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Tightening the net: in search of alternatives to destructive fishing and meshing programs

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Abstract

Industrialised fishing has changed the ocean irrevocably. As technology improved, so the quantity and range of sea life extracted from the ocean increased.[1] The discourse of extraction, which we usually associate with the mining industry, is appropriate here because the fishing industry has for centuries pretended to itself and the world at large that fish are a renewable resource even though their actual practices constantly pushed fish populations in a non-renewable direction. Fishery statistics chronicle precipitous declines in fish resources across every ocean basin 2 as humans have become increasingly efficient at exploitation

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Tightening the net: in search of alternatives to destructive fishing and meshing programs

Andrew R. Davis and Allison Broad

Industrialised fishing has changed the ocean irrevocably. As technology improved, so the quantity and range of sea life extracted from the ocean increased.[1] The discourse of extraction, which we usually associate with the mining industry, is appropriate here because the fishing industry has for centuries pretended to itself and the world at large that fish are a renewable resource even though their actual practices constantly pushed fish populations in a non-renewable direction. Fishery statistics chronicle precipitous declines in fish resources across every ocean basin [2] as humans have become increasingly efficient at exploitation:

> The global ocean has lost more than 90% of large predatory fishes, Although it is now widely accepted that single populations can be fished to low levels, this is the first analysis to show general, pronounced declines of entire communities across widely varying ecosystems.[2]

As sea life populations collapse due to over-exploitation, the fishing industries they once supported spiral into terminal decline, and with it thousand year old traditions of life lived in relation to the sea. Spawning runs of the now endangered[3] Atlantic Bluefin Tuna *(Thunnus thynnus)* once sustained a large seasonal fishery in Mediterranean Spain, employing thousands of men and sustaining hundreds of villages. Today their once working ports have been converted into tourist traps and the fish they once processed by the tonne can now only be found pasted onto t-shirts and souvenirs. A glimpse of what has been lost can be seen in Hemingway's youthful report on fishing for Atlantic Bluefin Tuna in Vigo Spain for the *Toronto Star Weekly* in 1922:

> A big tuna is silver and slate blue, and when he shoots up into the air from close beside the boat it is like a blinding flash of quicksilver. He may weigh 300 pounds and he jumps with the eagerness and ferocity of a mammoth rainbow trout. Sometimes five and six tuna will be in the air at once in Vigo Bay, shouldering out of the water like porpoises as they herd the sardines, then leaping in a towering jump that is as clean and beautiful as the leap of a well hooked

rainbow.[4]

The drastic changes wrought by humans on the marine realm mean that such accounts are unlikely to be repeated. But instead of perceiving catastrophic loss, we simply adjust our expectations and despite all the empirical evidence to the contrary continue to see abundance where now there is only devastation and loss. As Callum Roberts puts it, our 'environmental baselines' are drifting such that we embrace each fresh demonstration of oceanic devastation as the environmental 'new normal'. "In just the last fifty to a hundred years, the brief span of a single human lifetime, people have spent much of the wealth of the oceans, although the effects of overexploitation can be traced back much further in time. Today's generations have grown up surrounded by the seeming normality of coasts and seabed scarred by the rake of thousands of passes of the bottom trawl, and emptied of much of their riches."[5]

One of the more destructive technological innovations that enhanced the extractive capacities of the fishing industry was the (now banned) drift net.

Although designed to target lucrative species such as tuna, billfish and pelagic sharks (as long liners do today) drifts nets indiscriminately entangled vast numbers of non-target species. Stretching for tens of kilometres drift nets function as veritable walls of death. The collateral damage they caused was sufficiently great to move even the most fishing-friendly of legislators to ban their use. Recognition of the unsustainable nature of drift net fishing saw the United Nations ban drift nets longer than 2.5kms in the high seas (UN 1991). However, in spite of this agreement, many countries continue to use drift nets in their own Territorial waters. The US limited drift nets to 2.8km in length in 1987 and the European Union banned large drift nets in 2002, but their illegal use appears to persist (Caddell 2010). To this day 'small' nets less than 2.5kms continue to be used widely . Fortunately, there is talk of a complete ban of all drift nets across the Europe Union by the end of 2015 (EC 2014).

Exact estimates of the losses attributable to drift nets are difficult to come by, but as with Hemingway's report noted before anecdotal evidence is a powerful reminder of just how things have changed. A colleague recalls snorkelling around a Fish Aggregating Device (FAD) in the tropical Pacific in the early 1980s and frequently encountering oceanic white-tip sharks – a species implicated in numerous attacks on humans in offshore waters (eg airman in WWII). He maintains that within a few years encounters with these sharks became an unusual occurrence. These declines may not be wholly attributable to the depredations of driftnets, but nevertheless reflect wholesale change in oceanic ecosystems.

Sadly, banning drift nets isn't enough to stop them from destroying sea life. Abandoned and lost nets continue to destroy marine life long after their commercial function has ceased. Termed 'ghost fishing', these untethered nets entangle all forms of marine life – drowning air breathers such as seabirds, dolphins, marine turtles and dugongs or impeding animals until they die of over-exertion or starvation. They also attract scavengers – both vertebrate and invertebrate – which also become entangled, thus ensuring that the cycle of destruction continues. Traditionally these nets had larger mesh sizes allowing smaller fish and other animals to escape, but over the years the mesh size shrank to the point were virtually nothing could get through. In addition, the materials used were organic and would eventually decay and break down if lost, but in the 1950's the industry changed to synthetic materials that do not biodegrade, thus unleashing an unstoppable menace. The ghost nets pose a mortal threat to dugongs and marine turtles – with many populations of these species already regarded as vulnerable or endangered.[6]

The dramatic effects associated with ghost nets and other marine debris interacting with endangered or vulnerable marine fauna recently prompted the Australian Threatened Species Scientific Committee (TSSC) to nominate *'Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris'* as a Key Threatening Process (KTP) under Australia's Federal *Environmental Protection and Biodiversity and Conservation Act, 1999*. As of August 2015 this nomination had not been ratified.

There are no simple solutions to the issue of destruction of marine resources by these nets. Their removal poses significant logistical challenges – locating them is akin to finding the proverbial needle in a marine haystack. Indeed, with existing technology and the limited resources made available for ocean salvage operations by world and local governmental bodies, there seems little chance of net removal unless until they are washed ashore and can be eliminated from the marine environment.

Closer to shore, pelagic fish traps have been similarly destructive. These traps targeted kingfish (*Seriola lalandi*) with ruthless efficiency. The traps were unbaited and demonstrably low 'tech'; the reflection of sunlight off a motor vehicle hubcap was sufficient to attract the dangerously inquisitive kingfish and entire schools swam into these traps. Fortunately, these traps were banned in the mid 1990's with some recovery in the annual reported landings of fish in recent years.[7] A positive of these traps, and in stark contrast to drift nets, was they produced little bycatch and were dominated by the target species.

All of the examples above have proven to be so destructive that they have warranted close scrutiny and in some cases have been banned. Yet a highly destructive form of meshing persists in NSW waters; the Shark Meshing Program, also known as the Bather Protection Program.[8] This program is one part of a multipronged approach by the State Government to protect beach goers on the open coast of NSW.

The key aim of this program is to remove large dangerous sharks from coastal waters (Table 1). Established in 1937 just over 50 beaches are meshed over 200km of the NSW coastline from Wollongong to Newcastle. Similar programs occur in Queensland, Australia and KwaziZulu Natal in South Africa. These nets do not enclose beaches. They are set several hundred metres from the shore and extend 150 metres in length along the coast and are 'sunk' 6 metres deep and set from the bottom in about 10-12 metres of water8. They have a stretched mesh size of 60 cm and act as gill nets. The nets are removed during the majority of the whale migration season (May to August) and are usually fitted with acoustic 'pingers' to deter dolphins and other cetaceans (whales).

It's estimated that in the last 50 years more than 11,000 sharks have perished following entanglement in these nets. Many shark species are particularly vulnerable to exploitation, such as meshing, as they take many years to mature and then produce very small numbers of pups (this contrasts with many fast growing tuna species that may release millions of eggs on a daily basis for many months on end). Meshing and other coastal activities have driven the Grey Nurse Shark

(*Charcharias taurus*) to virtual extinction on Australia's east coast, prompting the NSW Fisheries Scientific Committee to recognise this east coast population as critically endangered and the shark meshing program as a Key Threatening Process.[9] Over the past 60 years close to 400 Grey Nurse sharks have been killed by the NSW shark meshing program.

The indiscriminate nature of these nets is disturbing. They capture large numbers of harmless non-target species, many of which are considered endangered or vulnerable by the IUCN (Table 2). There are records of turtles, dolphins and numerous harmless sharks and their relatives perishing in these nets. They also pose an entanglement threat to migrating whales with a number requiring nets to be cut from them (Table 2). In addition, the effectiveness of the meshing program has been questioned as 40% of the sharks captured are on the beachside of the nets9 (i.e., exiting the beach) and the attraction of large dangerous sharks to moribund animals in these nets cannot be ruled out.

A recent spate of shark fatalities in WA saw the State Government adopt extreme measures. A highly controversial drum lining campaign targeted large dangerous sharks in waters near Perth. It resulted in the capture and destruction of a number of large Tiger Sharks (*Galeocerda cuvier*) whereas White sharks (*Carcharodon carcharias*) which were implicated in the fatal attacks, were not captured. Subsequent surveys of beach goers recorded a surprising number that had had a shark encounter, yet the overwhelming sentiment was that sharks should not be harmed.[10]

We now have a much clearer understanding of the behaviour and movements of large dangerous sharks given technological advances in tagging and underwater observation (video). In addition, there are a raft of emerging technologies that offer the potential to render the destructive practices associated with beach meshing obsolete. Although still in their infancy, these alternatives are deserving of independent scientific scrutiny and where this has occurred several have shown considerable promise.

The unique biological characteristics of elasmobranchs (sharks and their relatives) provide an opportunity to develop taxon-specific deterrents that minimise impacts on other marine species. Among these unique characteristics are the electrosensitive organs possessed by all elasmobranchs – the Ampullae of Lorenzini. These organs allow sharks and rays to detect as little as one millionth of a volt and thereby detect their prey in turbid water or when buried under sand. Electromagnetic impulses, including powerful magnets, overstimulate these organs causing discomfort to the animals and act as a deterrent.

Other technological advances include hyperspectral scanning of waters from above or the use of sonar to detect and identify large sharks from beneath the waves. It has been argued that current aerial patrols by human observers are limited to identifying just 20% of large sharks, but with the aid of hyperspectral scanners (devices that detect wavelengths beyond those detectable by humans) this increases to 80% and animals can be distinguished at 3m beneath the surface. Although these are not deterrents they act to alert beach goers to the presence of large and potentially dangerous sharks.

Another promising development is the recent development of chemical shark deterrents, the so-called necromones. These contain extracts of dead sharks and at relatively low concentrations appear to be highly effective at driving sharks from the immediate area. All of these technologies are deserving of consideration and a combination of approaches may yield the best outcome. For example, the combination of strong magnetics with physical barriers (eg pseudo-kelp arrays that mimic the large alga *Ecklonia maxima* of southern Africa) has shown considerable promise in field tests in South Africa.

While assessing the utility of these alternate technologies to detect and deter large sharks it should not be assumed that these alternate technologies are harmless to non-target taxa. Attention should be paid to testing their effects in a rigorous scientific setting. For example, following anecdotal reports that electrical deterrent devices designed to affect sharks had negative effects on the behaviour of bony fishes (teleosts), Broad and co-workers used an experiment to test this notion. Their work did not support the contention that fishes other than sharks were negatively affected.[11]

It is our view that it is time to invest resources into further developing and testing these emerging technologies to ensure better outcomes for humans, sharks and the environment in general. Healthy oceans demand the presence of large apex predators – sharks; it is after all their domain. It is also our firm belief that the ultimate aim must be the removal of these destructive shark nets.

Table 1: Shark taxa targeted by the NSW Beach Meshing Program, their conservation status under IUCN and NSW Fisheries Management Act, as well as the number caught and released alive in the most recent Beach Meshing Seasons. [12],[13],[14],[15],[16]

Species targeted by the Beach Meshing Program				**Season (# released alive)**			**# caught**
Shark Species	**Latin Binomial**	**IUCN Listing^ (pop. status)**	**NSW FMA 1994**	**11/12**	**12/13**	**13/14**	**14/15**
White Shark	*Carcharodon carcharias*	V(unknown)	V	15 (6)	3 (0)	6 (1)	10 (0)
Mako shark	*Isurus* spp.	V(Decreasing)	-	2 (1)	2 (2)	6 (2)	8 (0)
Dusky Whaler	*Carcharhinus obscurus*	V(Decreasing)	-	8 (1)	6 (0)	10 (1)	6 (0)
Bronze Whaler	*Carcharhinus brachyurus*	NT(Trend Unknown)	-	4 (0)	3 (0)	3 (0)	4 (1)
Spinner Shark	*Carcharhinus brevipinna*	NT(Trend Unknown)	-	-	1 (0)	-	-
Common Blacktip Shark	*Carcharhinus limbatus*	NT(Trend Unknown)	-	11 (0)	11 (2)	9 (0)	5 (0)
Bull Shark	*Carcharhinus leucas*	NT(Trend Unknown)	-	1 (0)	1 (0)	1 (1)	4 (1)

Whaler sp.	*Carcharhinus* sp.	?	-	-	2 (0)	-	-
Tiger Shark	*Galeocerdo cuvier*	NT(Trend Unknown)	-	4 (3)	2 (2)	6 (1)	2 (0)

^ V Vulnerable, NT Near Threatened

Table 2: Non-target taxa (Bycatch) caught in the NSW Beach Meshing Program, their conservation status under IUCN and NSW Fisheries Management Act (1994) as well as the number caught and released alive in the most recent Beach Meshing Seasons.[17],[18],[19],[20],[21]

Non-target taxa in the Beach Meshing Program				**Season # caught (# released alive)**			
Species Identity	**Latin Binomial**	**IUCN listing^(Pop. Status)**	**NSW FMA 1994**	**11/12**	**12/13**	**13/14**	**14/15**
Grey Nurse Shark	*Carcharias taurus*	V(Trend Unknown)	CE	4 (1)	9 (3)	4 (2)	4 (0)
Green Turtle	*Chelonia mydas*	E(Decreasing)	V	1 (0)	-	10 (1)	4 (1)
Loggerhead Turtle	*Caretta caretta*	E(Needs Updating)	V	-	1 (1)	-	-
Hawksbill Turtle	*Eretmochelys imbricate*	CE(Decreasing)	-	-	-	-	1 (0)
Ornate Eagle Ray	*Aetomylaeus vespertilio*	E(Decreasing)	-	-	-	1 (1)	-
Leatherback Turtle	*Dermochelys coriacea*	V(Decreasing)	E	-	-	2 (2)	-
Turtle	*Cheloniidae* sp.	-	Protected	2 (2)	-	-	1 (1)
Smooth Hammerhead	*Sphyrna zygaena*	V(decreasing)	-	33 (0)	19 (0)	22 (0)	42 (1)
Scalloped Hammerhead	*Sphyrna lewini*	E(Unknown)	-	-	1 (0)	-	-
Hammerhead sp.	*Sphyrna* sp	?	-	3 (0)	3 (0)	-	1 (0)
Silky Shark	*Carcharhinus falciformis*	NT (Decreasing)	-	-	1 (0)	-	1(0)
White Spotted Eagle Ray	*Aetobatus narinari*	NT (Decreasing)	-	-	-	1 (1)	-
Thresher Shark	*Alopias vulpinus*	T (Decreasing)	-	-	-	-	1 (0)
Australian Angel Shark	*Squatina australis*	LC(Stable)	-	14 (4)	3 (1)	6 (6)	1 (0)
Giant Manta Ray	*Manta birostris*	V(Decreasing)	-	-	-	-	2 (2)
Humpback Whale	*Megaptera novaeangliae*	LC(Increasing)	-	-	2 (2)	1 (0)	-
Common Dolphin	*Delphinus delphis*	LC(Increasing)	Protected	1 (0)	-	4 (0)	3 (0)
Bottlenose Dolphin	*Tursiops truncatus*	-	Protected	-	-	1 (0)	-
Indo-Pacific Bottlenose Dolphin	*Tursiops aduncus*	-	Protected	-	-	2 (0)	-

^ CE Critically Endangered, E Endangered, V Vulnerable, NT Near Threatened, LC Least Concern

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[1] Thurstan et al. 2010.

[2] See Figure 1 in Myers and Worm 2003: 280.

[3] ICUN 2015.

[4] Hemingway 1922.

[5] Roberts 2007: Preface xiii

[6] A community group recently reported 47 dead turtles associated with 505 ghost nets cast up on the beaches of the Gulf of Carpentaria (www.cleanup.org.au)

[7] DPI NSW 2009.

[8] DPI NSW 2013.

[9] FSC NSW 2005.

[10] Gibbs & Warren 2015.

[11] Broad et al. 2010.

[12] DPI NSW 2013(A): 32-34.

[13] DPI NSW 2013(B): 25-26.

[14] DPI NSW 2014: 23-24,

[15] DPI NSW 2015: 20-21.

[16] All data from the NSW Beach Meshing Program is publically available at www.dpi.nsw.gov

[17] DPI NSW 2013(A): 32-34.

[18] DPI NSW 2013(B): 25-26.

[19] DPI NSW 2014: 23-24,

[20] DPI NSW 2015: 20-21.

[21] All data from the NSW Beach Meshing Program is publically available at www.dpi.nsw.gov

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