pristis spp.*), river sharks (*Glyphis spp.*), the grey nurse shark (*Carcharias taurus*), and the Maugean skate (*Zearaja maugeana*).
- Recognise that internal injuries caused by the ingestion of fishhooks is the major threat to Critically Endangered grey nurse sharks (*Carcharias taurus*). Therefore, the conservation priority is research and development into biodegradable fishhooks.

Mitigate fishing mortality

- As postulated by the keynote speaker, Prof Colin Simpfendorfer, recognise the need to mitigate fishing mortality for threatened species as it is the most pervasive threat.
- Achieve fishing mortality mitigation by improved reporting, reduction of bycatch, strengthening of regulations, catch and effort limits, handling and release guidelines, size and bag limits, spatial and temporal closures as a means to limit fishing mortality and support recruitment, and solidifying protections for threatened species.

Renew investment in federal and state recovery plans

- Assess the efficacy of individual specific recovery plans is required in order to adjust and redraft where necessary.
- Establish a legislative instrument to resource recovery plans in order to invest in the actions recommended by those plans.
- Investigate reliable past population estimates as well as current, comprehensive population analyses for listed species. There are potential efficiencies in grouping species with similar ranges, habitat preferences and life histories such as river sharks with sawfish, and the pelagic shark species.

Work with a range of stakeholders, discourage blaming and encourage ownership of solutions

- Manage fisheries through full cooperation and participation of the fishers themselves.
- Work with all stakeholders, discourage blame, and encourage ownership. Raise recreational and commercial fishing interests to a level that will allow successful and sustainable management of a fishery.

Improved labelling on import and domestic shark products.

- Inform consumers with appropriate, species specific labelling.
- To improve traceability of shark product, labelling must include species and country of origin.

Improved monitoring and regulating of trade in shark products

- Require species-specific source codes for all import and export of shark product to adequately confront this global issue.

Research resource sharing - for scientists to share samples

- Engender cooperative and collaborative attitudes within researchers and institutions.

NGO scientist collaboration

- Recognise the importance of public awareness and communication alongside scientific research.
- Engender collaboration between researchers and conservation NGOs, ensuring scientific legitimacy and accuracy with effective dissemination of information and raising public awareness.

Cessation of lethal shark control programs.

- Research and implement effective, non-lethal alternatives to lethal shark control.
- Enact rigorous testing of the effectiveness of deterrent technologies to assist consumers
- Utilise different methods and technologies of deterrence and detection in different situations for effective solutions.
- Increase public engagement, awareness and education of shark biology and ecology, and actions an individual can take to reduce the risk of shark/human interactions.

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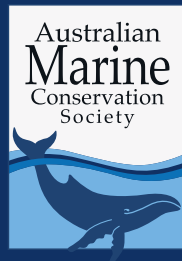
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