Selectivity of nets and drumlines used by the Queensland Shark Control Program in Mackay

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Summary

Catches of sharks and bycatch in the 5 mesh nets and 27 baited drumlines used by the Queensland Shark Control Program (QSCP) in the Mackay region were examined to determine the efficacy of both gear types, and determining whether gear could be altered (eg replacement of nets with drumlines) without altering risk to bathers. Catch- per-unit-effort showed orders of magnitude differences among species even within the same family for the two gear types. Nets exhibited higher catch rates (per unit of gear) for almost all shark species, particularly those species considered the most risk to bathers (tiger sharks and bull whalers). Both gears caught similar sized sharks but significantly smaller ($P<0.05$) tiger sharks (*Galeocerdo cuvier*) were taken on drumlines, a result similar to other QSCP areas. Bycatch species (turtles and marine mammals) were rarely caught on drumlines. The situation at Mackay differs from Cairns in that nets are far more effective at catching the higher risk shark species such as tiger sharks and bull whaler sharks. Catch rates at the two beaches that had both nets and drumlines (Bucasia Beach and Harbour Beach) showed that the Bucasia nets in particular caught proportionally higher numbers of bull whaler sharks than adjacent drumlines (twenty five times more bull whaler sharks were caught per net compared to an individual drumline at Bucasia) The catch rate data suggests that the removal of nets and replacement with drumlines would not be able to maintain the same level of catches (and therefore the same risk profile) at Bucasia and Harbour Beach for bull whaler sharks. In contrast, analysis of the Eimeo Beach catch data suggests that the net could be permanently replaced with drumlines due to the similarity in monthly catch obtained for both gear types. It is important to recognize that quantification of both ecological risk and risk to bathers is not a simple task and many unquantifiable factors (including individual shark behavior), not specifically related to the type and quantity of fishing gear used, will be important in determining overall risk and future catches of target shark species. There is also no guarantee that future catch rates will be as predicted based on past history.

Introduction

The Queensland Shark Control Program (QSCP) has been in operation for over 50 years (Paterson 1979, 1986) being implemented after a series of fatal shark attacks on Queensland beaches in the middle of last century. The program has successfully used a mixed fishing strategy of baited drumlines and large-mesh nets to target large sharks (> 1.5m) that are considered potentially dangerous to humans (Paterson 1990, Anon 2006).

Nets and drumlines have different catching characteristics with the former being a fairly passive system relying on meshing sharks while baited drumlines catch sharks that are actively feeding (Gribble *et al*. 1998a) and attracted to the bait. Over the years both methods have proven effective at catching large sharks but each has been shown to capture animals other than the targeted high-risk shark species (Paterson, 1986, 1990). In the past, nets have been replaced with drumlines in areas where specific bycatch species have been an issue (see for example Townsville and Capricorn Coast). When this has occurred, a rule based on economic costs of the two gears and also on historic total shark catch, has generally led to the replacement of 1 net with 6 drumlines. Recent analysis has however shown that the effectiveness of the two gear types varies regionally, probably related to a range of factors including, water clarity, proximity to estuaries and/or reefs, water depth. For this reason each location needs to be examined in isolation to account for local differences in efficiency.

The main high risk shark species in terms of potential to harm bathers are the tiger shark (*Galeocerdo cuvier*), bull shark (*Carcharhinus leucas*) and the white shark (*Carcharodon carcharias*) and recent research (Sumpton *et al* 2011) has shown that the efficiency of a particular gear varies dramatically from species to species as well as regionally. White sharks are not as high risk species in Mackay as there have been none caught in the QSCP in the last 20 years, although they are known to occur in the area and have previously been caught by the QSCP in Mackay. Other relevant research comparing the two gear types in South Africa (Dudley *et al*.

1998) concluded that drumlines had greater species selectivity for shark species and also reduced bycatch when compared to nets but overall the Natal Sharks Board in South Africa still regard a combination of both nets and drumlines as the optimum beach protection strategy.

There are basically 5 beach areas in the Mackay contract where shark fishing gear is located. Two of these areas have a permanent mix of both nets and drumlines while two others (Blacks Beach and Lamberts Beach) only have drumlines. Eimeo Beach has a net for approximately 7 months of the year (April to October) which is replaced with 6 drumlines for the remainder of the year when turtles are nesting.

In this report the selectivity of nets and drumlines for capturing sharks and bycatch in the Mackay Shark Control Program is discussed. Specifically, the species composition and size of sharks caught by the two methods are compared and the relative effectiveness of each method in catching sharks considered potentially dangerous to humans is assessed. Issues of non-target bycatch selectivity and risks associated with the replacement of nets with drumlines are discussed.

Materials and Methods

There are five beaches at Mackay that have QSCP gear but only three of these have both drumlines and nets (See Table 1 and Figure 1). Bucasia Beach and Harbour Beach both have two nets and 6 and 9 drumlines respectively while the single net at Eimeo beach is replaced with drumlines for approximately 5 months of the year (November to March) when marine turtles are nesting in the area. The other two beaches (Blacks Beach and Lamberts Beach) only have six drumlines each and will not be included in the gear comparison analysis as they are greater than 1km away from other QSCP net protected beaches and can probably be considered independent of the other three beaches where both gear types are used.

A feature of Mackay is the large tidal range (over 6 metres) which affects some of the logistic aspects of gear effectiveness and maintenance. Generally the gear at Blacks Beach, Eimeo Beach and Bucasia Beach are set in shallower water than the other two beaches. The three main rivers/ creeks that flow into the area are Eimeo Creek and McCreadys Creek that drain into the two bays to the north and the larger Pioneer River which enters the ocean about 3 kilometres south of Harbour Beach. Marine stingers are also a significant risk to bathers in this area during the warmer months of the year and swimmers are advised to take precautions to avoid being stung and/or to swim within enclosures. Of the beaches protected by QSCP gear, Bucasia Beach is the only one that has such a swimming enclosure, despite a number of other beaches in the region having enclosures but not having QSCP fishing gear (eg Seaforth and Haliday Bay). While these enclosures are mainly to protect bathers from marine stingers they also afford protection from shark interactions.

Surface mesh nets used by the QSCP in Mackay are constructed from two or three 62 m net panels each with a 6m drop and 1.6 mm diameter polypropylene mesh with a stretched mesh size of 50 cm (see Sumpton *et al* (2011) for a detailed description of gear types). In Mackay, the nets used at Bucasia Beach are the traditional three panel nets used on the Gold Coast, Sunshine Coast and other areas that use nets, while those used at Eimeo Beach and Harbour Beach are only two panel nets. There was also a period up to 2006 where one of the Harbour Beach nets was a bottom set net identical to those used in New South Wales but we have not adjusted for this in the analysis due to the similarity in shark catch between these two nets (see Appendix). Likewise, whilst we have conducted analyses incorporating the effects of 3 panel versus two panel nets we have generally presented data that assumes each net as an independent sampling unit with the same species catchability, although the impact of this assumption is presented in the subsequent discussion.

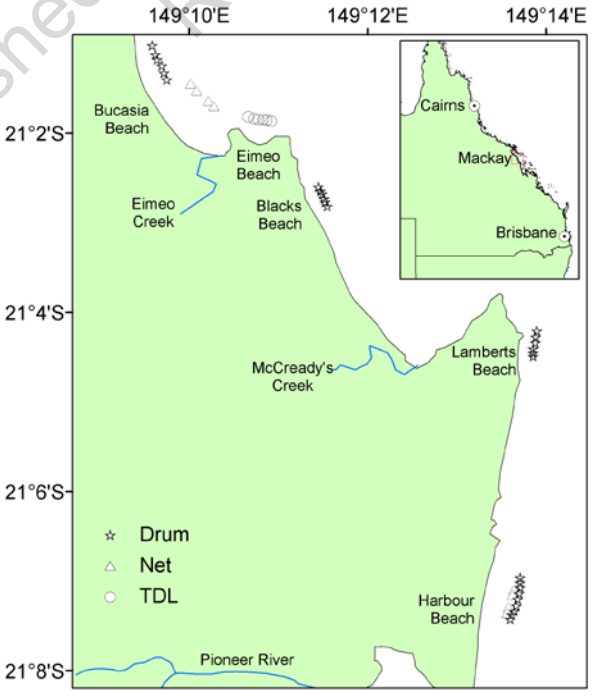
Drumlines in Mackay differ from those used in the southern part of the state consisting of two 14/0 Mustad shark hooks (set back to back) suspended from an A3 polyform buoy using a length of five millimeter galvanized chain trace and variable length of 14mm polypropylene rope (see Sumpton *et al* (2011) for more detail or drumline configuration). Nets and drumlines were generally set roughly parallel to the shore in water between 2 - 6 m in depth at low tide, with the distance to shore varying from beach to beach depending on local topography (See Figure 1).

QSCP fishing gear was checked and rebaited (in the case of drumlines) 14 days each month by a contracted fisher. Each day the gear was checked, details of shark catch and bycatch are recorded including species, sex, total length (curved carapace length for turtles) and the vitality (alive or dead) of each animal. This report concentrates on catch data collected from the five nets and 27 drumlines since 1992 with an emphasis on data collected after 1995. The current contract fisher has serviced the gear throughout this period (and earlier) but species identifications were more accurately determined from about the mid 1990's. It is also consistent with earlier comparative analyses conducted in Cairns and southern Queensland (Taylor et al 2012).

A number of generalized linear models were used to explore the catch rate data and adjust for the effects of various factors in determining catches but these were eventually abandoned due to aliasing as a result gear differences across beaches and obvious differences in the selectivities of the two gear types for almost all species. The analysis examines each beach separately although it is acknowledged that QSCP gear set at adjacent beaches probably impacts the catch and risk profile of other nearby beaches. This is particularly the case for the north Mackay area between Blacks Beach and Bucasia Beach, an area that has a particularly high density of fishing gear.

Size frequency distributions of sharks were compared using Kolmogorov-Smirnov tests and since these distributions were basically normally distributed average lengths were compared using Student's "t" tests.

Figure 1 Mackay area showing locations of Queensland Shark Control Program (QSCP) fishing gear (5 nets and 27 drumlines). TDL refers to the temporary drumlines that replace the Eimeo Beach net from November to March each year.



Results

Beach specific trends in catch of the two main high risk species are shown in Table 1. Generally beaches in the south had the highest tiger shark catches while bull shark catches were highest at beaches that had nets, and were generally in closer proximity to creek and river mouths (eg Bucasia Beach and Eimeo Beach). When catches were standardized for the quantity of fishing gear at the particular beaches the possible effects of gear saturation became more evident as catches from the high gear density beaches of Bucasia and Harbour were proportionally reduced.

Table 1 Number of bull sharks and tiger sharks caught at each of the five QSCP protected beaches at Mackay from 1996 to 2012. Standardised catches are also presented in the last two columns where each 3 panel net and set of 6 drumlines has been allocated as a single unit of gear with proportional allocation depending on number of panels and drumlines at each beach.

Beach	No. of nets	No. of drumlines	Bull shark catch	Tiger shark catch	Bull shark stand. catch	Tiger shark stand. catch
Bucasia Beach	2	6	106	77	35	26
Eimeo Beach#	1#	6#	78	52	78	52
Blacks Beach		6	71	109	71	109
Lamberts Beach		6	49	281	49	281
Harbour Beach	2	9	76	341	27	120

Table 2 presents the inter-specific differences in gear efficiency for shark species and bycatch at Bucasia and Harbour beaches. These data highlight that nets were generally the most efficient shark fishing gear at these beaches. Both of the main “high risk” target species (bull sharks and tiger sharks) were highly selected for by nets and were caught in the ratios of 12:1 and 2.5:1 respectively, in nets compared with drumlines although there were beach specific effects, particularly for bull whaler sharks. The Bucasia Beach nets being 3 times more efficient at catching bull whalers than the Harbour Beach nets. The differences for tiger sharks was less dramatic with gear efficiency ratio of 0.42 at Bucasia Beach compared to 0.39 for Harbour Beach.

Virtually all bycatch species (particularly marine mammals and turtles) were only caught in nets during the last 17 years (Table 2). Other low risk elasmobranchs (rays, tawny sharks and sawfish) were also predominantly caught in nets. This was particularly noticeable for cownose rays which were not caught on drumlines but over 100 were caught in nets. One exception to this was Zebra sharks which were more common on the Harbpour Beach drumlines than nets. Of the 21 manta rays caught by the QSCP in Mackay since 1995 only one was hooked on a drumline.

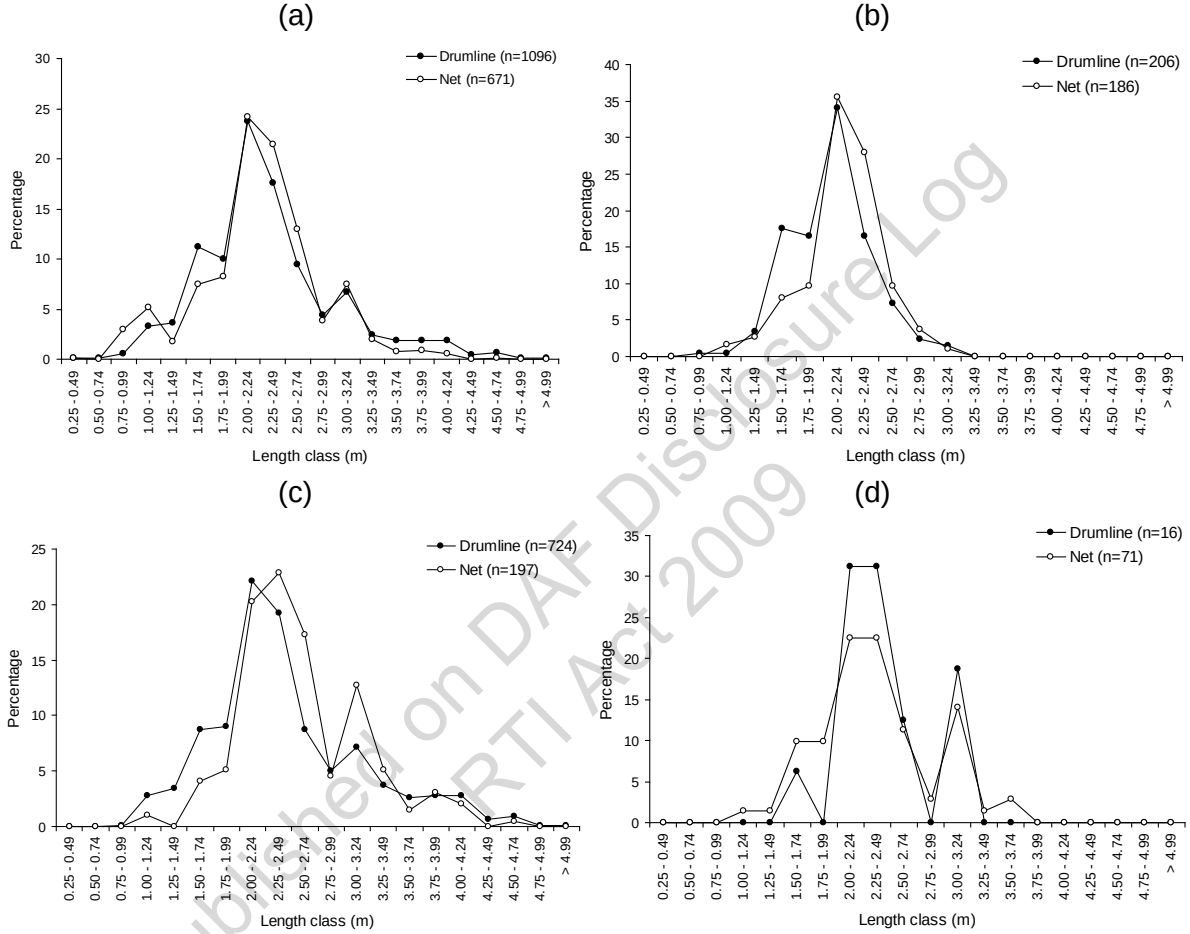
Drumline bycatch was obviously too low to statistically test for differences in size of bycatch species between gear types (Table 2). This result confirms that drumline bycatch is generally not as problematic in Mackay as in other areas. Net bycatch was also low compared to other areas that have QSCP gear.

Table 2 Total numbers of selected shark and bycatch species caught in QSCP nets and drumlines at Bucasia Beach and Harbour Beach from 1996 to 2012. Standardised gear efficiency ratio is the number of animals caught per drumline each year divided by the number caught per net per year.

Scientific name	Common name	Catch (No.) Bucasia Bch.		Catch (No.) Harbour Bch.		Standardised gear efficiency ratio	
		Drum line	Net	Drum line	Net	Bucasia Beach	Harbour Beach
Galeocerdo cuvier	Tiger shark	43	34	216	124	0.42	0.39
Carcharhinus leucas	Bull whaler	12	93	27	49	0.04	0.12
Carcharhinus amboinensis	Pigeye whaler	0	8	6	4	0.00	0.33
Carcharhinus brevipinna	Long-nose whaler	2	5	0	3	0.13	
Carcharhinus melanopterus	Blacktip reef whaler	4	22	4	12	0.06	0.07
Carcharias taurus	Grey nurse	1	0	0	0		
Sphyrna mokarran	Great hammerhead	0	1	0	0		
Sphyrna lewini	Scalloped hammerhead	0	32	4	14		0.06
Nebrius ferrugineus	Tawny shark	3	22	0	1	0.05	
Stegastoma fasciatum	Zebra shark	0	16	21	11		0.42
Rhinoptera neglecta	Australian cownose ray	0	110	0	21		
Pristis spp	Sawfish	0	1	0	0		
Manta birostris	Manta ray	1	7	0	13	0.05	0.00
Caretta caretta	Loggerhead turtle	2	6	0	6	0.11	
Chelonia mydas	Green turtle	0	4	0	19		
Sousa chinensis #	Indo-pacific humpback dolphin	0	2	0	1		
Orcaella heinsohni	Irrawaddy dolphin	0	0	0	1		
Dugong dugon	Dugong	0	1	0	3		

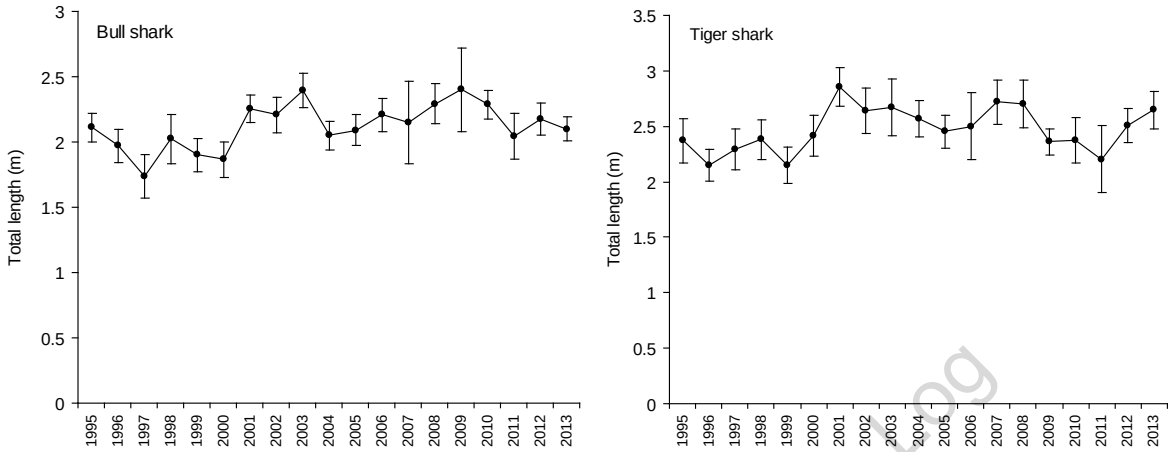
There was no significant difference (P>0.05) in the size of sharks (all species combined) caught in the two gear types (Figure 2). *G. cuvier* caught in nets were significantly larger (P<0.05) than those caught on drumlins. Small *G. cuvier* (<2 m) were relatively poorly represented in net catches, which contributes to the larger overall average size of this species in nets.

Figure 2 Size distributions of (a) all species combined, (b) bull sharks, (c) tiger sharks and (d) scalloped hammerhead sharks caught in Mackay from 1996 to 2012.



Catch data and observer records were also analyzed to assess any systematic misreporting of catches but there were insufficient bycatch records to asses under-reporting of bycatch. Shark catches did not differ between observer and non-observer days. A “shark bounty”, where contractors were paid for sharks greater than 2m in length was discontinued in 2002 and there was no evidence that this had affected the numbers of larger sharks recorded by the contractor (Figure 3). In fact there was evidence to suggest that the mean size of both bull sharks and tiger sharks had actually increased since 2001.

Figure 3 Average length of bull sharks and tiger sharks caught by the QSCP in Mackay from 1995 to 2013. 95% confidence intervals are shown as vertical bars. Shark bounty (where a price was paid for sharks in excess of 2m in length) was discontinued in 2002.



There was a trend for catching larger sharks (on average) during the spring and early summer (Figure 4). This trend was most noticeable for tiger sharks.

Figure 4 Seasonal change in the average length of bull sharks and tiger sharks caught by the QSCP in Mackay (Data from 1995 to 2013). 95% confidence intervals are shown as vertical bars.

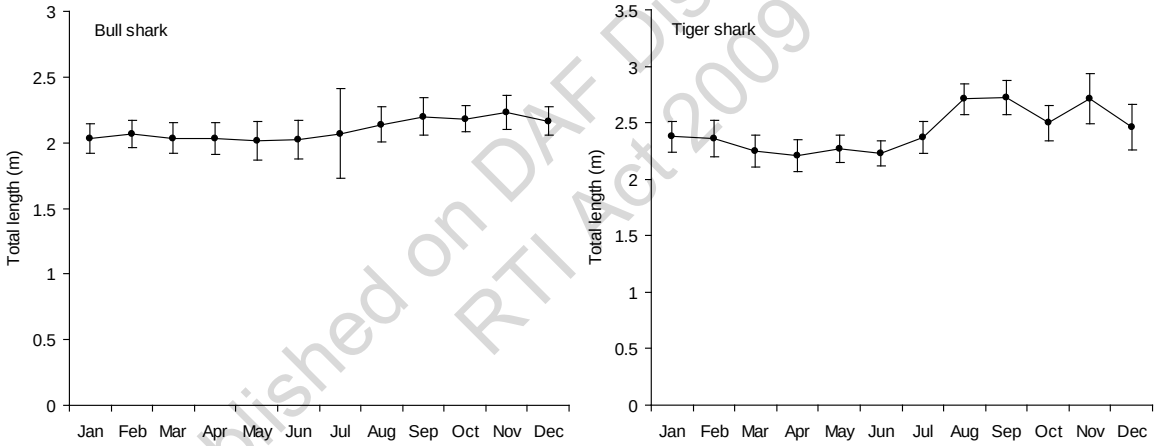
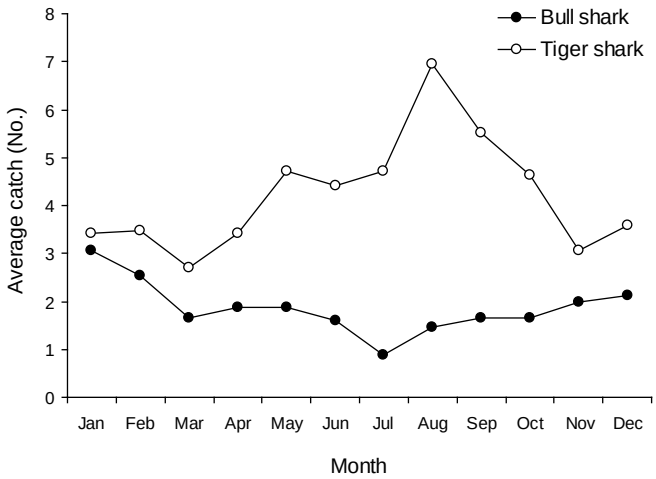


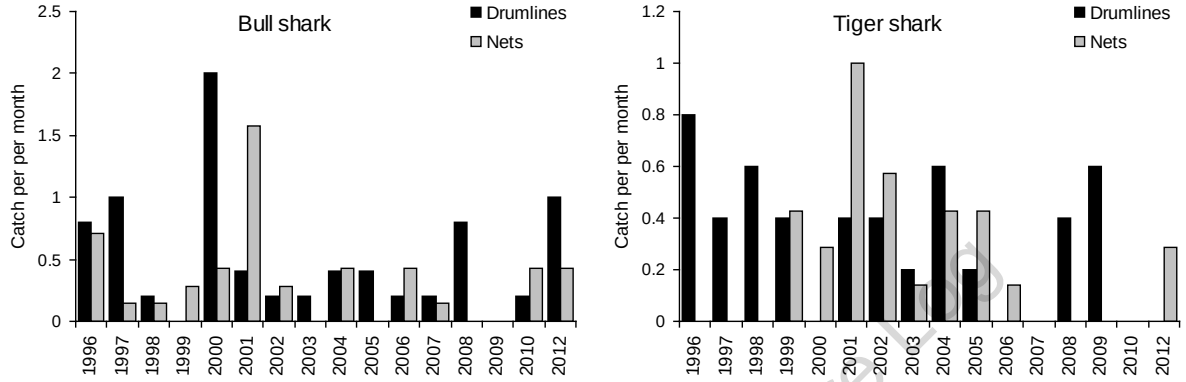
Figure 5 Average number of bull sharks and tiger sharks caught each month at Mackay from 1996 to 2012.



The seasonal catch of both high risk shark species (Figure 5) was contrasting with high bull shark catches during the summer months while tiger sharks dominated the catch during the

winter and spring period. Typically the summer is the highest rainfall season and the time of highest water turbidity.

Figure 6 Number of bull whaler sharks and tiger sharks caught in the Eimeo Beach net and drumlines per month from 1996 to 2012. A single net is used from April to October and this is replaced with 6 drumlines for the remainder of the year.



At Eimeo Beach the total numbers of tiger sharks caught in nets and drumlines between 1996 and 2012 was the same (26 sharks) while two more bull whaler sharks were taken on drumlines during the same period (40 on drumlines compared with 38 in the net). When catches were standardised for the different time periods that the two gears were in place the average monthly catch of both bull whaler sharks and tiger sharks was actually significantly greater on drumlines compared to nets (Figure 6). For this analysis the data are presented as total catch on all drumlines rather than being standardized per individual unit of gear since the single net at Eimeo was replaced with six drumlines each year and both “methods” were thus regarded as a single sampling unit for comparative purposes.

Discussion

Opinions differ on the shark species that pose the greatest risk to humans (Cliff *et al*. 1989, Cliff and Dudley, 1992; Last and Stevens, 1994). This is not surprising because risk is a function of the local abundance of a species, its preferred habitat (in relation to bather use) as well as the behavioral characteristics and diet of individual species. In the Mackay region the high risk species have different vulnerabilities to the two gear types but like other areas bull sharks are particularly susceptible to net capture, *G. cuvier* have large broad and blunt heads and that may be less likely to be meshed in nets than the other more fusiform-shaped Carcharhinid (whaler) sharks and are thus not as readily meshed. They also consume a broad array of prey (Lowe et al. 1996), and the preference of smaller individuals for teleost prey (Simpfendorfer 1993) may also explain the capture of sub-adults on drumlines. The white shark *C. carcharias* are also of less of an issue in this region due to their largely temperate/subtropical distribution. In other QSCP areas that use both fishing methods, *C. leucas* have been shown to be the most susceptible to net capture (Gribble *et al*. 1998a, Sumpton *et al* 2011). Werry (2010) has shown a relationship between *C. leucas* net catch and rainfall suggesting that increased turbidity or movement of sharks out of estuaries and into the near-shore environment may be responsible for enhanced net capture rates for this species. The Mackay contract area has a number of creeks and estuaries flowing into the sea and this may explain the comparatively high net catch of this species, particularly at Bucasia Beach where the nets are set directly in front of a creek mouth.

Given the highlighted vulnerability of the main target species to specific gear types the management policy of replacing one net with 6 drumlines (Anon 1992, Gribble *et al*. 1998a) has probably been effective at not increasing the risk of shark attack. Logistic and cost issues may also be influential in determining the most appropriate mix of gear for an area. For example, dolphins (mainly *Tursiops* spp) have been observed removing the baits off

QSCP hooks within a few seconds of them being baited on some specific beaches (Sumpton *et. al,* 2010) in southern Queensland. In these situations, baited drumlines are obviously less effective but the contractor and QB&FP observers report that Mackay does not have the same problems with scavenging dolphins as are experienced in southern Queensland (Sumpton *et al* 2010).

The ability of bycatch species to survive capture should also influence the appropriate fishing gear type, if survival of bycatch is to be maximised. Estimates of survival of some species of sharks are available for both the South African (Cliff and Dudley, 1992) and New South Wales (Reid and Krogh, 1992) shark meshing programs. Low rates of hammerhead sharks were evident in all three studies confirming them as the most vulnerable elasmobranch group. Non-obligate ram ventilators survived well in both types of gear and there were clearly dramatic differences in the ability of various taxa to survive capture in each type of gear. However, for almost all taxa, survival was highest on drumlines.

Of the main bycatch species, survival of *C. caretta* and *C. mydas* was relatively high in both gear types but significantly higher on drumlines. It was still somewhat surprising to have a high rate of turtle survival in nets due to the need of turtles to breathe, something that would only be possible if they were meshed towards the top of the net and able to surface. While drumline bycatch was low, survival was high, reflecting the ability of these animals to swim to the surface to breathe when hooked. Dolphin bycatch mainly occurs in nets and is an issue in KZN (Cockcroft 1990, Durham 1994, Dudley and Cliff 1993) as well as Australia (Dudley 1997). While pingers and acoustic alarms have been used on nets for many years their efficacy is debatable for some species and conditions (Jefferson and Curry 1996, Cox *et al.* 2003). During the present study all nets were fitted with dolphin pingers yet nets still posed the greatest risk to dolphins. Non-carnivorous bycatch such as *D. dugon* and *C. mydas* are unlikely to be caught on baited hooks although they can be foul hooked as they swim past a drumline. This has been observed occasionally for *C. mydas* (personal observation) although no *D. dugon* has been caught on a drumline to date in Mackay.

A mixed fishing strategy using both nets and drumlines has been recommended as most effective (Dudley *et al*. 1998, Anon 2006), the greater catch rate of target species on nets in the Mackay area Any reduction in nets in Mackay would certainly reduce the sawfish, dolphin, green turtle, loggerhead turtle and dugong catch. It would also reduce the catch of crocodiles which have recently been meshed in Mackay nets.

A number of other important beaches in the area are not protected by any QSCP gear Harbour Beach is patrolled life saver year round while Lamberts Beach, Blacks Beach and Eimeo Beach are patrolled during school holiday period (except June /July holidays). The concept of a regional protection strategy where individual beaches contribute to overall reduction in risk over a broader area has yet to be confirmed as a valid strategy. There are certainly other high use beaches in the immediate area around Mackay that have remained free of incident for many decades. Haliday Bay and Seaforth are examples of this. Both of these beaches have permanent swimming enclosures and do not have any QSCP fishing gear.

Recent movement studies have confirmed the wide ranging movement patterns of some individuals from the higher risk shark species.

Logistic issues related to the environment (both biotic and abiotic) also need to be considered and there are area specific problems including bait scavenging by dolphins and other marine animals. In some cases drumlines are rendered less than effective if scavengers remove the bait from the hook. Bait scavenging of drum lines is not a significant issue in Mackay sch4p4(6) Personal inf personal observation) and this is also supported by the low bycatch on drumlines in this area. Sumpton *et al*. (2011) has shown that drumlines pose

a greater risk to loggerhead turtles than do nets in southern Queensland but the fact that most of the turtles incidentally caught in Mackay are green turtles reduces the overall catch of these marine reptiles.

It needs to be recognized that these catch rates were still much lower than nets used by the QSCP in areas further south. The replacement of this net with drumlines should enable the maintenance of the same level of catch but there is no guarantee, and any quantification of precise changes in risk remains difficult. This is due to the uncertainties in assessing the behaviour of individual sharks that may or may or not be susceptible to one or other of the capture methods. The relatively high net catch of bull whaler sharks may be due to the proximity of nets to the nearby creek/river mouths. It is well established that nets catch bull sharks after rainfall events that increase turbidity and may increase the catchability of bull whalers (Werry 2010) in these types of locations.

The relatively high catch rates of target species in the Mackay nets suggests that the removal of nets and their replacement with drumlines is not as viable an option as it is for other QSCP areas. The number of drumlines located at each beach is currently relatively uniform at 6 per beach apart from Harbour Beach which has an additional 3 drumlines. Target shark species catch rates indicate that similar catch levels would be difficult to maintain by replacing nets with drumlines particularly at Bucasia Beach. The nets at Bucasia Beach are located in the optimum area to catch Bull whaler sharks, being located close to the mouth of an inlet. Another option may be to replace one of the Bucasia Beach nets with drumlines in order to test whether drumlines could maintain similar catch rates as historically achieved by the Bucasia Beach nets.

It is important to remember that there is no guarantee that the replacement of nets with drumlines will see the catch rates, predicted from historic analysis of previous catches, maintained.

There are a number of logistic issues that also reduce the relative efficiency in nets at Mackay. These mainly stem from the large tidal range experienced in the area where tidal range can exceed 6m. Discussions with the current shark contractor sch4p4(6) Personal informat have highlighted that nets in the region quickly become fouled during the warmer months of the year and particular rendering them less effective for meshing sharks. In addition a number of contractors both current and previous have noted that nets work best when they "self bait". That is they tend to catch when another marine animal has become meshed in the net and effectively attract sharks to the net where they are meshed. Despite these inefficiencies the Mackay nets still outperform drumlines to a significant degree.

In terms of maintaining catch rate of tiger sharks the replacement of the two Harbour nets with 5 drumlines should maintain tiger shark catch rates. However, and additional 16 drumlines would be required to replace the Harbour nets in order to maintain the same level of catch. This analysis and discussion is obviously heavily dependent on the assumption that the gears are virtually acting independent of one another but this is clearly not the case as it is difficult to accurately predict whether a shark that is meshed in a nets would also be likely to be caught on a drumline if that net was not there. Gear saturation effects, and other logistic features of the gear plus individual shark behavior is obviously very influential in determining catches. There is no guarantee that the sharks would be taken on.

There is a history of drumline replacement with nets in other QSCP areas.

The Eimeo net has been replaced with drumlines regularly during part of the year

Bucasia Beach also has a swimming enclosure and discussions with the local surf club at Eimeo Beach and the current contractor confirms that there is limited swimming outside the

Bucasia enclosure with much more bather activity at Eimeo Beach. What are the effects of the Bucasia net on the Eimeo catch??

There are three nets in the Mackay contract area that are only 2 panels as opposed to the usual 3 panel nets. These are the two at Harbour Beach and the Eimeo net. This latter net is also replaced with drumlines during the period of November to March when nesting turtles are more common in the area.

One of the features of the Mackay area is the proportionally high fishing effort at two of the beaches. There are few areas protected by QSCP gear that have two nets as well as drumlines

One of the features of drumlines that make them a less effective option is the fact that bait quickly becomes decomposed and less effective during the warmer months of the year.

The issue of drumline bycatch is also not as problematic as only mullet are used to bait drumlines and there have been no significant cetacean bycatch on drumlines at Mackay.

Drumlines were added to both Lamberts Beach and Black Beach when the current contractor took over operations of the Mackay contract.

Acknowledgements

sch4p4(6) Personal inf the shark contractor at Mackay provided useful discussion regarding the gear and other aspects of the operations of the Shark Control Program. Several QB&FP Officers and local council officers also contributed valuable local knowledge and their experience dealing with the QSCP at Mackay.

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Appendix – Comparison of top set and bottom set net at Harbour Beach, Mackay (2001 to 2006)

Table 1 Numbers of various species of animals caught in top set and bottom set mesh nets at Mackay between 2001 and June 2006. Species considered to be non-target or bycatch species are shown with an asterisk.

Common name	Qld net (top set)	NSW Net (bottom set)
Blacktip reef whaler	3	2
Bull whaler	4	5
Cownose ray*	5	1
Dugong*		1
Eagle ray*	1	
Flatback turtle*		1
Green turtle*		1
Hammerhead shark	1	
Loggerhead turtle*		4
Long nose whaler	2	
Manta ray*	1	4
Pigeye whaler	1	
Sawfish (ray)*	1	
Scalloped hammerhead	1	5
Shovelnosed ray *		2
Tawny shark*	2	3
Tiger shark	23	22
Grand total	45	51

Table 2 Average size of various species of animals caught in top set and bottom set mesh nets at Mackay between 2001 and June 2006.

Common_name	Qld net (top set)	NSW Net (bottom set)
Blacktip reef whaler	2.47	1.45
Bull whaler	1.98	2.40
Cownose ray	0.40	0.00
Dugong		2.16
Eagle ray		
Flatback turtle		1.00
Green turtle		0.94
Hammerhead shark	2.90	
Loggerhead turtle		0.99
Long nose whaler	2.10	
Manta ray	1.40	1.23
Pigeye whaler	2.30	
Sawfish (ray)		
Scalloped hammerhead	1.90	2.46
Shovelnosed ray		1.65
Tawny shark	3.05	2.60
Tiger shark	2.49	3.01

Overall the bottom set net caught more bycatch than the conventional Queensland top set net whereas there were no significant differences in the shark catch between the two nets.

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