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Community monitoring of reef sharks in the Coral Sea and Great Barrier Reef, Australia



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Abstract

This report provides preliminary results on 678 reef sharks counted by freedivers participating in *The Great Australian Shark Count* (GASC) in the Coral Sea and Great Barrier Reef waters between October and December 2007. Data reported here were collected using two different methodologies: Dedicated counts and Opportunistic counts. The most common species of reef shark counted in the Coral Sea was the Grey Reef Shark (69%) and the most common species of reef shark counted on the Great Barrier Reef was the White Tip Reef Shark (25%). The GASC project will continue throughout 2008 and early 2009 and with increased data collection will greatly improve the capacity for spatial and potentially temporal comparisons among species. These are important information gaps for fisheries and marine park managers.

Background

Australia has an large number of shark species, with at least 167 true sharks inhabiting Australian waters (Last and Stevens 1994). Sharks are captured by commercial, indigenous, recreational and game fishers, and in shark control programs for bather protection. Sharks are taken as target species and as incidental catch, which is either retained or discarded. In 1998/99, two thirds (66%) of the quantified Australian shark catch was comprised of just 15 species or groups of shark species, with the gummy shark contributing the greatest proportion (27.7 %) of the total catch (DAFF, 2004). Sharks are also valued for their intrinsic contribution to marine ecosystems and tourism. A single shark has been estimated as being worth between \$3,300 and \$250,000 to the tourism industry (Chin and Kyne 2007; WWF, 2007)

There are widespread concerns that shark catches in Australia have increased in recent years, that there is a general lack of scientific information on fished shark species, and that sharks generally are vulnerable to overfishing and climate change (AIMS, 2004; Robbins et al, 2006; Chin and Kyne, 2007). Primarily through the Australian Government Department of the Environment and Water under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), there have been recent increases in research activities and in the management of sharks in response to these concerns. Management responsibility for sharks is shared between the six State Governments, the Northern Territory and the Australian Government.

The main indicator of stock abundance used in assessments for all the target shark fisheries is catch per unit effort (CPUE) information from fishers' mandatory returns (DAFF, 2004). In recent years non-destructive fishery independent research (eg. Meekan and Cappel, 2004; DEWHA, 2008) and community monitoring of sharks has been undertaken for high profile and protected species such as Grey Nurse Sharks, Great White Sharks and Whale Sharks (Otway, 2001; Unidive 2006; CCSA, 2008; ECOCEAN 2008). Disagreement and controversy over abundance estimates for grey nurse sharks, and how these data have been interpreted by conservation and management agencies, has also resulted in legal disputes between stakeholder groups (NCC, 2007; Recfish Australia, 2007).

Relatively little research has been undertaken on reef sharks in the Great Barrier Reef (GBR) and Coral Sea areas (Chin and Kyne 2007; Undersea Explorer, 2007). A recent study on two of the most common GBR reef sharks, the grey reef shark (*Carcharhinus amblyrhynchos*) and the white tip reef shark (*Triaenodon obesus*), concluded that abundance of these species had declined dramatically on the GBR (Robbins et al., 2007). A separate more recent study on reef sharks reported that the catch per unit effort based on commercial fisheries data had been relatively stable since 1989 (Heupel et al., unpublished data). These studies highlight the need for greater understanding of the status of reef shark populations on the GBR.

The lack of information on the status of sharks in Australian waters and the need for better education about the role and importance of sharks in ecosystem integrity led to the development of "The Great Australian Shark Count". This is a community based monitoring program initiated by spearfishers of the Australian Underwater Federation (AUF) and implemented in October 2007 (AUF, 2007). In the first six months of this program, over 4000 shark sightings were reported throughout Australian waters by skindivers (AUF, 2008). This report provides more detail on sharks counted by freedivers on the GBR and in the Coral Sea between October and December 2007.

Methods

Underwater visual counts were made of all sharks sighted by skindivers usually while conducting recreational spearfishing activities. Data reported here were collected using two different methodologies:

(1) Dedicated counts - A freediver (A. Smith) recorded the species and maximum numbers of sharks sighted within 30 metres of a group of spearfishers who were aiming to attract pelagic fish with flashers and berley (Figure 1). This was carried out during a charter trip to a number of reefs, shoals and seamounts in the Coral Sea and on the Great Barrier Reef during December 2007 (Figure 2). Some individual sharks were recognisable due to individual markings (Figures 3, 4). This methodology minimised double counting the same individual shark. The freediver count used a methodology similar to a Stationary Point Count (Samoilys and Carlos, 2000), but as we attract the sharks it is also similar to Baited Remote Underwater Video (AIMS 2004; Meekan and Cappo, 2004). Additional information on time, length, sex and environmental variables was also recorded where possible (Appendix 1).

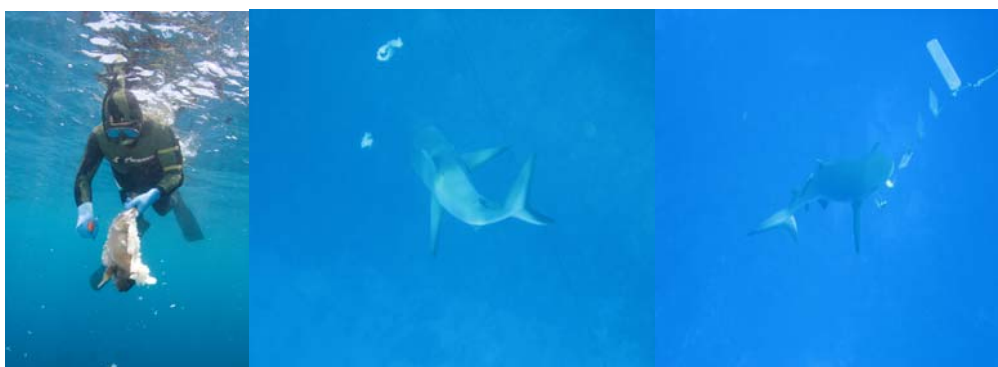


Figure 1- A freediver berlying with fish (left); Grey Reef Shark eating berley (middle); and Grey Reef Shark attracted to flasher (right).



Figure 2. Map of locations where dedicated counts of sharks were undertaken from 8-15 December 2007.

(2) Opportunistic counts - multiple freedivers recorded information on shark species, number, size, sex, date, time period, location, water temperature, visibility and depth observed. These data were reported by freedivers and spearfishers in Queensland waters between October and December 2007. They reported sightings by logging onto the Great Australian Shark Count website (AUF 2007). A data verification process was established where one of the authors checked for possible errors, duplication and also randomly selected 20% of participants for data verification (by phone call).

Results

Dedicated Coral Sea shark counts

A total of 443 sharks from 5 species were recorded from 30.5 hours of freediving (average 14.5 sharks/hour), comprising: 304 Grey Reef *Carcharhinus amblyrhynchos* (69%), 91 Whitetip Reef *Triaenodon obesus* (21%), 45 Silvertip *Carcharhinus albimarginatus* (10%), 2 Tiger *Galeocerdo cuvier* (<1%) and 1 Great Hammerhead *Sphyrna mokarran* (<1%) Sharks (Table 1, Figure 3) (Table 1). Due to the large number of sharks, individual lengths and sex were generally not determined; however a size range was estimated.



Figure 3- Grey Reef Shark (left) and White Tip Reef Shark (right)



Figure 4. Individual markings on a Grey Reef Shark

Table 1 – Counts of sharks by species, date, location, effort, and comments from the Coral Sea trip 8-15th December 2007. WT - White Tip, GR - Grey Reef, ST - Silver Tip, T - Tiger, GH - Great Hammerhead.

Date	Location	Daily Effort (hrs)	WT	GR	ST	Other	Total	Comment
8/12/07	Bougainville North	3:20	22	49	17		88	
9/12/07	Bougainville	3:10	14	25			39	
10/12/07	Holmes	5:00	27	102	1		130	Small GR
11/12/07	Holmes West	3:00	8	25	1		34	
11/12/07	Flora North	1:30		13	6		19	
12/12/07	Flora SE & W	3:20	12	52	4	1	69	T
13/12/07	McDermott	2:00			3	2	5	T, GH
14/11/07	Seamount	4:30		20	11		31	Hook in ST
15/12/07	Jenny Louise	5:00	8	18	2		28	
	TOTALS	30.5	91	304	45	3	443	

The interaction rate at three Coral Sea reefs ranged between 11 and 26 sharks per hour (Figure 3). For each of the three reefs there was some daily and location variability. The Seamount and Jenny Louise Shoal had an average of 5-7 sharks per hour. This may be because the Seamount was a small area of about 4 hectares with the shallowest point at about 28 metres. In contrast, McDermott Bank had the lowest relative number of sharks with an average of 2.5 diver\hour. This was because there were no Grey Reef or White Tip Sharks but rather large sharks such as Tiger, Greater Hammerhead and Silvertips.

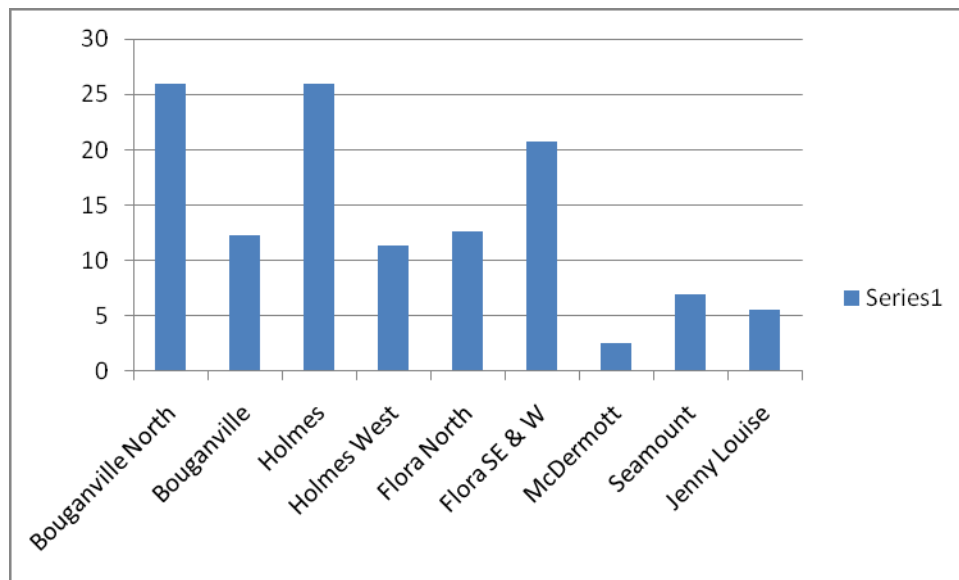


Figure 3. Average interaction rate of sharks (all species combined) counted per diver hour from Coral Sea and Great Barrier Reef.

Opportunistic counts

A total of 235 sharks from 11 species / species groups were recorded opportunistically by freedivers, comprising 58 Whitetip Reef (25%), 48 Grey Reef (20%), 39 Whaler group *Carcharinus spp* (17%), 38 Blacktip *Carcharhinus melanopterus* (16%), 20 Tiger (9%), 16 Silvertip (7%) and 16 other (7%) Sharks (Table 2). The information was grouped according to three locations: Coral Sea, Great Barrier Reef and South Queensland (Table 2).

Table 2- Summary of location, species and number of sharks, from Queensland waters (October to December 2007). WT- White Tip, GR- Grey Reef, BT- Black Tip, WH- Whaler species, ST – Silver Tip, T- Tiger

Location	WT	GR	BT	WH	ST	T	Other	Total
Coral Sea	-	11	4	7	-	12	-	34
Great Barrier Reef	58	37	34	24	16	5	2 Wobbegong 4 Tawny	180
South Qld	-	-	-	8	-	3	1 Silky 2 Hammerhead 7 Grey Nurse	21
Total	58	48	38	39	16	20	16	235

Discussion

Diversity and abundance of sharks

There were striking differences in the diversity of and diver interaction rates with sharks between the various reefs and shoals in the Coral Sea and on the Great Barrier Reef. General trends from the dedicated count methodology in the Coral Sea were that Grey Reef Sharks were more common than all other sharks at all reefs, and that the greatest number of Grey Reef Sharks were at Holmes and Bouganville Reefs. It is interesting that the Grey Reef Sharks at Holmes Reef were also the smallest observed (from 50cm, pers. observ) compared to most other locations, and also the most aggressive, coming to the surface and biting speared fish and approaching close to freedivers. Whitetip Reef Sharks were not recorded from McDermott shoal and the Cairns Seamount (Table 1). This finding is consistent with Fishbase (2008), which considers them to be a sluggish inhabitant of lagoons and seaward reefs, often found resting in caves or under coral ledges during the day, usually on a sand patch, or in a channel.

The data from the opportunistic counts (Table 2) is difficult to interpret because of the different divers, skill, location and effort involved. There were low numbers of sharks observed from the Coral Sea and South Queensland, but reasonable numbers (180) from the Great Barrier Reef. The data from the opportunistic counts of sharks on the GBR indicates that Whitetips were the most common, closely followed by Grey Reef, Whaler Group and Blacktip Reef Sharks. The primary difference between the two data sets is that Blacktip Sharks were not recorded during the dedicated counts.

It is recognised that there has been considerable work done on sharks at Osprey Reef (Undersea Explorer, 2007), but this research has focussed on length, growth and movement. There is one published estimate of abundance that states: "The resident population of sharks at Osprey Reef, the main dive site in the Coral Sea, is 40 animals" (WWF, 2007). However, we have heard anecdotal reports of between 100 to 200 sharks from several freedivers and SCUBA divers at one location known as "Scuba Zoo" at Osprey Reef (Craig Barnett, Norkat II, pers comm.).

There are no similar community monitoring programs with which to compare our data here, however there are some scientific studies reporting reef shark abundance and distribution estimates. Robbins et al. (2000) used underwater visual census of reef crests on 21 reefs in the northern and central Great Barrier Reef and at the Cocos Keeling Islands to derive mean reef shark density estimates of between 0.4 and 2 per hectare for these areas. The total number of sharks observed and the species involved were not reported in the paper, but it appears that less than 40 sharks were counted. Despite the small sample sizes, there were significant differences between mean reef shark abundance from different management zones. The greatest abundance of reef sharks was reported in no-entry (preservation) zones.

Meeken and Cappo (2004) reported that there was a striking difference in the species composition and abundance of sharks between Mermaid Reef (closed to fishing) and Scott Reef (open to fishing) in WA waters. BRUVS recorded 88 sharks from 8 species in 75 deployments at Mermaid Reef, but only 14 sharks from 5 species in 28

deployments at Scott Reef. When corrected for sampling effort, the authors estimated that sharks were, on average, from 4 to 17 times more abundant at Mermaid Reef than at Scott Reef. Analysis of BRUVS tapes also showed that it took twice as much time (50 min) at Scott Reef for sharks to appear in the video than at Mermaid Reef, further suggesting that they were much less abundant at Scott Reef than at Mermaid Reef (Meekan and Cappo, 2004). One of the few Grey Reef sharks seen at Scott Reef had a wound in its left jaw that may have been caused by fishing gear.

Implications for future monitoring and management

This baseline data comprises the first monitoring information on relative abundance and distribution of sharks in the Coral Sea and may be useful for future estimation of population size. With increasing numbers of reported shark sightings during the project, there will be increasing utility of the data; however, it is important to recognise the limitations of the methodology before making valid interpretations. Some of the issues of community reporting of data include poor species identification, potential double counting of animals, and recall bias. Most of the data collected by GASC will be ad hoc (unstructured) reporting, however the Coral Sea data collected here may provide greater insight into estimates of relative abundance. The use of underwater diver census methods also has limitations for highly mobile species such as sharks, where behavioural responses of sharks can greatly influence sightings and can also be highly variable by location, season, time of day/tide, and location within a reef. It is possible that a means of attracting sharks within visible range (by spearfishing and/or berleying) provide more accurate estimates of relative abundances of sharks, however it is uncertain the extent of reef area that sharks may be attracted from. Spatial information on species distribution is likely to be of significant benefit from the GASC project.

The GASC project will continue throughout 2008 and early 2009, and with increased data collection will greatly improve the capacity for spatial comparisons among species and hopefully also allow temporal comparisons, particularly between seasons. These are important information gaps for fisheries and marine park managers. From even initial data collected we can see benefits from the GASC, through continuation of the project beyond 2008 will be highly dependent on future funding.

The Coral Sea and the Great Barrier Reef Marine Park are important areas for all Australians. These include commercial and recreational fisheries and tourism operators. A voluntary agreement between commercial fishers and the tourism industry have been made to not catch fish at Osprey Reef in the Coral Sea (Murphy, 2007). WWF-Australia has a campaign to declare the entire Coral Sea region a Marine Protected Area (WWF, 2007). The monitoring data from the Great Australian Shark Count is essential baseline information for fishers, divers, conservationists and managers to consider in the context of current and future management.

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Appendix 1 – Data recording sheet



Date:		Dive #:		Divers:	
Time: eg Morning, or 9:30-10am		Location		GPS	
1		1		1	
2		2		2	
3		3		3	
4		4		4	
Wind: 0 - 5k, 5 - 10k, 10 - 15k, 15 - 20k, 20 - 25k, 25k+			Sky: blue sky, <50% overcast, >50% overcast, drizzle, moderate rain, heavy rain		
Current: eg slight		Vis and temp:		Depth (m) eg 10-20	

Maximum number of sharks sighted (for up to 4 dives)

Data	Whitetip	Blacktip	Grey Reef	Whaler	Tiger	Other
Number						
Length						
Sex ratio (unknown, M, F)						
Number						
Length						
Sex ratio (unknown, M, F)						
Number						
Length						
Sex ratio (unknown, M, F)						
Number						
Length						
Sex ratio (unknown, M, F)						

Comments: