



# Boosting shark safety in the Whitsundays region



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## Disclaimer

While all efforts have been made to verify facts, this report is not a published scientific paper.

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# 1.0 Executive Summary

Following several shark bite incidents in the Whitsundays from 2018 to 2019, the Queensland Government commissioned research to understand the abundance, distribution and movement of sharks in the Whitsundays. In conjunction with this research, Fisheries Queensland commissioned Reef Ecologic to work with key stakeholders in the Whitsundays to investigate how water users such as boaters, fishers, swimmers and divers could reduce their risk of a shark bite by altering their own behaviours. The project began in November 2019 and was completed in January 2021.

The project commenced with a series of stakeholder workshops, bringing together tourism operators, fishers, divers and other Whitsundays community members with marine managers and shark researchers to explore potential risk factors and co-design possible solutions.

Following a pause due to the COVID-19 pandemic, the project resumed in September 2020 with the Reef Ecologic team working with selected bareboat sailing charter operators as the test group for the project. The objectives of the project were to: 1) identify human behaviours that could be contributing to increased risk of shark bites, 2) identify ways to alter these behaviours to reduce risk of shark bites, 3) pilot trial a behavioural intervention for at least one key stakeholder group targeting at least one priority behaviour.

Building on the Queensland Government's SharkSmart guidelines a behavioural change intervention research study was designed with the aim of influencing fishing, swimming and waste disposal behaviours of tourists. The following eight desired SharkSmart behaviours were investigated with bareboat tourists in the Whitsundays region.

## In-water swimming/snorkelling behaviours

- Avoid swimming near (within 200 m) people who are fishing.
- Avoid swimming in murky water.
- Avoid swimming alone.
- Avoid swimming near baitfish or schooling birds.
- Avoid swimming in busy anchorages.
- Avoid swimming at dawn or dusk.

## Boating and fishing behaviours

- Avoid fishing near (within 200 m) people who are swimming.
- Avoid throwing fish frames/fish scraps into the water.

A before, after, control, impact (BACI) scientific study design was used to test the effectiveness of interventions. Surveys were conducted before and after intervention to measure changes in knowledge and behaviour. Between September and December 2020, behavioural interventions were delivered for two tourism companies. A third company was used as a control and did not receive any intervention. A total of 229 tourists were surveyed upon return of their trip. The main water-based activities undertaken by guests were swimming/snorkelling (91.3%) and fishing (68.2%). The majority of tourists (98.3%) were from Australia with 86% from Qld.

Tourist knowledge of shark safety behaviours was very high (93-100%), but knowledge was not a strong predictor of behaviour. Approximately 3 out of 10 people ignored one or more of the voluntary

SharkSmart guidelines and participated in risky behaviours including swimming alone, swimming with baitfish, swimming in murky water, not following signage and disposing of food or fish scraps in the water. The knowledge-behaviour inequality was particularly evident when it came to several in-water and waste disposal behaviours. Despite very high knowledge of the importance of keeping fish waste and food scraps out of the water where people swim (100% of respondents claimed to be aware of this behaviour both before and after the intervention), around 30% of people reported throwing food waste or fish waste into the sea.

Six recommendations are provided with the aim of improving research and encouraging behaviour change to reduce the risk of shark bites in the Whitsundays region. Comprehensive recommendations are in Chapter 10 and an abbreviated summary of the recommendations is:

- I. Expand shark safety interventions to other tourism operators in Whitsundays.
- II. Expand shark safety interventions to include recreational and commercial fishers
- III. Management agencies influence behavioural change through mechanisms such as special management zones, regulation, or penalties.
- IV. The Australian Shark Attack File include additional data that support behavioural change interventions.
- V. A higher level of caution is applied in the Whitsunday region between September and December due to increased shark risk
- VI. In future studies, include surveys of fishing catch and barriers to keeping food and rubbish onboard

## 2.0 Background

Sharks inhabit Queensland coastal waters and over one million tourists (Binney, 2009) and locals who swim, surf, fish, snorkel and SCUBA occasionally interact with fear and/or awe (Haskell et al. 2014). Many sharks are timid and actively avoid encounters with people (Gibbs and Andrew 2015, Richards et al. 2015). Commercial and recreational fishers report that interactions with sharks are increasing, and a Western Australian study recorded shark depredation or “shark tax” on around 40% of recreational fishing trips, with on average 11-13% of all fish caught depredated by sharks (Mitchell et al. 2019). There is evidence that fatal shark bites on humans are increasing (McPhee 2020), though some species are endangered and have declined, and there is limited data on others (MacNeil et al. 2020). The international shark attack file puts the global risk of shark bite as one in 11.5 million, and in Australia as one in 555,555 (Australian Shark Attack File, 2020). Typical shark bite mitigation strategies include signage, closed areas, nets, drumlines, swimming enclosures, aerial and shoreline surveillance, personal shark deterrents and monitoring and notification of tagged or observed sharks. Many government strategies have a lethal impact on large, potentially dangerous sharks. ‘SharkSmart’ is a relatively new approach adopted by the Queensland Government to educate and urge humans to take personal responsibility for their actions on and in the water to reduce the risk of shark bites. Local environmental conditions also drive shark bite risks (Midway et al. 2019).

A survey of 751 Queensland water users conducted by the Department of Agriculture and Fisheries Queensland in November 2019 and found that 73% of survey water users accepted personal responsibility for their safety in the water, but only 60% knew how to behave in a way that reduced their risk of a shark interaction.

A web-based survey of 204 boaters by Smith et al. (2020) identified patterns in use, behaviours, perceptions, and beliefs relating to recreational experiences in the Whitsundays. Results indicated that



52% of respondents sometimes\often\always encounter sharks, compared to 81% for turtles, 75% for whales and 15% for dugongs (Smith et al. 2020). Following the shark bite incidents in Cid Harbour, thirty-eight per cent of people were more vigilant in SharkSmart practices, 22% had increased fear over the past 12 months (Smith et al. 2020). Eighty-nine per cent were aware of swim safe messages to minimise the risk of unwanted shark encounters (Smith et al. 2020) and the most well-known message was “Don’t swim at dawn or dusk’.

Following a cluster of six shark bites in the Whitsundays region in 2018/19 (Heathcote, 2018, Table 1), Smith et al. (2020) found “the increase in unwanted encounters was attributed mainly to lack of awareness, ignoring safe practices and discarding food off boats. People have some knowledge of swim-safe and ‘SharkSmart’ behaviours, but do not have enough knowledge to inform their choices about risky behaviour.”

Table 1. Shark bite data from the Whitsundays region from Australian Shark Attack File and media reports.

Date	Time	Location	Sex	Age	Activity	Shark species	Shark size	Other
5 Jan 1993	09:00	Line Reef	M	21	Spearfishing		1.5	Laceration left forearm
25 Jan 1997	11-11:30	Whitehaven Beach	M	27	Snorkelling	NA	1.8-2.1	Left leg lacerated, punctures to the right leg
28 Feb 1997	12:00	Whitsunday Passage	M	30	SCUBA	Tiger	2-3	Left arm bitten
13 Feb 2010	13:30	Dent Island	F	60	Snorkelling	NA	2	Lacerations to leg and buttocks
10 Sep 2018	NA	Cid Harbour	M	NA	NA	NA	NA	finger
19 Sep 2018	18:00	Cid Harbour	F	47	Snorkelling	NA	NA	Left thigh
20 Sep 2018	13:45	Cid Harbour	F	12	Swimming	NA	NA	Left leg
5 Nov 2018	17:30	Cid Harbour	M	33	Swimming	NA	NA	Fatal
25 Mar 2019	12:30	Hardy reef	M	25	Snorkelling	Grey reef	NA	Puncture mark right buttock and left hip
29 Oct 2019	10:20	Hook Passage	M	28	Snorkelling	NA	NA	Left foot
29 Oct 2019	10:20	Hook Passage	M	22	Snorkelling	NA	NA	Lacerations to the lower right leg

Following a call for tenders in September 2019 For the purchase of a behaviour change project for safe swimming practices in the Whitsundays region (FQ19024), the Queensland Government contracted Reef Ecologic Pty Ltd to develop and deliver the project

According to the Queensland Government’s SharkSmart program (Fig. 1) and related scientific literature, four groups of ‘SharkSmart’ behaviours have been identified. They are:

- 1) Swim location/avoidance of swimming in the following places:
  - Anywhere fish are cleaned
  - Murky water
  - Busy anchorages
  - Signed locations and known high-risk locations (e.g., Cid Harbour)
  - Estuary mouths and canals
  - Near sewage outfalls
- 2) Swim time/avoidance of swimming at the following times:
  - Dawn

- Dusk  
Time of year  
Moon cycle
- 3) Other swimming habits / follow the guidelines of:
    - Swim with a buddy or in a group
    - Avoid swimming if you have a bleeding wound
  - 4) Boat waste management practices / following rules about:
    - Throwing food and scraps overboard
    - Filleting fish and disposing of frames at sea
    - Sewage disposal (both from boats and on-land)



Figure 1. Queensland Government SharkSmart sticker and brochures.

The Great Barrier Reef Marine Park Authority also developed SharkSmart and Responsible Reef Practices programs that had similar messages (Fig. 2). The Queensland Government reviewed and updated SharkSmart messages in September 2020 (Table 2).



Figure 2. Commonwealth Government SharkSmart and Reef Smart information.

The recommended Qld Government SharkSmart behaviours evolved during this project (Table 2) and contained a combination of in-water, on-vessel, positive and negative messages. The major changes were that two of the 2020 messages associated with fishers, food scraps, fish waste and swimming were combined into one message from September 2020. Also, a new message associated with avoiding schools of baitfish and diving birds was added (Table 2).

Table 2. Changes in Queensland Government SharkSmart messages over time (in bold).

Old Government pre September 2020	Old Government September 2020 onwards
Don't swim at dawn or dusk	Avoid swimming at dawn or dusk
Always swim in clear water	Swim in clear water and <b>away from fishers</b>
Don't throw food scraps or fish waste overboard	<b>Keep fish waste and food scraps out of the water where people swim</b>
Don't swim where fish are being cleaned	
Swim, surf, snorkel or dive with a buddy	Have a buddy and look out for each other
Follow local signage and swim between the flags at patrolled beaches	Swim between the flags at patrolled beaches and check signage
	<b>Reduce risk, avoid schools of bait fish or diving birds</b>

The project methodology (Fig. 3) aimed to work in collaboration with partner agencies/organisations/businesses e.g. tourism operators, tourism bodies, Whitsunday Charter Boat Industry Association, Whitsundays Local Marine Advisory Committee; Great Barrier Reef Marine Park Authority, Queensland Parks and Wildlife Service (QPWS) and Fisheries Queensland. The workshops (Table 3) helped form a research program that can provide recommendations about ongoing behaviour change strategies for future trial/implementation and advice on potential motivations/barriers to behaviour

change. Due to the significant challenges of the COVID-19 pandemic on the Whitsunday tourism industry, the timeline of the project was varied and extended to the 2020/21 summer season.

## 3.0 Project goals and design

The project goals were shaped by the Queensland Government 5-point plan to improve safety of tourists in the Whitsunday region (Queensland Government 2018). The plan included:

- Provide \$250,000 towards scientific research into shark prevalence and behaviour in Cid Harbour
- Maintain Cid Harbour as a no-swim zone until that assessment is complete
- Develop a high-profile education campaign to immediately educate locals and visitors about shark safety
- Develop a broader SharkSmart education campaign, similar to the successful CrocWISE campaign running in North Queensland
- Continue to meet with industry stakeholders and experts to develop and progress responses.

This project focussed on three main objectives:

1. Identify human behaviours that could be contributing to increased risk of shark bites;
2. Identify possible ways to alter these behaviours to reduce risk of shark bites;
3. Pilot trial a behavioural intervention for at least one key stakeholder group, targeting at least one of the behaviours identified in step 1.

While the question of whether or not the behavioural interventions may or may not reduce the risk of shark bites could not be empirically studied, a key part of the work was to develop a deeper understanding of the issues and the stakeholders, to generate ideas for a range of potential interventions or solutions, and to better understand the relevant social context including barriers and benefits to change. Given the pilot nature of the project, expectations of substantial behavioural change were low, but expectations around an improved understanding that could lay a foundation for future work in this area, were high.

This project involved a multi-step approach to identify, understand, and ultimately influence behaviours.

- |                |                             |
|----------------|-----------------------------|
| <b>Step 1:</b> | Target behaviours           |
| <b>Step 2:</b> | Explore behavioural context |
| <b>Step 3:</b> | Design solutions            |
| <b>Step 4:</b> | Trial solutions             |
| <b>Step 5:</b> | Evaluate solutions          |



Figure 3. Methodology for SharkSmart behavioural change project.

## 4.0 Target behaviours

The first step in the methodology was to identify the human behaviours that could potentially lead to increased risk of shark bites and focus in on a few key target behaviours for testing. The main objective being to answer the question ‘What needs to change?’ and to define this in behavioural terms. To do this, we first needed to understand the historical, temporal and geographical attributes that might be contributing to increased human-shark interactions in the region. To understand this, we needed to tap into local knowledge. Extensive stakeholder engagement was a key tactic for building the background knowledge necessary to answer the question at hand.

Consultation commenced on 4 November 2019 and the project team undertook 50 consultation events (workshops, meetings, emails, phone calls, presentations) including approximately 200 people between November 2019 and 14 January 2020 (Fig. 4, Table 3). Stakeholder consultation was coordinated in consultation with Tourism Whitsundays, Whitsundays Charter Boat Industry Association, Fisheries Queensland and the Great Barrier Reef Marine Park Authority to ensure a wide representation of key stakeholders.



Figure 4. Stakeholder consultation meeting in Airlie Beach.

Participants identified, from their personal knowledge and experiences, a range of historical and modern events that may have contributed to increased shark-bite risk factors for the region. These included:

- A significant decline in water clarity associated with coastal development over several decades (murky water may be associated with an increased risk of shark bite);
- A 42% increase in private boat ownership in the Whitsunday Regional Council Area between 2005 (4,233) and 2019 (6,019) with the area having an average of 145.8 boat registrations per 1,000 persons – the highest in the state (boats are a potential shark attractant particularly where fishing is the most common boat-related activity as is the case in Queensland);
- High-density multi-use sites where fishing (a well-established shark-attracting activity), fish feeding (potential attractant), boat lights (potential attractant) sewage discharge (potential attractant), at-sea food waste disposal (a potential attractant) and swimming/snorkelling frequently overlap;
- Increased overlap of fishing and swimming/snorkelling due to extensive coral damage following cyclone Debbie which increased snorkelling activity in zones where fishing is allowed;
- A high proportion of young, non-local or inexperienced water users who may be less likely to follow ‘SharkSmart’ behavioural guidelines; and
- A suite of poorly understood ecological factors (e.g., suitability and location of shark habitat, environmental change and degradation, climate impacts, overfishing, and changes to shark fishing effort).

A summary of the key public consultation and key field activities is below in Table 3 and Appendix A. During four workshops a total of 103 people were consulted and/or surveyed and during the three site inspections, a total of 102 people were observed working or participating in tourism activities. In addition, contact details have been recorded for over 100 people who are interested in further information and action. In summary, 205 people have been consulted/surveyed/observed in the SharkSmart project in the first stage.

Table 3. Summary of workshops and field inspections associated with the SharkSmart project.

Date	Purpose	Location	Attendees
25/11/2019	Workshop 1 - Broad stakeholder workshop	Airlie Beach	35
25/11/2019	Workshop 2 - Crew workshop	Airlie Beach	32
16/12/19	Workshop 3 - Targeted tourism workshops	Airlie Beach	8
17/12/19	Workshop 3 - Targeted tourism workshops	Airlie Beach	8
3/12/2019	Workshop 4 - Shark Control Program Scientific Working Group	Brisbane	25
18/12/19	Field inspection 1	Hook and Whitsunday islands	30
18/12/19	Field inspection 2	Chalkies Bay, Whitehaven Beach	25
18/12/19	Field inspection 3	Hayman, Hook, Border Islands	27

Stakeholder workshops and field inspections were used to deliver the first three stages of the methodology: Target, Explore, Design Solutions (Fig. 4) and fulfilled the following information needs:

- Identify and prioritise the behaviours most likely to contribute to and/or reduce risk of shark bites in the region;
- Identify the potential factors working for and against these behaviours (e.g. barriers and benefits);
- Identify the target audiences (e.g. tourists, locals, boat captains, etc.);
- Access local knowledge concerning risks to swimmers;
- Better understand the needs and desires of key stakeholder groups (e.g. the tourism sector); and
- Gain key local insights to support SharkSmart behavioural changes.

In the first two workshops, 67 stakeholders with extensive local knowledge about environmental, social and economic conditions, tourism, fishing and boating and events in the Whitsunday region helped to identify historical and modern events, geographical features and conditions, and behaviours that could be related to shark bite risk. This information was captured through the processes of participatory mapping, development of seasonal calendars, and creation of historical timelines. The information generated from these activities has been summarised into three figures: (1) Historical timeline (Fig. 5), (2) Seasonal calendar (Fig. 6), and (3) Spatial mapping of areas of interest (Fig. 7).

## Historical timeline

Workshop participants applied their knowledge and observations to create a historical timeline capturing key social and environmental events as well as broader trends that they felt might be relevant in explaining the increased interactions (e.g., shark bites, sightings, depredation) between sharks and people in the region (Fig. 5). Key trends observed by participants included:

- General increase in tourism and recreational use of the region from the 1970s
- Increase in private recreational boating and fishing in the past 10-20 years
- Increase in fishing activities
- Increased interactions with sharks (sightings, bites, depredation)
- Increased frequency of damaging cyclones
- Reduction of sites available to fishers (due to marine park zoning and regulation)

- Reduction of sites suitable for snorkelling (due to cyclone damage and declining water visibility)
- Increased water temperature
- Decreased water visibility and quality
- Increased dredging and coastal development

Key events noted by participants included:

- Reef Protection Markers Program
- Rezoning of the Marine Park
- Amendment of the Whitsundays Plan of Management
- Changes to shark fishing regulations
- World Wildlife Fund buy-out of two commercial shark fishing licenses

This activity generated significant discussion around a few key points. First, a progressive decline in water clarity was widely discussed and largely attributed to dredging and coastal development in the region. This general opinion of the workshop participants was that a decline in clarity has caused substantial problems for the tourism industry over the years and decreased the aesthetic value of the underwater ecosystem.

Secondly, workshop participants noted that major coral damage caused by cyclones including Cyclone Debbie in 2017 has greatly impacted the aesthetic value of key snorkelling sites. The degradation of several key snorkelling sites in green zones has forced tourism operators to visit alternative sites, many of which are in blue zones where fishing occurs, located in deeper water near steep drop-offs, or generally positioned in locations considered to be “sharkier” habitat types (such as harbours, deep water, near channels, headlands). Day Trip charter boats in particular are highly limited with the locations they can visit due to the timing and weather considerations involved in their activities. For these reasons, fishing and swimming/snorkelling now occur more frequently in the same locations.

A fisher who attended, stated that local shark populations had dramatically increased over the past decade, however, there was insufficient scientific evidence to affirm or refute this perception which is not in agreement with global trends or local research (Barnett et al. 2019). Also discussed was potentially increase shark depredation (taking fish that have been caught by fishers) (Mitchell et al. 2018).



# Historical Timeline

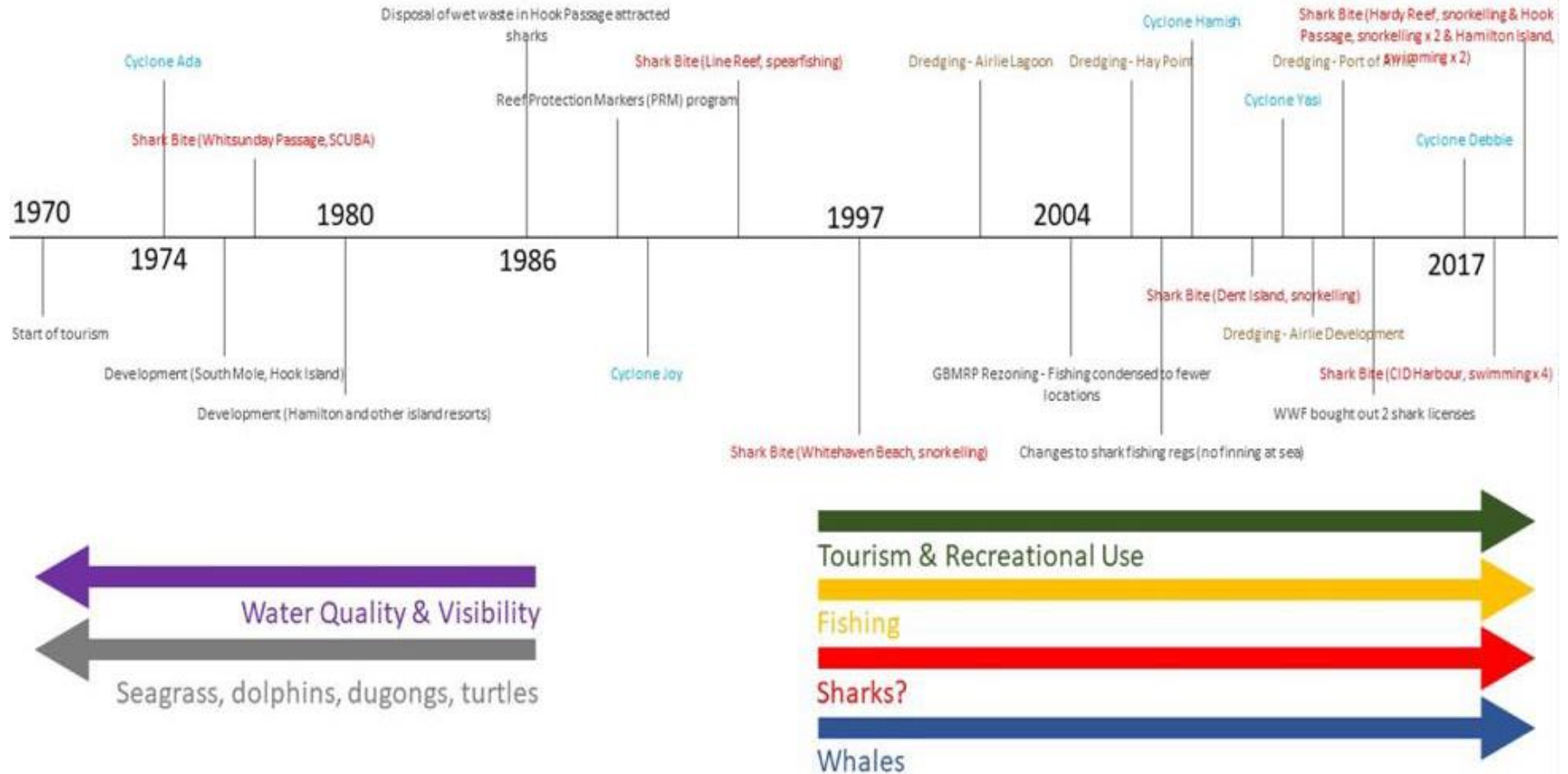


Figure 5. Historical timeline of environmental, social and tourism events in the Whitsundays region that are relevant to the SharkSmart project. Direction of arrows indicate general decreasing (left) or increasing (right) trends.

## Seasonal calendar

Most of the workshop participants spend a great deal of time on the water in the Whitsunday region. Participants combined their substantial local knowledge to create a seasonal calendar of ecological, environmental and social events they felt could contribute to shark-human interactions (Fig. 6).

For example, shark bites in the region have predominantly occurred between September and December. According to the workshop participants' observations, this timeframe correlates with a general period of increased activity in the marine environment including increased sightings of bait fishes, shark breeding, coral spawning, and turtle nesting/hatching. Interestingly, this also correlates to the period they identified as the peak snorkelling-swimming season.

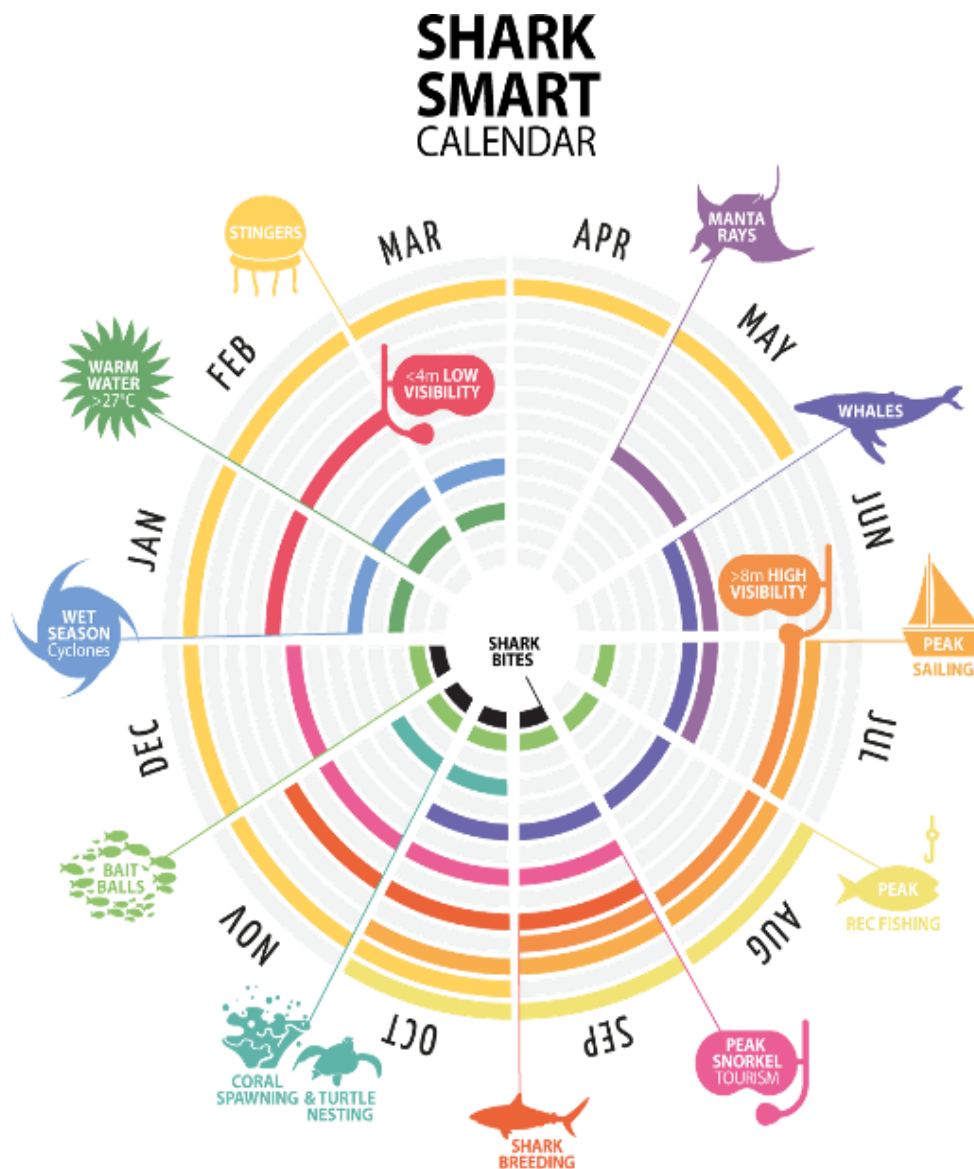


Figure 6. Shark safety seasonal calendar of Whitsundays human, biological and weather patterns.

## Participatory mapping

A participatory mapping exercise was undertaken to capture local knowledge about spatial characteristics of the region and identify areas where people felt sharks may be more abundant. Through this process, participants identified where various activities were taking place (e.g. fishing, snorkelling, fish feeding, shark sightings, popular anchorages, etc.) and identified areas deemed to be more “sharky” (defined by participants as areas where sharks are more likely to be observed/encountered) than others (Fig. 7). In some cases participants were able to define particular characteristics that made a location more likely to be “sharky” (such as proximity to deep water drop offs or popular overnight anchorages or fishing sites, previous sightings, or reduced visibility) and in some cases participants were not able to define specific characteristics but intuitively felt that some locations were riskier than others. While scientific studies can no doubt provide more rigorous information, local knowledge has been successfully used in Fiji, among other locations, to identify known shark habitats (Rasalato et al, 2010).

The mapping exercise revealed that due to a range of factors including site degradation caused by coral bleaching and cyclones, more tourism activities, including snorkelling and swimming, are now deemed to occur in areas considered to be more “sharky” according to participants’ intuition and local experience. Further research to ground truth this local knowledge and apply more scientific approaches to identify higher-risk locations for shark encounters are recommended to supplement this data. Citizen-science and reporting mobile apps, such as the GBRMPA Eye on the Reef app, may provide valuable information about shark sightings that could be useful in building a more thorough picture of shark distribution and behaviour in the region.



Figure 7. Spatial participatory mapping workshop and key for Whitsundays and close-up of observations adjacent to Hook Island. Key: Anchor: mooring sites, Swimmer: swimming and snorkelling sites, Arrows: current, Question mark- unknown

## Behaviour identification

Following extensive discussion around the historical, temporal and spatial contexts that may contribute to human-shark interactions, workshop participants identified the human behaviours that they believed could influence the likelihood of a shark bite.

Participants generated a list of 27 human behaviours (consolidated to 23) to reduce shark bites in the Whitsunday region (Appendix B, Fig. 8).



Figure 8. Ranking the importance of SharkSmart behaviours.

## Behaviour ranking

Behaviours were then ranked. For comparison, ranking was conducted during two tourism industry workshops (one consisting primarily of industry/business owners, Government stakeholders and shark scientists; and one of tourism boat crew), one expert panel meeting (comprising the Queensland Government Shark Control Program Scientific Working Group), and an online survey (directed to shark experts - members of the Queensland Government Shark Control Scientific

Working Group or researchers with PhDs on sharks in Queensland or who had published scientific papers on sharks in Queensland). The rankings from the groups had similarities and differences (Table 4). The behaviour ‘Don’t swim in murky water’ was ranked highly by the two tourism industry groups. The shark researchers ranked ‘Don’t swim near boats that are fishing or where fish are cleaned’ as the highest. We compare the different rankings of the groups in Table 4.

Table 4. Comparison of three stakeholder groups’ opinions about the most important SharkSmart behaviours. Bold indicates priority behaviours listed by all three groups.

Rank (Importance)	Researchers	Industry / Owner Workshop	Crew Workshop
1.	Don’t swim near boats that are fishing or where fish are cleaned	<b>Separate location of fishing and swimming/snorkeling</b>	Don’t swim in murky water
2.	<b>Don’t throw food scraps or rubbish overboard</b>	Don’t swim in murky water	Don’t swim at dawn and dusk
3.	<b>Don’t intentionally bait sharks</b>	<b>Don’t throw food scraps or rubbish overboard</b>	<b>Separate location of fishing and swimming/snorkeling</b>
4.	<b>Separate location of fishing and swimming/snorkeling</b>	Don’t swim near boats that are fishing or where fish are cleaned	<b>Don’t intentionally bait sharks</b>
5.	<b>Don’t swim at dawn and dusk</b>	<b>Don’t swim at dawn and dusk</b>	<b>Don’t feed fish</b>
6.	Don’t swim near bait balls (diving birds, jumping fish, rippling water)	<b>Don’t intentionally bait sharks</b>	Follow local signage and information
7.	<b>Don’t feed fish</b>	Follow local signage and information	Don’t throw food scraps or rubbish overboard
8.	<b>Don’t swim in murky water</b>	<b>Don’t feed fish</b>	Don’t swim near boats that are fishing or where fish are cleaned
9.	Don’t swim in estuaries or busy anchorages	Swim in shallow water, avoid swimming near drop offs	Don’t splash while swimming / jump off boats
10.	Exercise more caution during high-risk months (Sept-Jan)	Don’t swim where sharks have been sighted	Don’t swim where sharks have been sighted
11.	Dispose of sewage waste correctly	Don’t swim near bait balls (diving birds, jumping fish, rippling water)	Swim in shallow water, avoid swimming near drop offs
12.	Follow local signage and information	Swim with a buddy	Swim with a buddy
13.	Don’t splash while swimming / jump off boats	Don’t swim in estuaries or busy anchorages	Don’t swim in estuaries or busy anchorages

Interestingly, of the seven shark bite incidents that have occurred in the Whitsundays since 2018, four involved swimming in a busy anchorage and two were associated with splashing while swimming (pers comm with tourism operator involved in the incident) yet these behaviours didn’t rank in the top five in terms of priority. It would be interesting to explore this further. Perhaps the participants gave higher priority to those behaviours they deemed to be the root cause of the incidents or those that would have greater long-term impact on the problem. In any case, this ranking should be considered with caution for use in other applications as prioritisation might change dramatically if a different question were posed (e.g. ‘Which behaviours would be the easiest or quickest to adopt to maximise short-term risk reduction?’).

It is also worth noting that the highest-ranked behaviour *Separate locations of fishing and swimming/snorkelling* was not a key message of the SharkSmart Queensland program campaign prior to this project. In 2020, a related behaviour was ‘Don’t swim where fish are being cleaned’ which was updated in September 2020 to ‘Swim in clear water and away from fishers’. It is important to note that while some behaviours previously not included in the Queensland Government SharkSmart program were identified as important in the Whitsunday region (e.g. don’t swim where people fish or near bait balls), some behaviours (e.g. swim between the flags) were considered to be irrelevant. For that reason, it is recommended that SharkSmart behaviour change and communication programs are carefully tailored

for individual regions. Similarly, priority behaviours may differ from region to region and may differ depending on the human activities that bring sharks and people in contact (e.g. surfing, boating, fishing, swimming, snorkelling, etc.).

## Target behaviours

Workshop participants generally agreed to preferentially adopt the rankings by the shark experts as a proxy for better scientific data, thus the group's prioritised behaviours are as follows in order of importance:

1. Don't swim near boats that are fishing or where fish are cleaned
2. Don't throw food scraps or rubbish overboard
3. Don't intentionally bait sharks
4. Separate location of fishing swimming/snorkelling
5. Don't swim at dawn and dusk
6. Don't swim near bait balls (diving birds, jumping fish, rippling water)
7. Don't feed fish
8. Don't swim in murky water
9. Don't swim in estuaries or busy anchorages
10. Exercise more caution during high-risk months (Sept-Jan)
11. Dispose of sewage waste correctly
12. Follow local signage and information
13. Don't splash while swimming / jump off boats

It is important to consider that without more rigorous scientific data to support behavioural ranking, prioritisation is still somewhat arbitrary and largely based on opinions and perceptions. In lieu of better data, this is a valid approach. However, the above ranking should not be used to disregard any particular behaviour or discredit its potential importance in reducing the risk of shark bites. Some behaviours will be more important than others to achieve specific goals or for particular target groups.

The behavioural prioritisation above has been used in this project as a guide for the necessary purpose of reducing the scope of the project to a manageable pilot study.

## 5.0 Explore behavioural context

Following identification of the target behaviours, we worked with stakeholders to further explore the context around these behaviours:

- Who is engaging in the behaviours, where, when and why?
- What are the barriers and benefits to these groups adopting more desirable behaviours?
- What relevant regulations or policies are in place that could help?

The following potential target groups were identified:

- Tourism operators and their patrons
  - Fishing charters
  - Bareboat charters
  - Day trip operators

- Overnight or multi-night trip operators
- White boats and yachties
- Recreational fishers and boaters
- Commercial fishing operators (particularly where fishing locations overlap with swimming)
- Swimmers (including paddle boarders, kite surfers, kayakers, and similar)

Key communication channels for these groups included:

- Channel 16 – emergency communication radio channel for shark sightings
- Radio can be used to hail a specific boat to notify of shark sightings or risk factors such as bait balls, fishing, etc.
- 100 Magic Miles – comprehensive guidebook for the Whitsunday Islands
- Lost Islands – history and geography of the islands
- Cruising notes – guide on boating in the Whitsundays
- QPWS/GBRMPA flyers, interpretive signage, moorings, fact sheets
- GBRMPA Visiting Whitsundays guide
- GBRMPA zoning maps
- Tourism provider websites
- Whitsundays marinas
- Boat shops and Chandlery
- Campgrounds and hotels
- Local newspaper and community newsletters
- GBRMPA Eye on the Reef mobile app (apps must all be available offline and there were varying reports on whether people could access these apps offline)
- QLD Fisheries mobile app (apps must all be available offline and there were varying reports on whether people could access these apps offline)

Stakeholders identified a number of key challenges in adopting desired target behaviours.

1. Don't swim near boats that are fishing or where fish are cleaned
  - i. It is impossible to tell where a boat may have been fishing in the past or identify sites that are heavily fished
  - ii. When fishing occurs, fish frames and excess bait are almost always dumped at sea to prevent smelly waste on boats – this can happen anywhere at any time (other than in no fishing zones)
2. Don't throw food scraps or rubbish overboard
  - i. Throwing food scraps overboard to attract fish is fun and fish feeding is popular with tourists
  - ii. Food scraps can be smelly and there is limited space for waste on board boats so disposing of it at sea is an attractive alternative
3. Don't intentionally bait sharks
  - i. Baiting sharks can be fun and interesting for tourists who want to see these animals up close
  - ii. Baiting sharks can offer “bragging rights” for some thrill seekers
  - iii. Sharks are attracted to the same bait as other fish so baiting can be accidental
  - iv. It is very difficult to know when and where people have intentionally baited sharks and hard to enforce
4. Separate location of fishing swimming/snorkelling
  - i. Several mooring sites (e.g. Cid Harbour) are very popular for fishers and swimmers so these activities regularly occur together in close proximity
  - ii. There is little public or tourist information in place that advises against



- swimming and fishing in the same location
- iii. There is currently no regulation that prevents or discourages this in the Great Barrier Reef Marine Park
- 5. Don't swim at dawn and dusk
  - i. Lack of clear understanding of what time period constitutes dawn and dusk
  - ii. Lack of widespread information clearly explaining the behavioural ask
- 6. Don't swim near bait balls (diving birds, jumping fish, rippling water)
  - i. People don't know what to look for to identify bait balls
  - ii. It is impossible to tell if a bait ball has recently passed through an area if there are no signs
- 7. Don't feed fish
  - i. Fish feeding is very popular with tourists
  - ii. There is a perception that fish feeding is economically important for tour operators (to improve trip satisfaction as some guests request refunds if they are unable to complete their snorkel experience due to environmental conditions)
  - iii. It is very difficult to determine if fish feeding is occurring and to enforce permit compliance around this activity
  - iv. The impact of fish feeding on ecosystem changes (improvement or damage) and on shark attraction is poorly understand
- 8. Don't swim in murky water
  - i. Water in the Whitsundays is generally considered murky
  - ii. There is no clear definition of murky water – people might not know if the water is murky or not
  - iii. If the weather is hot, people want to swim regardless of the water clarity
- 9. Don't swim in estuaries or busy anchorages
  - i. Many visitors anchor their boats in these locations and people traditionally swim while the boat is anchored rather than underway
  - ii. People, especially visitors, may not know what constitutes a busy anchorage or an estuary
  - iii. Lack of widespread information that clearly defines the behavioural ask
- 10. Exercise more caution during high-risk months (Sept-Jan)
  - i. Lack of publicly available information about high risk periods
- 11. Dispose of sewage waste correctly
  - i. People may not be well trained in operating sewage bilge systems
  - ii. People might forget and leave the systems open inadvertently while moored
- 12. Follow local signage and information
  - i. Signage is not always visible from boats
  - ii. Signage is only available in limited locations
- 13. Don't splash while swimming / jump off boats
  - i. People in the Whitsundays are on holiday and this is a fun activity
  - ii. Limited public information is available to dissuade people from doing this

In a third workshop from 16-19 December 2019, we met with representatives from across the tourism sector to better understand their operations, their clientele and opportunities for implementing behavioural change interventions in this sector. During the course of this workshop, participants considered the specific behavioural context around a number of priority behaviours in more detail and contributed their opinions and ideas about barriers and benefits to adopting behaviours and potential solutions. Results are presented in the following tables 5, 6, 7 and 8.

Table 5. Exploration of behaviour associated with food scraps, audience, regulation, barriers and benefits to adopting the behaviour and potential solutions.

<b>Behaviour</b>	<b>Don't throw food scraps or fish frames overboard.</b> Sharks are scavengers and may be attracted to any type of food waste (or the fish it attracts). Both food scraps and fish waste
<b>Audience</b>	Passengers, some crew, rec boats, charter boats, fishing boats, day boats, cruising yachts (at Hamilton),
<b>Regulation</b>	GBRMPA regulations
<b>Barriers</b>	<ul style="list-style-type: none"> <li>• Smelly bait</li> <li>• Throwing food scraps or bait overboard to feed the fish is popular</li> <li>• Limited space on boats</li> <li>• Ignorance (impacts, fines, legality)</li> <li>• Lack of easily available knowledge</li> <li>• Convenience, want to attract animals</li> <li>• Fish to eat straight away</li> <li>• Get rid of guts out in the ocean</li> <li>• Fillet at sea</li> <li>• Using fewer plastic bags for storage</li> </ul>
<b>Benefit</b>	<ul style="list-style-type: none"> <li>• responsible</li> <li>• do the right things</li> <li>• don't want to attract shark for themselves and fishing</li> <li>• ecological- not adding nutrients to the environment</li> </ul>
<b>Solutions</b>	<ul style="list-style-type: none"> <li>• Sealed storage</li> <li>• Incentives to bring food scraps back</li> <li>• Delivering effective communications, signage and education messages</li> <li>• Rubbish collection facilities</li> <li>• Fish bins – local council (Gold Coast, Tasmania) keep mess on own boat – crocs!</li> <li>• Make recommendations to DAF</li> <li>• Barge that collects rubbish collection at sea</li> <li>• 10 popular snorkelling bays are also popular fishing boat</li> <li>• One collection point on Whitehaven (everyone goes there)</li> </ul>

Table 6. Exploration of behaviour associated with swimming in murky waters, audience, regulation, barriers and benefits to adopting the behaviour and potential solutions.

<b>Behaviour</b>	<b>Don't swim in murky waters</b>
<b>Audience</b>	Tourists and locals, all snorkelers
<b>Regulation</b>	No relevant regulation
<b>Barriers</b>	<ul style="list-style-type: none"> <li>• There is no clear definition of murky water (people may not know what murky water is)</li> <li>• The water visibility is generally low (murky) in the Whitsundays</li> <li>• It's hot</li> <li>• Limited by time and conditions</li> <li>• Only swimming options</li> <li>• Don't know that's its murky (fluffy – green water)</li> <li>• Think its low risk</li> <li>• Tidal fluctuation</li> <li>• Don't know about better sites</li> <li>• Don't care</li> <li>• Everyone is doing it</li> </ul>
<b>Benefit</b>	<ul style="list-style-type: none"> <li>• Can't see, can't see reef or fish,</li> <li>• Better photos</li> <li>• Better aesthetic values</li> <li>• Lower risk of shark risk</li> </ul>
<b>Solutions</b>	<ul style="list-style-type: none"> <li>• Find better sites (tides, locations, conditions)</li> <li>• Find a 'safer' site</li> <li>• Guide with information on top 30 sites</li> <li>• Local knowledge</li> <li>• Less than 2 metres</li> <li>• Lack of information</li> <li>• Use a secchi disk to measure vis</li> <li>• Communication</li> <li>• Crew training and information for guests</li> </ul>

Table 7. Exploration of behaviour associated with fishing and swimming, audience, regulation, barriers and benefits to adopting the behaviour and potential solutions.

<b>Behaviour</b>	<b>Don't fish / fillet fish near where people are swimming</b>
<b>Audience</b>	<ul style="list-style-type: none"> <li>• Commercial fishers stay away from snorkelers- have set locations, deeper water, shoals, have local knowledge. Good to communicate with.</li> <li>• Recreational fishers local residents (some lots of knowledge, some don't, some transient populations from mines or tourists working. Attitude is highly variable)</li> <li>• Recreational fishers – visitors</li> <li>• Recreational spear fishers (local and visitors)</li> <li>• Passing yachties- fish and spear</li> <li>• Tend to anchor &lt;in current&gt;</li> <li>• Drifting in current on outside bays that people</li> <li>• Local rec fishers are not reliant on tourism industry, often work in mining/ trades, hard to contact, they are positively motivated by catching own fish, 70/30 male females &amp; family groups, 20-30yr old males more difficult to engage</li> </ul>
<b>Regulation</b>	GBRMPA regulations prohibit fishing in green zone
<b>Current Situation</b>	<p>After cyclone Debbie, popular snorkel sites were damaged and tourism operators have shifted sites to alternative sites. These sites overlap with fishers.</p> <p><b>Key overlap sites include:</b></p> <ul style="list-style-type: none"> <li>• Chalkies</li> <li>• Mackerel Bay</li> <li>• Saba</li> <li>• Stonehaven</li> </ul>
<b>Barriers</b>	<ul style="list-style-type: none"> <li>• Several of the mooring sites are popular and recreational fishing activities occur close to snorkelling</li> <li>• Have the right (due to zone)</li> <li>• Don't know</li> <li>• Don't care</li> <li>• Limited locations -They want same sheltered weather locations as snorkelling</li> <li>• Tend to anchor</li> <li>• Herd mentality</li> <li>• Go for spots to snorkel and then fish at same spot (already at location)</li> <li>• Concern for snorkel operators – if people have been fishing at dawn and have just left</li> </ul>
<b>Benefit</b>	<ul style="list-style-type: none"> <li>• Less people to scare away fish</li> <li>• Not always best spot</li> <li>• Snorkel times are not ideal fishing times (dawn /dusk)</li> <li>• Wont potentially hurt people</li> <li>• More thoughtful (being a considerate person)</li> <li>• Not attracting fish/sharks to snorkelling area</li> <li>• Less crowding</li> </ul>
<b>Solutions</b>	<ul style="list-style-type: none"> <li>• Signage – at boat ramp</li> <li>• Good communication</li> <li>• Volunteer no fishing zone (request from snorkelers, on reef protection zone)</li> <li>• Educate them before hand – high traffic swim zones at certain bays e.g. 8.30- 3.30pm</li> <li>• Boat rego as communication tool</li> <li>• Fishing comps/ boat shows</li> <li>• Action items</li> <li>• Send messages that tourists scare away fish/ poor fishing opportunities</li> <li>• Multi-activity groups- could get education on not fishing where you swim</li> </ul>

Table 8. Exploration of behaviour associated with fishing feeding, audience, regulation, barriers and benefits to adopting the behaviour and potential solutions.

<b>Behaviour</b>	<b>Don't feed the fish (pellets)</b>
<b>Audience</b>	Tourism crew (pellets), Rec users (scraps), fishers (guts)
<b>Regulation</b>	GBRMPA tourism operator permits allow regulated fish feeding
<b>Barriers</b>	<ul style="list-style-type: none"> <li>• Fish feeding (with pellets) is a popular tourism attraction in many bays</li> <li>• Passengers love seeing the fish from feeding</li> <li>• Possible unhappy guests</li> <li>• Post Debbie GBRMPA recommendation to keep feed the fish so they stay and keep recovery of reef</li> <li>• Poor weather option&gt;feed fish from boat so they see them&gt; bottom line &amp; guest experience &amp; crew morale (not getting abused)</li> <li>• People with medical issues who can't snorkel (can see fish)</li> <li>• Keeps fish numbers high in certain areas and increases interactions</li> <li>• Unhappy operators</li> <li>• Unhappy agents</li> </ul>
<b>Benefit</b>	<ul style="list-style-type: none"> <li>• Creates a more natural ecosystem</li> <li>• Reduce costs on pellets \$100 for 20kgs</li> <li>• Save stocking issues, running out</li> <li>• Reducing risk of shark bite</li> <li>• Addresses popular concern of shark safety</li> <li>• Not adding additional nutrients into environment</li> <li>• Some passengers don't like interfering with ecosystem</li> <li>• Reduce nutrient&gt;improved visibility</li> <li>• Advertise no fish feeding/ ahead of the curve</li> </ul>
<b>Solutions</b>	<ul style="list-style-type: none"> <li>• Do it for last resort</li> <li>• Discuss reasons why?</li> <li>• Provide solutions- go to the bar palm bay, hikes,</li> <li>• Citizen science activities/ eye on the reef/ coral watch</li> <li>• Cruise Whitsundays has already stopped fish feeding other than at pontoons</li> </ul>

Throughout all the workshops, a number of potential solutions and general observations were identified by participants. While many of these were out of scope for this project, they provide a range of options that warrant further consideration and investigation as additional risk-reduction activities.

Actions to improve water quality:

- Concerns about Shute Harbour development leading to decreasing visibility
- Concerns that dredging for Port of Airlie led to decrease in visibility
- Concerns that ongoing urban development where dirt is not properly stabilised and no vegetation leads to increased sediment in the water following rain
- Upstream catchment management behaviours

Shark bite incident management:

- All operators and representatives have a ready set of key messages for media
- Operators and crew know in advance what to say and what not to say
- Central point of coordination for all media enquiries
- Operators and crew trained in first aid including tourniquet application

The following ideas were also generated through this process and were “parked” for future consideration:

- Create alternative tourism options for when conditions are not suitable for in-water activities (to reduce need for fish feeding)
- Improve tourist and local education and use of communication products
- Make SharkSmart awareness program compulsory including safety messaging on all commercial vessels (similar to airplane briefing)
- Provide key information about shark bite risk reduction strategies to all tourism operators (e.g. fact sheets)
- Develop training and briefings for crew including shark incident management
- Develop signage, website, apps
- Tailor messages for different audiences and languages
- Create a shark feeding/dive experience far away from swimmers
- Install fish filleting infrastructure at all Whitsunday boat ramps to encourage fish filleting on land (appropriate disposal of waste should be considered);
- Shark deterrents, bite resistant wetsuits, deterrent colours
- Make policy and regulation changes to separate swimming and fishing in high use marine environments
- Develop a decision support or risk analysis tool to help tourism operators determine shark-risk factors at various sites
- Support additional research to explore biological and social factors that contribute to risk
- Request additional information to be collected by Shark Attack File (e.g. non-fatal incidents, species, behavioural context, environmental context such as presence of bait balls, temperature, water clarity, time of day)

## 6.0 Design solutions

### Target Audience

Given the small scope of this pilot study, the target audience was narrowed from all potential water users in the Whitsundays to bareboat operators only. There were several reasons that this focus was recommended and agreed by the Department of Agriculture and Fisheries and the tourism industry. Bareboats undertake multiple activities including fishing, swimming, snorkelling and cruising. The sector of the tourism industry has commonalities both with other tourism operations as well as with recreational boaters and fishers, making it a good choice to trial approaches that could apply to multiple groups. Bareboat tourists were involved in several of the shark bite incidents in Cid Harbour. Operators were very interested in supporting this project and other research that may result in increased knowledge about tourism behaviour, shark bite risk and actions. In addition, bareboats are often chartered for multiple days, which offers greater opportunity to influence knowledge, attitudes and ultimately, behaviours.

### Target Behaviours

The key in-water and onboard vessel behaviours that we selected as a focus for the intervention are in Tables 9 and 10.

Table 9. Risky in-water behaviours and targeted shark safety behaviours used to reduce risks.

<b>Risky Behaviours (In-water swimming/snorkelling)</b>	<b>Desired behaviour</b>	<b>Alternative behaviour promoted</b>
Swimming near (within 200 m) people who were fishing	Avoid swimming near (within 200 m) people who are fishing	
Swimming in murky water	Avoid swimming in murky water	
Splashing or making noise while swimming	Avoid splashing or making noises while swimming	
People swimming alone	Avoid swimming alone	Swim with a buddy
Swimming near baitfish or schooling birds	Avoid swimming near baitfish or schooling birds	
Swimming in estuaries or busy anchorages	Avoid swimming in estuaries or busy anchorages	
Swimming in Cid Harbour	Avoid swimming in in Cid Harbour	

Table 10. Risky boating and fishing behaviours and targeted shark safety behaviours used to reduce risks.

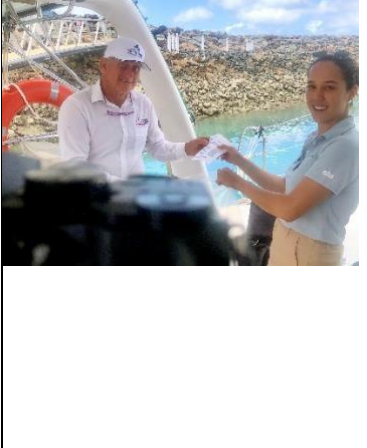
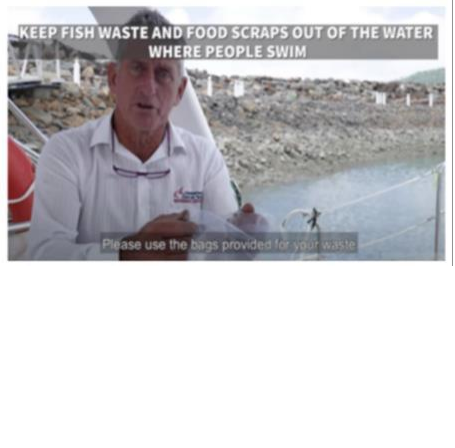


<b>Risky Behaviours (Onboard or Fishing)</b>	<b>Desired behaviour</b>	<b>Alternative behaviour promoted</b>
Throwing fish frames/food scraps into the water	Avoid throwing fish frames/food scraps into the water	Dispose of food waste and fish frames using bags and bins provided
Fishing near people swimming	Avoid fishing near people swimming	

## Intervention



In consultation with the bareboat operators and the Queensland Government, a pilot behavioural change intervention was devised with the aim of influencing fishing, swimming and waste disposal behaviours of bareboat renters. The following approaches and materials (Table 11, 12) were included in the intervention:



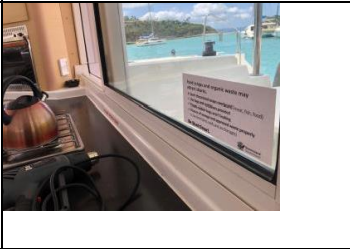



1. **Pre-trip instructional video briefing** – this featured local people discussing and demonstrating desired behaviours with an aim to establishing social norms
2. **Pre-trip verbal briefing from crew** – key information and reminder messaging was supplied for addition to pre-trip briefing
3. **Printed SharkSmart poster (A4)** – information on risk reducing behaviours
4. **Printed SharkSmart brochure (A4)** – information on risk reducing behaviours
5. **Provision of clear, organic waste bag** – appropriate products supplied to make the behaviour easier
6. **Provision of food waste management instructions** – clear instructions were provided for waste management; these were located in the galley and near the bins
7. **Food waste sticker prompt near rubbish** – reminder stickers or prompts were placed near rubbish to remind guests of waste management instructions
8. **Food waste sticker prompt on boat deck** – sticker prompts were used near the BBQ areas on the boat decks to remind people not to throw food overboard
9. **Fishing and swimming sticker prompt on boat** – sticker prompts were used on the deck to remind people of correct fishing and swimming behaviour

Table 11. Intervention types and target audience for Whitsunday shark safety trial project.

Intervention Tool	Image 1	Image 2	Brief Description
1. Pre-trip instructional video briefing			<p>A pre-trip video briefing was designed and shown to all tourists at a briefing to build boaters knowledge, skills and belief in their capacity to adopt ‘SharkSmart’ behaviours. Locals were used to host the video, to promote, explain, and to ‘model’ the desired behaviours. This approach can help improve adoption. The behaviours that were introduced included: don’t swim where people are fishing or in busy anchorages – as sharks can associate boats and fishing with food, check local signage before swimming, don’t swim at dusk or dawn, stay away from schools of baitfish, swim in clear waters, swim/snorkel/dive with a buddy, don’t throw waste overboard, use bags provided for waste, don’t fish/chum/berley while people are in the water. <a href="https://www.youtube.com/watch?v=d17id9NOR6s&amp;feature=youtu.be">https://www.youtube.com/watch?v=d17id9NOR6s&amp;feature=youtu.be</a></p>
2. Pre-trip verbal briefing from crew			<p>Four briefings were used to educate guests about SharkSmart behaviours and provide clear, personal instructions to minimise risk. Person to person interactions and the provision of face-to-face advice can be a stronger motivator than passive information sharing. The primary pre-trip briefing tool was the instructional video supported by secondary briefing and Q&amp;A with bareboat staff.</p>
3. Printed SharkSmart posters (A4)			<p>SharkSmart posters were provided to tourists during pre-trip briefing to reinforce messaging around swimming/snorkelling behaviour and boating/fishing behaviours. These materials were also on display on the vessel and functioned both as information sources and as reminders.</p>



<p>4. Printed SharkSmart brochure (A4 trifold)</p>			<p>A SharkSmart brochure was provided to tourists during the pre-trip briefing to reinforce messaging around SharkSmart behaviours. These materials were also on display on the vessel and functioned both as an informational source and as a reminder.</p>
<p>5. Provision of food waste management instructions</p>	<p><b>Onboard Food Waste Management</b></p> <ul style="list-style-type: none"> <li>• Please dispose of food, meat and fish scraps into the clear plastic bags in the galley.</li> <li>• Tie a knot and place in the large clear bag when full.</li> <li>• Use another small clear bag when needed.</li> </ul> <p style="text-align: center;"><b>Thank you!</b></p>		<p>Provision of clear waste management instructions was provided to tourists during the pre-trip briefing to reinforce messaging around SharkSmart behaviours. The messages were displayed in several forms and locations, along with the supplies necessary to comply with the instructions, were designed to motivate adoption of this key behaviour.</p>
<p>6. Provision of clear, organic waste bag</p>			<p>Heavy-duty, tear resistant and leak proof plastic waste bags were provided. Guests were asked to place their rubbish in these bags, rather than throwing organic waste in the ocean or placing it in forward compartments in the boat that may drain into the ocean. This was designed to prevent smells and leaks from waste draining into the sea and potentially attracting sharks. The bags were transparent to allow staff to complete a visual inspection and photograph rubbish content.</p>

<p>7. Food waste sticker prompt near rubbish bag</p>		<p><b>This bag could save a life.</b> Help prevent shark bites by bagging these items:</p> <ul style="list-style-type: none"> <li>✓ Fish frames</li> <li>✓ Unused Bait</li> <li>✓ Food scraps</li> </ul> <p><b>Be safe. Be SharkSmart.</b> <small>Visit <a href="http://www.sharksmart.gov.au">www.sharksmart.gov.au</a> or call 1300 739 763 for more SharkSmart tips.</small> </p>	<p>Reminder for Bareboat renters to follow target behaviours. No food or fish frames overboard. Stickers were designed to be placed as close to the location of the activity to be influenced as possible (e.g. in the galley, near the rubbish).</p>
<p>8. Food waste sticker prompt on deck or in galley</p>		<p><b>Food scraps and organic waste may attract sharks!</b></p> <ul style="list-style-type: none"> <li>✗ Don't throw food scraps (meat, fish, organic waste) overboard</li> <li>✓ Use bags and containers provided</li> <li>✓ Ensure rubbish bags aren't leaking</li> <li>✓ Dispose of sewage and approved waste properly (1 nm from land, reefs, anchorages and people)</li> </ul> <p><b>Be safe. Be SharkSmart.</b> <small>Visit <a href="http://www.sharksmart.gov.au">www.sharksmart.gov.au</a> or call 1300 739 763 for more SharkSmart tips.</small> </p>	<p>Reminder for Bareboat renters to follow target behaviours: no food or fish frames overboard. Stickers were designed to be placed as close to the location of the activity to be influenced as possible (e.g. the back deck, near BBQ, fish filleting area, water entry point).</p>
<p>9. Food waste, fishing and swimming sticker prompt on boat deck</p>		<p><b>Food scraps, bait and fishing may attract sharks!</b></p> <ul style="list-style-type: none"> <li>✗ Don't fish where people swim</li> <li>✗ Don't throw food scraps or fish frames overboard (especially where people swim)</li> <li>✓ Follow SharkSmart swimming guidelines</li> </ul> <p><b>Be safe. Be SharkSmart.</b> <small>Visit <a href="http://www.sharksmart.gov.au">www.sharksmart.gov.au</a> or call 1300 739 763 for more SharkSmart tips.</small> </p>	<p>Reminder for Bareboat renters to follow target behaviours: no fishing and swimming in the same place, no food or fish frames overboard, no shark baiting, safe swim. Stickers were designed to be placed as close to the location of the activity to be influenced as possible (e.g. the back deck, near BBQ, fish filleting area, water entry point).</p>

The intervention strategy addressed capability, opportunity, and motivation as per the COM-B model of behavioural change. Barriers addressed by the intervention strategy included:

- Lack of knowledge or capability to adopt desired behaviours (such as knowing when and where to swim or how to identify a bait ball)
- Lack of necessary supplies (e.g. appropriate rubbish bags for keeping organic waste on board were supplied)
- Lack of knowledge about the consequences of engaging in risky behaviour
- Lack of motivation to adopt desired behaviours
- Forgetting to engage in the desired behaviour (prompts and reminders were provided)

Table 12. Behavioural change intervention methods used in this project to reduce risk and increase safety of tourists.

<b>Behaviour Change Intervention</b>			
<b>Behaviour Change Tactic</b>	<b>Mechanism of Action (behavioural driver of change)</b>	<b>Mechanism Definition (description of theory of change)</b>	<b>Delivery Tools</b>
Information about health, social and environmental consequences	Perceived vulnerability, attitude towards the before, intention to act, beliefs about consequences and knowledge.	When a person understands the relevant consequences and believes themselves to be vulnerable to these consequences, and when their attitude and intention towards a behaviour is changed, they may be more likely to act.	1, 2, 3, 7, 8, 9
Instruction on how to perform the behaviour	Knowledge, skills, belief in capability.	If a person has the knowledge and skills required to perform the behaviour and the belief in their own capability, they may be more likely to act.	1, 2, 3, 4, 6, 7, 8, 9
Prompts/cues	Memory, attention and decision processes. Environmental context and resources, behavioural cueing.	Behaviours can be triggered by cues from the external environment. Alterations to the environmental context (e.g. placement of signage) can support memory recall, influencing behavioural selection.	3, 4, 5, 6, 7, 8, 9
Adding objects to/modifying the environment	Changing the environmental context and available resources. Behavioural cueing.	By modifying the environment or providing resources that make it easier to adopt a behaviour, and by providing additional reminders, likelihood of change increases.	3, 4, 5, 6, 7, 8, 9

The intervention was designed based on the knowledge and opinions of workshop participants. It could have been strengthened by direct research on barriers and benefits of behavioural adoption by the target group. This was outside of the scope of this study and prevented logistically given the nature of the target group (tourists on holiday), the already time-consuming bareboat check-in and check-out procedures. Intervention elements with stronger and more behaviourally-informed components were recommended but not adopted for a range of reasons including cost, time to develop, industry sensitivities around the use of fear-based messaging, industry comfort and familiarity with communication-focused approaches and “awareness raising”, as well as logistical considerations.

## 7.0 Trial solutions

An experimental before, after, control, impact (BACI) study was used study design with intervention and control groups of tourists who chartered vessels in the Whitsunday region was adopted between August and December 2020 (Table 13).

Table 13. Experimental design for the Whitsundays shark safety behavioural change project

	Operator 1 Control	Operator 2 Intervention	Operator 3 Intervention
<b>Pre-Intervention</b>	August/September		
<b>Intervention</b>	Control did not participate in the intervention, continue with surveys and rubbish collection	October- December	

### Training of tourism operators to deliver interventions

In advance of each phase, face to face training and consultation was undertaken with each of the three operators to ensure consistency in the delivery of interventions and data collection. Standard operating procedures (SOPs) were issued to tourism operators to provide clear instructions to share with other team members after face-to-face consultation (refer to Appendices D & E). A local scientist in the Whitsunday region was employed to assist primarily with the collection of rubbish data from one of the operators and the other two operators were self-sufficient and helped collect rubbish data. Regular phone call and email communication occurred to check in with the operators and keep the scientists updated with operator's progress and to provide project updates.

### Surveys and Data Collection

The primary tool used to evaluate the effectiveness of the interventions was a post-trip survey, emailed to all bareboat renters at the conclusion of their trip during the pre-intervention and intervention phases. Additional information was collected through weighing organic waste and examining photographs of organic waste to determine the quantity of fish or meat scraps retained.

The initial 'pre-intervention survey' phase involved collecting data on demographics, knowledge of SharkSmart behaviour and tourism activities through an online survey which was sent to all charter guests at the end of their trip.

Survey 1 (refer to Appendix C) was distributed to guests on selected bareboats following their trip in the pre-intervention phase. Survey questions were divided into three general sections: (1) trip information,

(2) activities undertaken on the trip, (3) and knowledge of SharkSmart information. Survey 1 was distributed in the pre-intervention phase; however, Survey 2 was a replica that continued throughout the intervention phase to measure changes in surveys responses and data.

The intervention phase commenced on 12 October 2020 when materials were provided to inform guests on the bareboat trips about being safe in and around the water, promoting ‘SharkSmart’ behaviours. Intervention materials were only distributed to 2 of the 3 operators, with the other being the control group.

## Data Analysis

Survey data was analysed to compare changes in behaviour between the Pre-Intervention Phase and Intervention phase. A Fisher’s Exact test was used for each question to analyse the frequency distribution of responses on the Likert scale between the two phases. A p-value less than 0.05 indicates that the null hypothesis rejected and that the proportion of people participating in such behaviour during pre-phase and after intervention is the same. ANOVA was used to comparing the bottom and top levels of the Likert scale for each question to look at differences between each phase. A summary of the different statistical analyses conducted are listed in Table 14.

Table 14. Experimental designs for the Whitsunday shark safety behavioural change project.

<b>Before After Control Impact (BACI)</b>				
<b>Statistical Analysis</b>	<b>Before-After</b>	<b>Control-Impact</b>	<b>Parameters</b>	<b>Description</b>
t-test, Kruskal-Wallis, ANOVA	Pre-Intervention (Aug/ Sept 2020) vs Post-Intervention (Oct/ Dec 2020)	Operator 1 vs Operator 2, 3	SharkSmart Behaviour, Fishing Behaviour, SharkSmart Awareness	Compare mean responses for each behaviour/ awareness question between phases and across operators
Fisher’s Exact test	Pre-Intervention vs Post-Intervention	Operator 2, 3	SharkSmart Behaviour, Fishing Behaviour, SharkSmart Awareness, Rubbish Collection	Compare frequency distributions between phases for treatment group (operator 2, 3)
ANOVA	Pre-Intervention vs Post-Intervention	Operator 2, 3	SharkSmart Behaviour, Fishing Behaviour, SharkSmart Awareness	Compare bottom-level and top-level responses on the liker scale for each behaviour/ awareness question between phases
ANOVA	Pre-Intervention vs Post-Intervention	Operator 1 vs Operator 2, 3	Knowledge and Change in Behaviour	Compare differences in knowledge and change in behaviour between phases

## 8.0 Results and evaluation of solutions

A summary of the full survey results is in Appendix F, a summary of the statistical analysis is in Appendix G and a summary table of the differences in knowledge and behaviour is in Appendix H.

### Understanding tourist activities

Tourists took part in both in-water snorkelling and swimming activities and on the water fishing (Fig. 9). In-water activities were popular with 88% in the pre-phase increasing to 93% in the intervention phase. Fishing was also a highly popular on the water activity that stayed constant throughout the study at 67-68% (Fig. 9).

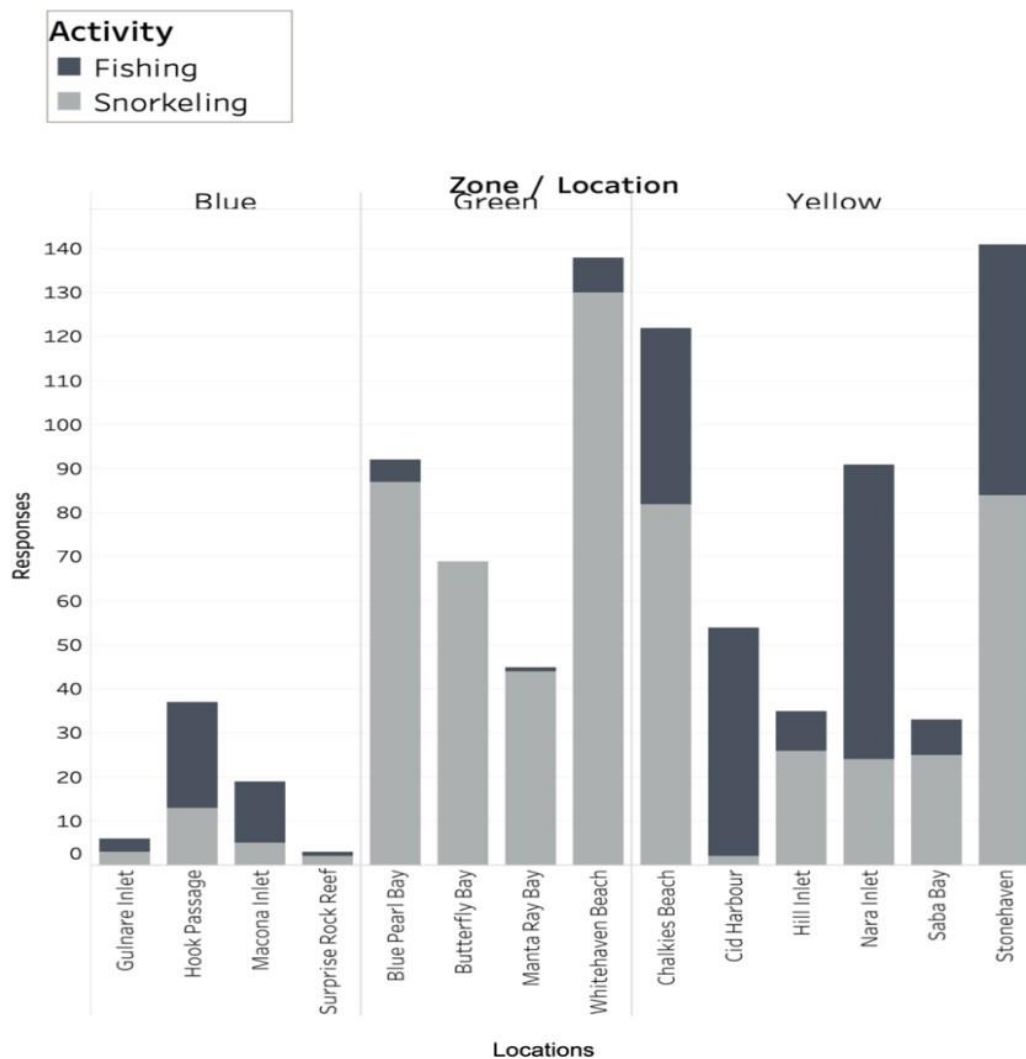


Figure 9. Comparison of number of tourists participating in snorkelling and fishing activities fourteen locations in the Whitsunday region and the relevant Marine Park zones.

Like all areas in the Great Barrier Reef Marine Park, the Whitsunday Islands is made up of a variety of zones including Marine National Park (Green) zone and Conservation Park (Yellow) zones with limits

on recreational fishing, no commercial fishing or spearfishing and a habitat protection (Dark blue) zone that allows fishing except trawling. Survey questions were designed to determine the locations that people were using for activities and to highlight areas that may have multiple activities occurring (Fig. 10). Swimming in areas with high fishing activity is not recommended but is difficult to control or influence in a busy area like the Whitsunday Islands.

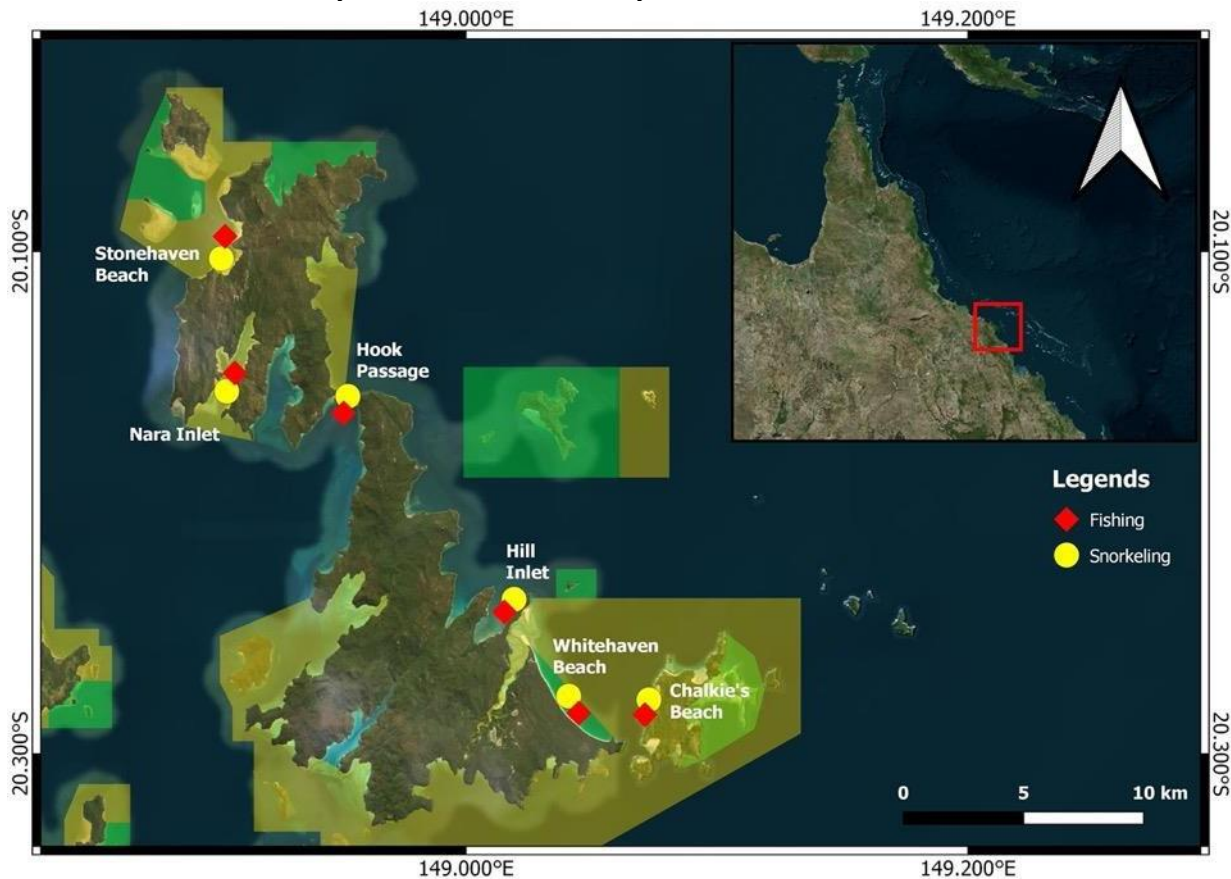


Figure 10. Map of snorkelling and fishing activities of survey respondents in the Whitsunday region and the relevant Marine Park zones.

Survey results indicated 13 of the 14 main sites that people visited were used for both fishing and snorkelling (Fig. 9). The majority of this happened in Conservation Park (Yellow) zones at Stonehaven, Chalkies Beach, Nara Inlet, Hill Inlet. Due to the special management zone in the Whitsundays, spearfishing is not allowed in Conservation Park (Yellow) zones. In Habitat protection (Dark blue) zones, Hook Passage had a crossover of activities (Fig. 10). A surprising survey result was that there were a small number of guests who reported that they fished in Green no-take zones where fishing is not permitted. The most popular sites where both fishing and in-water activities occurred were Stonehaven, Chalkies Beach, Whitehaven Beach, Hill Inlet and Nara Inlet (Fig. 9, 10).

## Changes in tourist knowledge and behaviour

Tourist knowledge was high (between 93.75 and 100%) for all six shark safety behaviours (Fig. 11) both before and after the intervention. Between 79.58% (pre) and 83.39% of respondents (post) were extremely aware of SharkSmart behaviours. The lowest awareness was for 'Avoid swimming with schools of baitfish or diving birds' at 93.75%. There was no statistical significance in tourist knowledge of SharkSmart behaviours between groups (Control, Treatment) and phases ( $F_{3,20} = 1.03$ ,  $p = 0.40$ ).

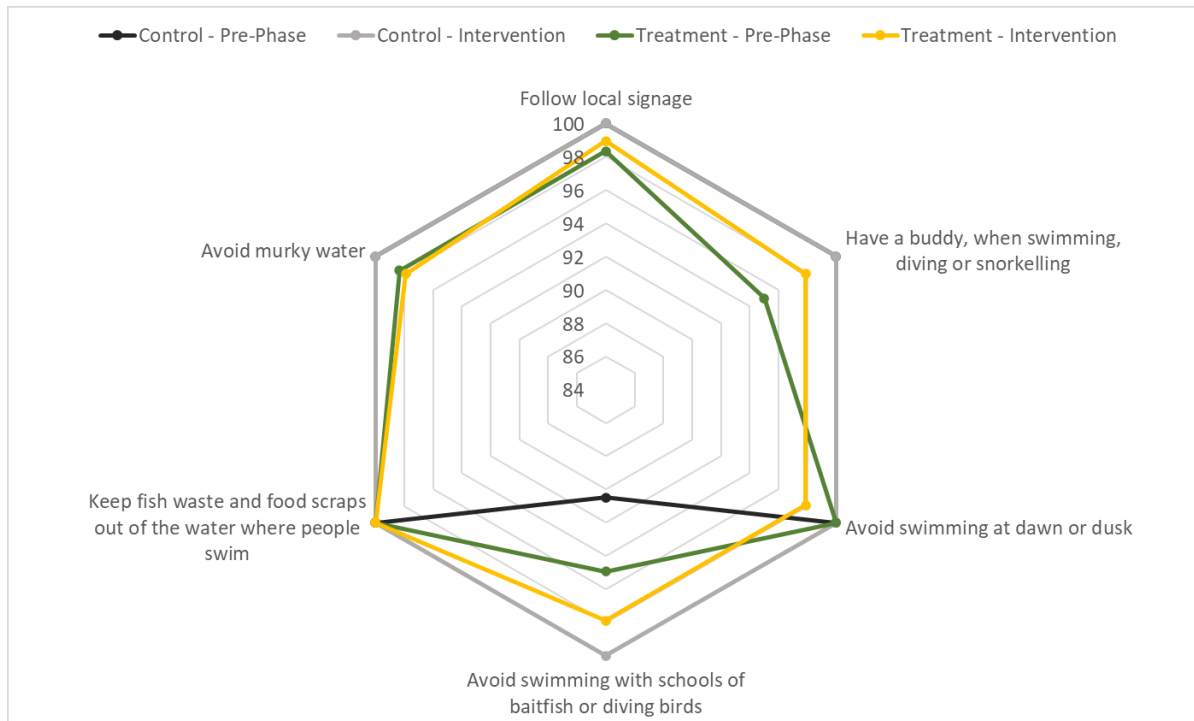


Figure 11. Tourist knowledge of behaviours during the Pre-Intervention (black, green) and Intervention (grey, orange) phases of the study for control and treatment groups. Scale is from 0 to 100%.

Shark safety behaviours are broken down into two categories, 1) Behaviours to reduce risk of encountering a shark during in-water activities such as swimming and snorkelling, 2) Behaviours to reduce risk of attracting sharks during on the water activities such as boating and fishing. There was no significant change ( $F_{3,28} = 0.1$ ,  $p = 0.96$ ) in behaviour following the intervention for six of the eight behaviours (Figure 12). The largest change was an 8.9% reduction in splashing or making noise when swimming or snorkelling. There was a reported 7.4% increase in chumming and berley behaviour.



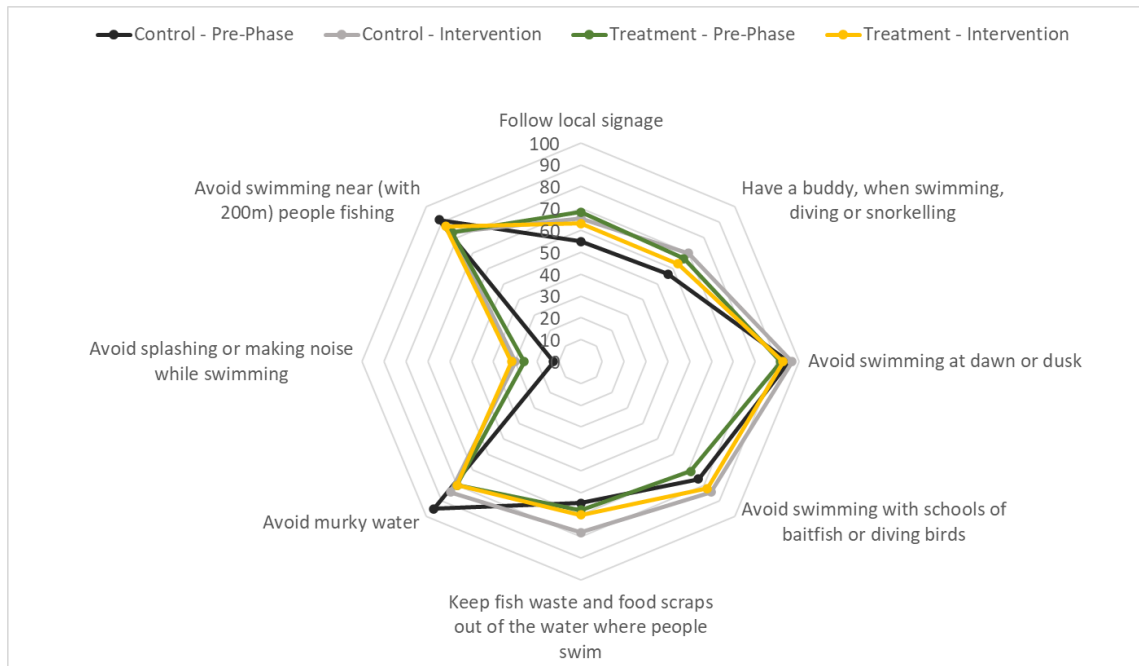


Figure 12. Tourist behaviours during the Pre-Intervention (black, green) and Intervention (grey, orange) phases of the study for control and treatment groups. Scale is from 0 to 100%.

Some risky behaviours IN water were more common (Fig. 13) than others (e.g. splashing while swimming, people swimming alone), while others were reported as uncommon (swimming in locations people were advised to avoid).

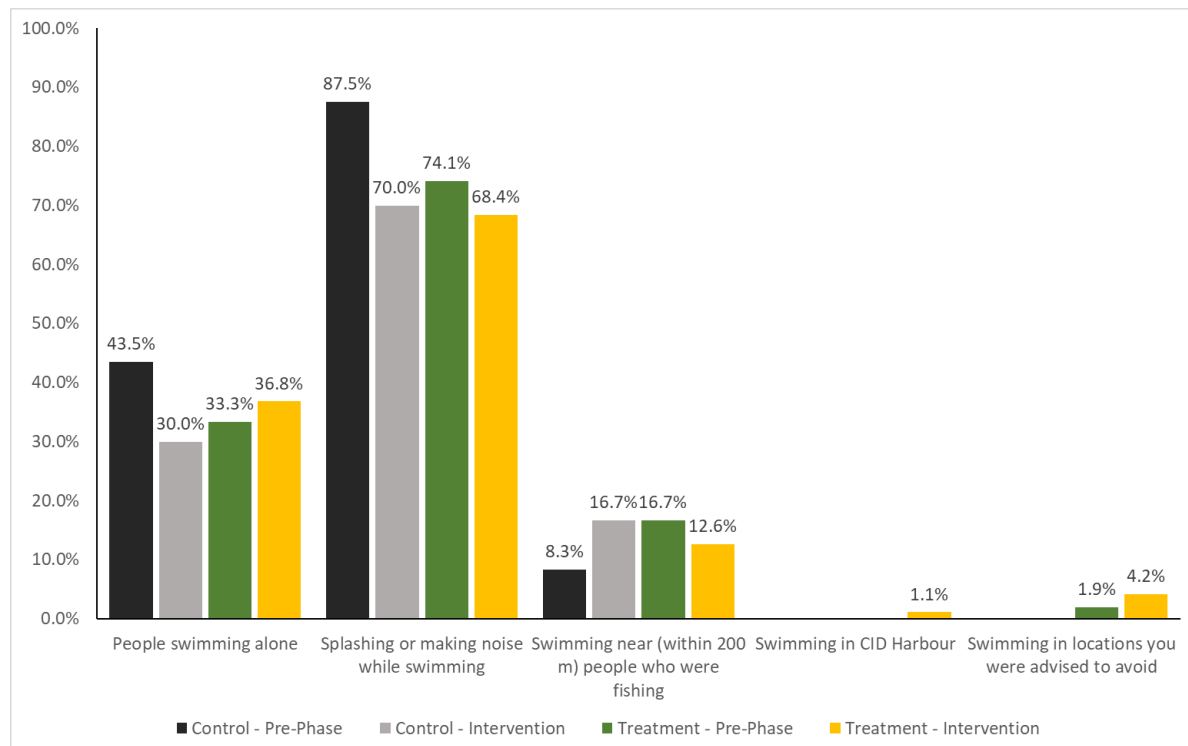


Figure 13. Percentage of people participating in risky behaviours in the water during the Pre-Intervention (black, green) and Intervention (grey, orange) phases of the study for control and treatment groups.

Some risky behaviours ON water were more common than others (Fig. 14) with 21-35% of people reporting throwing fish frames overboard.

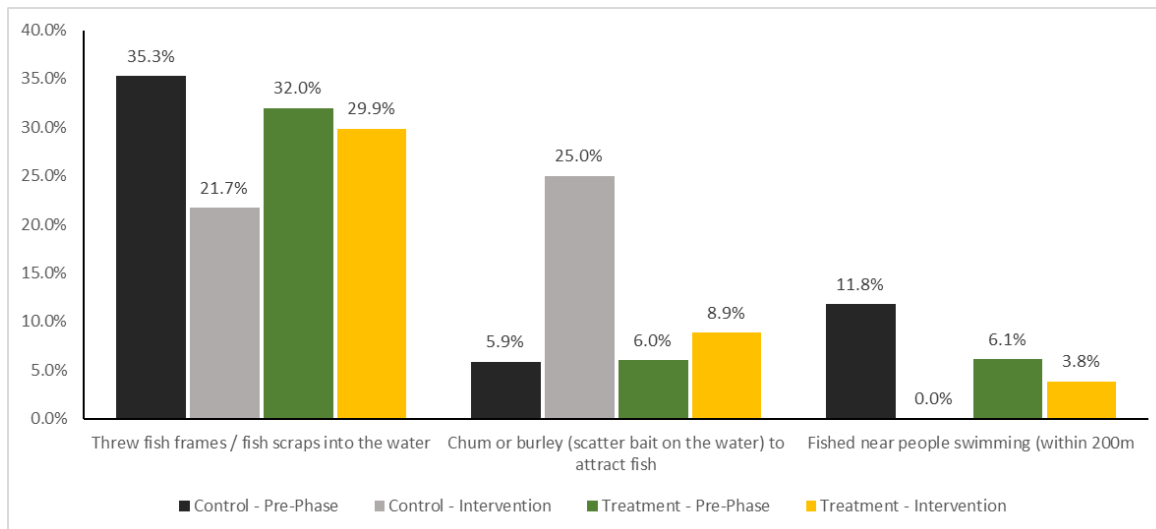


Figure 14. Percentage of people participating in risky behaviours on the water activities including boating and fishing during the Pre-Intervention (black, green) and Intervention (grey, orange) phases of the study for control and treatment groups.

## Relationship between knowledge and behaviour

Knowledge is an important driver of behaviour but often not a good predictor. In this study, we were interested in the interaction between knowledge and behaviour to better understand where knowledge is a good predictor of behaviour and where it isn't.

We observed a highly variable relationship between tourist knowledge and behaviour for each of the SharkSmart behaviours (Fig.15). There is strong relationship (over 80%) for two behaviours and moderate relationship (60-80%) for four behaviours. There is an average difference of 23.5% between average knowledge (97.9%) and average behaviour (74.4%) and a minimum difference of 7.4% and a maximum difference of 33.75%. Analysis of Variance (ANOVA) showed there is a significant difference between pre-intervention knowledge and behaviour ( $F_{1,10} = 24.17$ ,  $p = 0.0006$ ) and post-intervention knowledge and behaviour ( $F_{1,10} = 22.71$ ,  $p = 0.0007$ ).

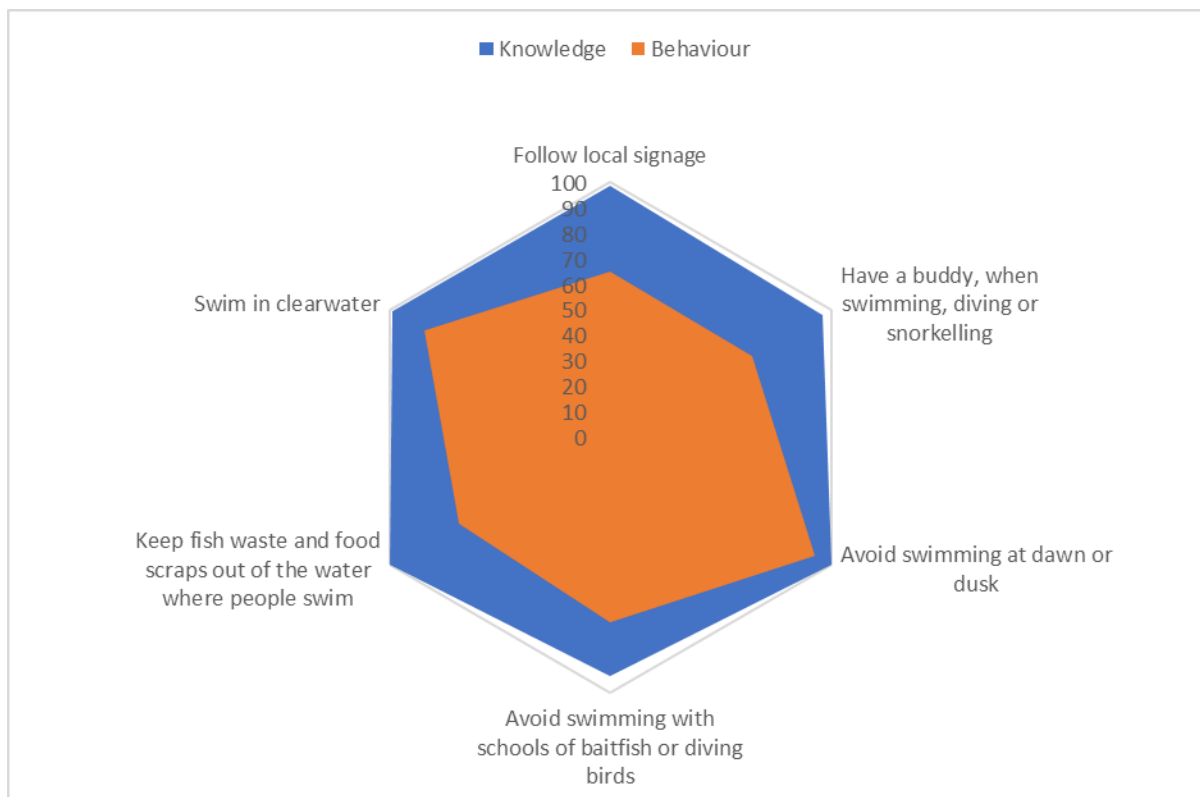


Figure 15. Relationship between knowledge (blue) and tourism behaviour (orange) associated with six shark safety actions. Scale is from 0 to 100%

## Rubbish disposal behaviour

With the Whitsundays being a highly popular boating destination, a variety of boats spend time among the islands and an increase in food and fish scraps entering the water may attract fish and potentially sharks. Data on rubbish, food and fish waste disposal was collected in a number of ways though the post trip survey and by physically inspecting fish and compostable waste after the trip to weigh and analyse the contents (Table 15, Appendix I).

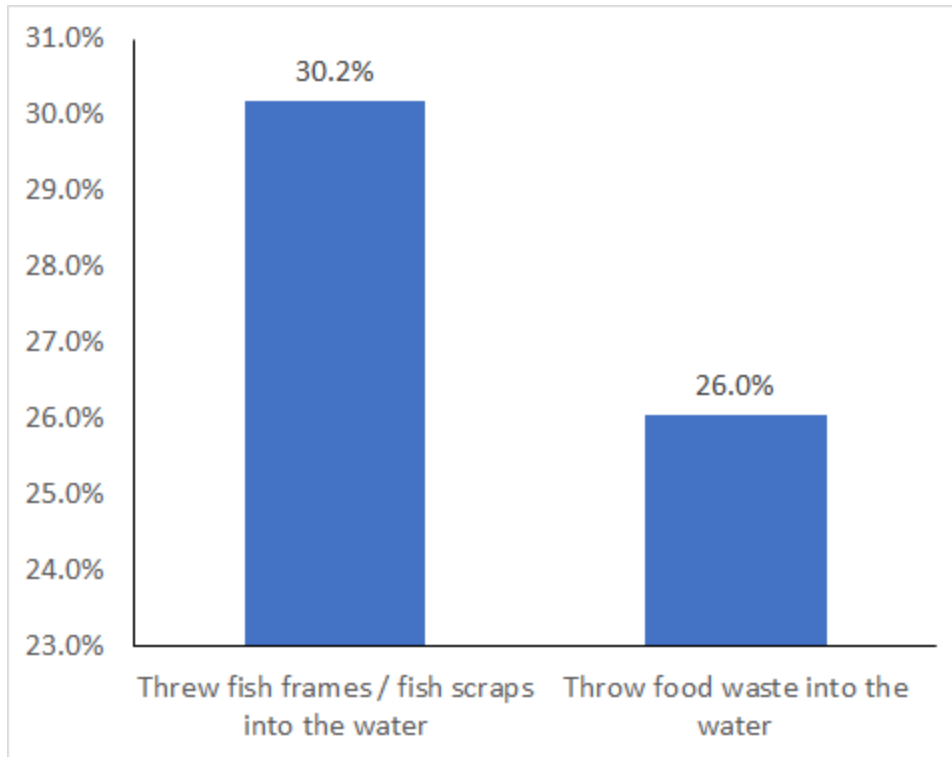


Figure 16. Percentage of people throwing fish waste or food scraps into the water (all data combined).

The percentage of survey respondents that reported throwing fish waste or food scraps into the water was relatively high (26-30%) (Figure 16), despite high levels of knowledge that these activities were not SharkSmart (100%). There was no significant change in the results before or after the intervention.

Table 15. Changes in rubbish disposal behaviours (weigh, meat or fish) of charter boat tourists in the Whitsunday in the pre-intervention and intervention stages.

Food Scrap and disposal behaviours	Data collection method	Pre Intervention	Intervention Survey	Change
Food waste returned and weighed at marina (Per person/per day in grams)	Physical collection of rubbish data	163.47	225.49	62.2 (gram) increase
Meat or fish scraps found in rubbish collected at the marina.	Physical collection of rubbish data	20%	20%	0% no change
Percentage of people who threw food scraps into the water.	Survey Response	28.4	30.71	2.31 (%) increase
Percentage of people who threw fish frames and scraps into the water.	Survey Response	32.84	28.71	4.13 %decrease
Percentage of people who disposed of food in onshore facilities (at Hamilton Island)	Survey Response	72.84	74.22	1.38 (%) increase

Collecting rubbish from the galley in a clear plastic bag allowed visual inspection and weighing of food waste to determine if it contained any fish or meat scraps. This helped determine if guests were keeping fish and meat scraps and disposing of them on land, or if they were disposing of it overboard. In advance

of departure, signage was placed in the galley with instructions to keep compost, fish and meat scraps in the clear bags onboard.

Food rubbish was collected post trip in the Pre-intervention and the Post Intervention from 20 boats in the Pre-Intervention Stage and 15 in the Intervention phase. Additional boats in both phases were attempted to collect additional data, however, some vessels disposed of their rubbish at Hamilton Island in advance of returning to the marina. These vessels were not excluded from weight calculations.

163.47g per person per day was the average amount of food scraps per boat during the pre-intervention stage. 225.49 grams per boat was the average amount of rubbish returned in the intervention stage. The total amount of rubbish weight returned to the marina increased by 15.94% during the intervention stage.

An average of 163g (SE = 22.15) per person per day of rubbish was collected during the Pre-intervention phase while an average of 225.49 (SE = 51.59) per person per day was collected during the intervention phase (Fig. 17). Analysis of variance (ANOVA) showed no significant differences ( $F_{1,33}=1.46$ ,  $p = 0.24$ ) in mean rubbish collected between phases.

A total of 20% of all rubbish collected during the Pre-intervention phase had fish or meat in it (Table 18). During the intervention phase, this number remained the same with no change recorded. Fisher's exact analysis showed no significant differences ( $p$ -value = 1) between phases.

## **SharkSmart information exposure**

Our results indicate that recipients of the intervention had increased exposure to SharkSmart information. Survey respondents who received the intervention, reported seeing more SharkSmart information than those who did not receive the intervention. In particular, pre-trip briefings, fact sheets and stickers were more commonly sighted by those who received the intervention (Figure 17). Interestingly, the number of people who sighted a pre-trip video declined following the intervention stage, despite our pre-trip video only being introduced during the intervention. This points to other video content being shared by tourism operators in advance of the trip. The highest number of respondents received SharkSmart information from pre-trip briefings (147), local signage (127) then fact sheets (113).

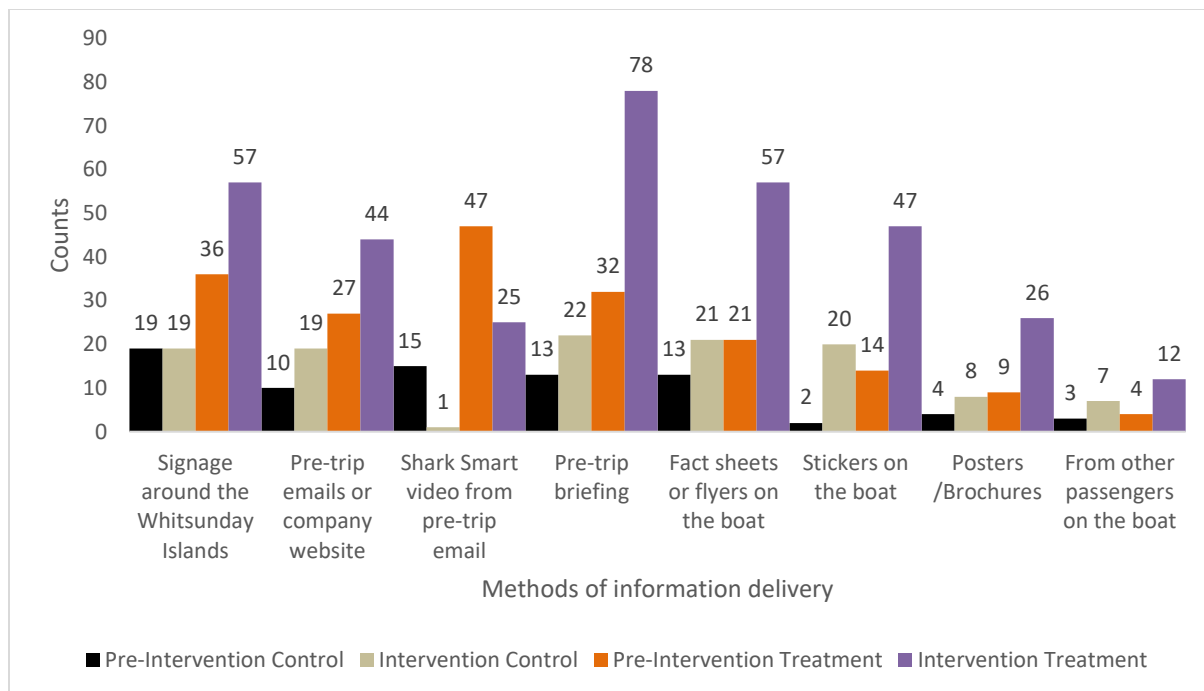


Figure 17. Survey respondents indicated how they received information during their trip about SharkSmart behaviours during the pre-intervention and intervention stages. Control responses for this question were n=59 and pooled operators for the treatment were n=157.

## Preferred method of receiving SharkSmart information

The pre-trip briefing was the most preferred method of receiving information (5.4 out of 6, with 6 being the preferred method and 1 representing the least preferred). This was followed by local signage (4.7), pre-trip emails/company website (4.6) and factsheets (4.4) (Fig.18). The posters and brochures ranked the lowest at 2.6 which indicates similar material may be better absorbed though fact sheets (4.4) or Stickers (3.9). The use of video for information was still positive at 3.82, however, people did prefer the face-to-face briefing for information. Respondents demonstrated that they are absorbing information from a variety of sources, so it is important to have SharkSmart material widely available. For future SharkSmart behavioural studies, researchers conducting face to face briefings would be highly beneficial.

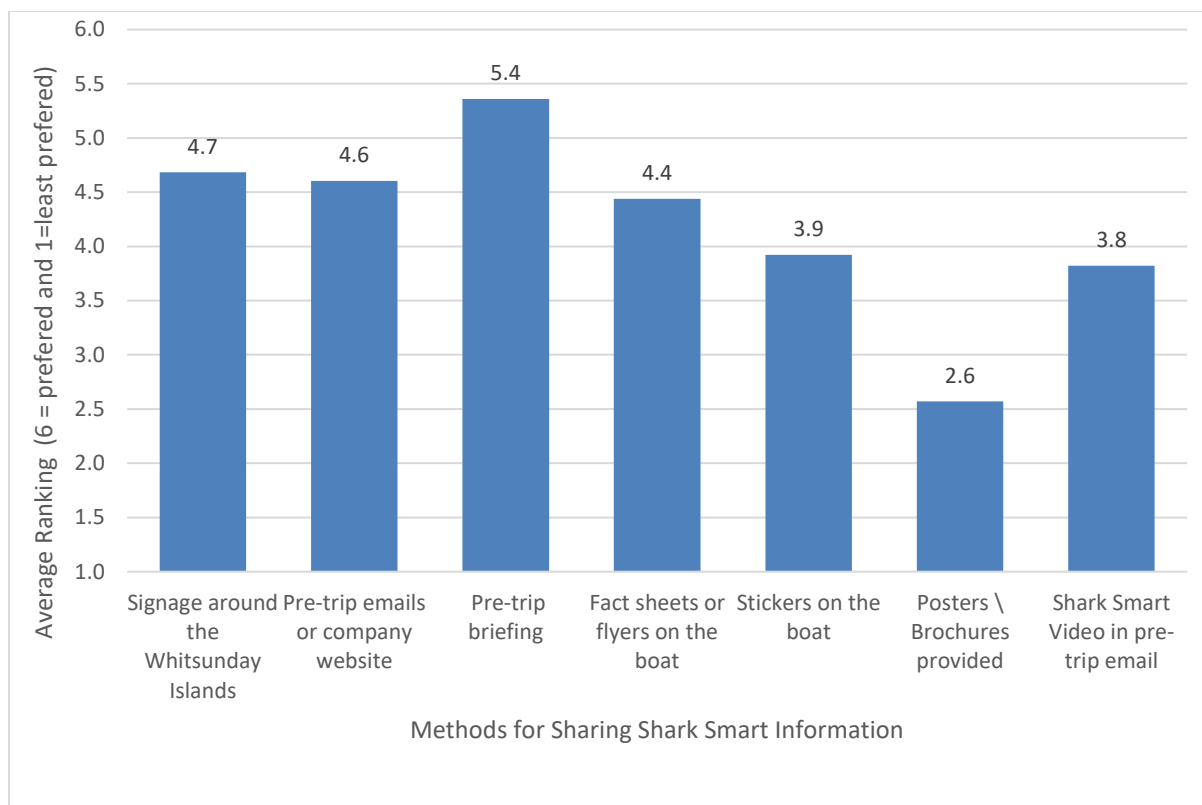


Figure 18. Survey respondents ranked their preferred method of receiving SharkSmart information during the pre-intervention and intervention stages. Data is pooled and averaged for each information delivery method.

## 9.0 Discussion

This pilot research project highlighted many important considerations for boosting shark safety of tourists in the Whitsundays. While tourist knowledge of shark safety behaviours was very high (93-100%), knowledge was not a strong predictor of behaviour. This is a common pattern in behavioural studies but was somewhat unexpected in this instance, where we predicted risk-aversion to be a very strong driver of behaviour. The knowledge-behaviour inequality was particularly evident when it came to several in-water snorkelling and swimming and waste disposal behaviours. Despite very high knowledge of the importance of keeping fish waste and food scraps out of the water where people swim (100% of respondents claimed to be aware of this behaviour both before and after the intervention), around 30% of people reported throwing food waste or fish waste into the sea. This is a concern as these behaviours are hypothesised to attract sharks to boats or to areas where the activity frequently occurs.

### High level of knowledge

Our survey results found a very high knowledge of all shark safety behaviours by bareboat charter tourists. Overall, knowledge of tourists on SharkSmart guidelines was 98% with only 1-1.78% of respondents not aware of SharkSmart behaviours. Between 79.58% (pre) and 83.39% (post) were

extremely aware of SharkSmart behaviours. We believe that these very high levels of awareness may be due to the very high proportion of Queenslanders in the survey. In a typical, non-COVID-19 tourism season with many international and interstate tourists we expect that this level of awareness would be significantly lower. As a comparison the surveys by Smith et al. (2020) indicated 89% were aware of swim safe messages to minimise the risk of unwanted shark encounters, which is 10% less than this study.

The three most well know shark safety messages from our survey results were: Avoid swimming at dawn or dusk, Follow local signage and Keep fish waste and food scraps out of the water where people swim. The survey by Smith et al (2020) similarly reported that the most well-known message was “Don’t swim at dawn or dusk”. It is noteworthy that the lowest awareness was for the new behaviour that was introduced in 2020 as a result of the Whitsundays workshop and in the updated Queensland wide SharkSmart program ‘Avoid swimming with schools of baitfish or diving birds’.

## In-water activities and behaviours

The popular locations for snorkelling and swimming in the Whitsundays are surrounding the northern side of Hook and Hayman Islands according to Colfelt (2019) (Fig. 19). Our surveys confirmed that Whitehaven Beach and adjacent Chalkies Beach at Whitsunday Island, Blue Pearl, Butterfly, Stonehaven and Manta Ray were popular with snorkelling for charter boat tourists. There have been no historical shark bites on the northern side of Hook Island and there has been one previous bite at Whitehaven Beach in 1997. There have been no historical shark bites in Marine National Park (green zones) in the Whitsundays region. Interestingly, Espinoza et al. (2014) reported that the relative abundance of sharks was significantly higher in non-fished sites or protected areas in the Great Barrier Reef Marine Park.

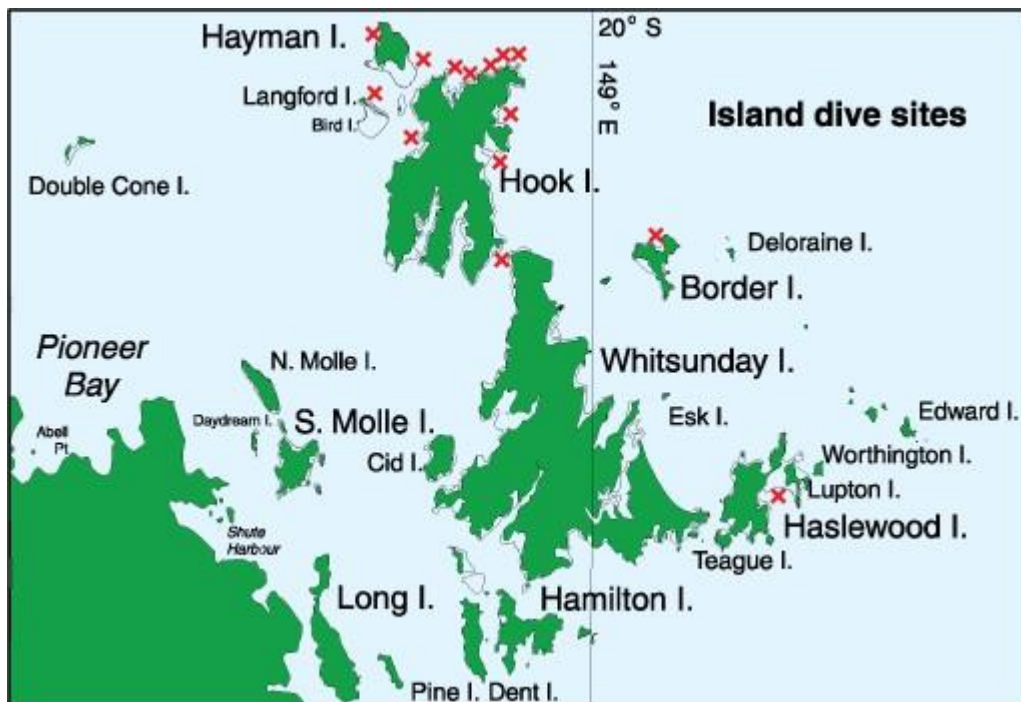


Figure 19. Popular snorkelling sites on the north of Hook and Hayman Islands (Colfelt 2019).

The Whitsundays Islands are a very popular boating destination with visitors coming to sail, fish, hike



and snorkel. With so many people utilising the area, sheltered anchorages are often busy and the risk of people attracting sharks to these areas increases with dumping food overboard and fishing. Key behaviours from the workshops with local stakeholders and researchers indicated separating areas of swimming and fishing as the top behaviour which may increase the safety of water users. A shark safety behaviour that was emphasised in the Intervention Phase is ‘Avoid swimming near (200m) people who are fishing’ as this activity may increase the chances of attracting a shark, which can pose risk to nearby swimmers and snorkelers. One of the potential challenges is the activity of spearfishing which involves both snorkelling and capturing fish. This risk of an incident is likely to increase if other risk factors are present such as schooling fish and low visibility water.

A behaviour that local tourism owners, crew and researchers all ranked as important is ‘Don't swim in murky waters’. The Whitsunday Islands are nearshore fringing reefs that have visibility from 2 to 15m and average of 4-6m and sediment is easily stirred up with wind creating poor visibility and murky conditions (Colfelt 2019). The reality of snorkelling in nearshore fringing reefs is the visibility is rarely crystal clear like you would find on reefs further offshore, however, knowledge of local sites and tidal movements can increase chances of swimming in clearer water. During the workshops, the local interpretation of ‘murky water’ ranged from not being able to see your feet to 2-5 metres.

Two in-water activities this project focused on were ‘Avoid Splashing or making noise while swimming’ and ‘Have a buddy/avoid swimming alone’. Splashing or making noise while swimming’ was a behaviour identified by both shark researchers and local tourism crew as risky. Erratic splashing and panic like noises have been thought to attract sharks. This behaviour is difficult to reduce without making people scared to enter the water as people jump off boats and naturally make noise while swimming and snorkelling with friends. Adopting the alternative behaviour of ‘avoiding splashing or making noise while swimming’ may reduce the risk of shark bite. Swimming alone is not only a shark safety behaviour but also a general water safety behaviour that should be encouraged at all times in the ocean. It is common practice for in-water activities such as SCUBA diving but should also be encouraged for snorkelling and swimming.

The Queensland Government identified different risk profiles for water users, based on their attitudes to shark risk. The category ‘She'll be righters’ (18% of water users; mostly aged 16 to 29 years) are less worried about the consequences of risky behaviours and are less likely to follow the shark safety behaviours. Interestingly, this category of 16-29 years of age represents a disproportionately high 50% (5 of the 10, Table 1) of shark bites that have occurred in the Whitsundays region. Demographic data was originally included in our survey but was redacted to shorten the survey for faster completion. The inclusion of this data would have allowed us to determine if behaviours were more or less common for different demographics which would be useful in designing future interventions. The limitations of working with time poor tourists were a factor in this decision.

## On the water activities and behaviours

Researchers and stakeholders ranked ‘Avoid throwing food and fish scraps overboard’ as the third most important shark safety behaviour. With many boats staying in anchorages overnight, more food may be disposed of in these areas as well as people fishing from their moored or anchored vessels which may attract sharks to associate these locations with food (Colfelt 2019). Sharks may be attracted to fishing bait and struggling fish. We observed several recreational fishing boats returning at the end of a day from an outer reef trip and visiting Manta Ray Bay to dispose of large amounts of unused bait to feed and excite fish (Trevally, Maori wrasse, Batfish etc) so they could watch the fish from their boats.

Although 100% of people were aware of the behaviour to keep fish waste and food scraps out of the

water, the pre-surveys between August-September indicated that a minority (28.4%) but relatively high number of charter boat tourists disposed of food and fish scraps into the water. Following the intervention, including a pre-trip educational video, stickers, brochure and briefing to remind them not to dispose of fish and food scraps, post-surveys between October-December indicated that 30.7% disposed food waste and fish scraps, showing an increase of 2.31%. Similarly, 28.4% disposed of food scraps initially which declined to 20%, a reduction of 8.4%.

However, this is still a high proportion of people who dispose of food into the water which may attract sharks and reduce the safety of snorkelers and swimmers. Therefore, this behaviour should be reinforced with further behaviour change programs so that it becomes a social norm to dispose of scraps on land rather than in the water. The awareness was very high, but the adoption of the desired behaviour was low so further investigation is required into barriers of change (such as storage of rubbish, smell of rubbish, desire to feed fish etc)

## Research limitations

This research project was a pilot study and was limited by a number of factors. Firstly, the design of the surveys was relatively simple and with limited replication that is typically used in academic studies of behavioural change. Secondly, the survey responses are self-reporting and there may be over or under-estimation of behavioural changes. Our results also indicate further challenges associated with using a self-reporting methodology to detect behavioural change as well as compliance/non-compliance with specific behaviours. For example, respondents reported high levels of knowledge as well as high levels of compliance around swimming in clear water, but interestingly, Whitsunday waters are generally considered to be murky in many locations and for much of the year. Thus, the high proportion of people reporting only swimming in clear water was unpredicted and may indicate another area where more research is needed. Typically, an independent observer or remote camera system would provide an alternative methodology to confirm the results

The level of exposure of study participants to other education campaigns (e.g. Queensland Government SharkSmart campaign; GBRMPA Reef Smart campaign) prior to and/or during the study was not quantified. This has the potential to influence awareness and behaviour variably both within and between treatment groups.

The scale and budget of the shark safety intervention study was a limitation. The study relied on volunteer tourism operators to implement interventions and collect data. Tourism operators in the Whitsundays were impacted by the COVID-19 pandemic and as a result the sample size was reduced, particularly relating to rubbish collection. Rubbish weight and images were not recorded for all samples making statistical analysis less powerful. Rubbish collection was a difficult task as boats arrived back at different times and many boats disposed of their rubbish at Hamilton Island rubbish disposal mid-trip or before returning to shore. Having researchers collect this data and brief the guests on returning data to shore would reduce data gaps and errors. The study would have benefitted from the collection of fishing effort data (e.g. number, species, weight, kept, released) and shark observations (sightings, depredation of catches) to provide further context to the behaviour change results. As with other behaviours, direct measurement of rubbish disposed overboard (e.g. by an independent observer or remote camera system) would provide an alternative methodology to assess this behaviour but would be difficult to implement.

Information on fishing effort, catch and use would have added further context to the assessment of on the water behaviour change. In order to expand on the information in the survey results associated with fishing and waste, one person was opportunistically interviewed who chartered a bareboat vessel in December 2020. It was a family trip with four people on board and they participated in snorkelling and

fishing. They reported that they had a very successful fishing trip and caught approximately 20 fish over the 8-day charter (Fig. 20). The majority of fish were Coral trout and Giant trevally. Fish were caught on lures, trolling and spearfishing. Two coral trout were kept for food and the rest of the fish were released. The respondent reported that fishing at Chalkies was surprisingly good around the moorings. They observed that eight out of 10 boats on moorings at Chalkies were fishing. They observed several small reef sharks following captured fish but did not have any fish taken. They observed snorkelers very close (10m) to people fishing. They reported that they disposed of fish scraps while underway and a distance away from the anchorage. They reported that the pre-departure bareboat briefing is complex and long (4 hours) and that there is an opportunity to better inform people about shark safety behaviour and correct disposal of food and fish scraps.



Figure 20. A coral trout captured by a tourist at Chalkies Beach, a popular swimming location in the Whitsundays.

## Stakeholder engagement

Effective behavioural change campaigns require extensive background research to understand target groups and behavioural contexts. In addition, strong stakeholder engagement is essential. A key success of this pilot project in the Whitsundays region is the comprehensive consultation, engagement and partnership with tourism, government, research and scientific experts that was undertaken in developing the interventions. Almost two hundred people have shared knowledge and been consulted. The project methodology was co-designed with key stakeholders from the tourism industry, government and researchers. The study focused on the stakeholders concerns and recognised that there is no one-size-fits-all approach for successful behaviour change projects. For this reason, it was important to test our approach and consider the feedback from the tourism operators in the Whitsunday region about survey design, delivery, length and intervention tools and adapt our approach accordingly. Building on the learning, interest, and community momentum generated by this pilot project it is advisable to continue progressing SharkSmart behavioural change programs in the Whitsundays region.

This project was also influential in the evolution of the Queensland Government SharkSmart campaign which was informed by the consultation workshops. The primary changes were the merging of two

behaviours on food scraps into one behaviour, and a new behaviour on avoiding schools of baitfish and diving birds. The negative words ‘Don’t’ were replaced with positive words. The use of a SHARKS acronym in 2020 aimed to tie all of the behaviours together in one, memorable way, for people to see and understand.

## Summary

The results of this study provide clear indications on where knowledge-focused interventions may be most helpful for tourists and management agencies. They also provide useful guidance for focusing future research (e.g. answering key questions such as “do people understand what constitutes murky or clear water?” or “can people sufficiently recognise the signs of bait balls in order to avoid swimming near them?”).

The project found very high levels of knowledge of bareboat tourists for Queensland SharkSmart behaviours in the Whitsundays (> 98%). High compliance (>90%) exists for some tourists behaviours (avoid swimming in CID Harbour, avoid fishing near people swimming). Medium non-compliance (20-40%) exists for other behaviours such as avoid throwing food and fish waste overboard, avoid swimming alone, avoid swimming near people fishing, avoid splashing and making noise while swimming and avoid throwing fish scraps into the water.

Approximately three out of 10 people and up to 8 out of 10 people ignored one or more of the voluntary SharkSmart guidelines and participated in risky behaviours including swimming alone, swimming with baitfish, swimming in murky water, splashing when swimming and not following signage and disposing of food or fish scraps in the water. Clearly, there is much more to be done to improve adoption of SharkSmart behaviours in the Whitsundays.

Further research is recommended to better understand the relative importance of various human behaviours in contributing to the risk of shark bites and in attracting sharks to boats and people. Additional social research is recommended to better understand the context around key behaviours and determine where barriers may prevent behavioural change.

## 10.0 Recommendations

Six comprehensive recommendations are provided with the aim of increasing awareness and encouraging human behaviour change to reduce the risk of shark bites and increase safety of tourists in the Whitsundays region. The benefit of implementation of each recommendation are predicted.

- I. In partnership with Fisheries Queensland SharkSmart program, Tourism Whitsundays and GBRMPA consider expanding shark safety interventions (a pre-trip educational video, posters, stickers) from selected bareboat operators to other tourism operators in Whitsundays. Even though the interventions resulted in minimal behaviour change in the present study, it is important to continue to deliver SharkSmart information through a variety of methods whilst continuing to explore potential barriers to behaviour change.  
Benefit- increase safety of tourists
- II. Expand shark safety interventions to include recreational and commercial fishers and focus on “Avoid fishing near (within 200m of) people swimming” or in popular swimming/snorkelling locations.

Benefit- improve relationship between fishers and tourists and increased safety of tourists

- III. Relevant management agencies should consider the viability of using policy measures to influence behavioural change (e.g. special management zones, regulation, or penalties).  
Benefit. Faster behavioural change and increased safety of tourists.
- IV. It is recommended that the Australian Shark Attack File consider whether additional data could be collected that could support future behavioural change interventions.  
Benefit. More accurate data and research on activities and potential responses.
- V. In the absence of further information, it is recommended that a higher level of caution is applied in the Whitsunday region between September and December as this is the time of increased shark risk an optimal period for the delivery of future communication, education, and behavioural change initiatives.  
Benefit. Increased safety during potential higher risk periods.
- VI. In future expanded studies, it would be beneficial to do a series of semi-structured interviews to get additional personalised feedback about fishing catch and barriers to keeping food and rubbish onboard and people's experience as a whole.  
Benefit. More accurate data and research on activities and potential responses.

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## 12.0 Appendices

### Appendix A. Record of consultation with tourism operators at each project phase

Phase	Consultation Operator 1	Consultation Operator 2	Consultation Operator 3 (control)
Stage 1- Initial consultation	Field trip Whitsundays 22/08/2020 – project presentation and overview	Field trip Whitsunday 22/08/2020 – project presentation and overview	Field trip Whitsundays 23/08/2020 – project presentation and overview
Stage 2- Pre-intervention and training	Field trip Whitsundays 14/09/2020 Progress update, assistance with rubbish collection and survey set up, filming of a pre-trip educational video	Field trip Whitsundays 13/09/2020 Progress update, assistance with rubbish collection and survey set up	Field trip Whitsundays 13/09/2020 Progress update, assistance with rubbish collection and survey set up, volunteer assistance introduced
Stage 3- Intervention	Field Trip Whitsundays 13/10/2020 Distributing intervention material, setting up boats with stickers/brochures/posters, a pre-trip educational video	Field Trip Whitsundays 13/10/2020 Distributing intervention material, setting up boats with stickers/brochures/posters, a pre-trip educational video	Field Trip Whitsundays 13/10/2020 No meeting, continuation with survey/rubbish collection, no intervention

## Appendix B. Potential behaviours to reduce shark bites in the Whitsundays region

Behaviours (as ranked by shark experts)	Discussion and observations (from workshop and interviews)
<p>1. <b>Don't swim where people are fishing or in places where fish are cleaned.</b> Fishing boats may attract sharks looking for an easy meal.</p> <p><b>Fishing may attract sharks.</b> Don't fish where people are swimming or where you plan to swim.</p>	<p>This was the key behaviour ranking top priority by both shark experts and tourism operators. While definitive separation of these activities is unlikely without regulatory separation, there are many opportunities to influence voluntary adoption of practices that separate fishing and swimming (e.g. communication programs that focus on community safety and everyone has a role to play in keeping the community safe). Key focus groups for this behaviour include recreational boaters and fishers, charter fisher operators, bareboat renters, and tourism operators who decide on swimming locations for their guests. Separating these behaviours should be a key priority for future investment.</p>
<p>2. <b>Don't throw food scraps or fish frames overboard.</b> Sharks are scavengers and may be attracted to any type of food waste (or the fish it attracts).</p>	<p>This is an important behaviour that is mostly relevant to bareboats, private boaters and recreational fishers.</p>
<p>3. <b>Don't intentionally bait sharks.</b> Sharks can learn to associate boats with food. Intentionally baiting sharks creates a safety risk for everyone.</p>	<p>Videos of intentional shark baiting from bareboats and private boats have been provided to Reef Ecologic and are cause for concern, particularly as these activities are at times happening in popular swimming locations in the Whitsundays. Tourism staff have observed highly active sharks pursuing paddleboarders in an area approximately 40 min after an episode of intentional baiting was observed.</p>
<p>4. <b>Avoid the water at night, dawn, and dusk.</b> Many sharks are most active at these times and are better able to find you than you are to see them.</p>	<p>The behaviour 'Don't swim at dawn or dusk' is not relevant to day-boats who generally snorkel between 9am and 3 pm but is specifically relevant to overnight charter boats.</p>
<p>5. <b>Avoid swimming near bait fishes.</b> Diving seabirds or surface ripples caused by jumping fish often indicate schools of bait fishes.</p>	<p>This was seen as important behaviour for the Whitsundays and was anecdotally linked to previous shark bite incidents.</p>

<p>6. <b>Don't feed fish.</b> Fish pellets attract small fishes, which in turn attract larger fishes and sharks.</p>	<p>Some tourism operators are reluctant to stop this popular guest activity as it understandably thrills visitors. There is a high level of uncertainty about how much fish feeding is occurring in the region with some tourism operators suggesting it only occurs on rare occasions at 1-2 sites and others suggesting it is a widespread activity that occurs on nearly every trip in a multitude of locations around the islands. Further research into this is recommended. One of the local suppliers of fish pellets estimated many kgs of pellets are purchased from them each year. Fish biologists indicated that a relatively small amount of fish food could substantially alter fish and therefore potentially shark behaviour. The degree to which this behaviour could be conditioning sharks to approach particular areas or boats is unknown and would be ideal for further research.</p>
<p>7. <b>Don't swim in murky water.</b> Sharks can't see as well and are more likely to make a mistake. You are also less likely to see a shark if one is present reducing the window of opportunity to leave the water.</p>	<p>This behaviour is seen as particularly problematic in the region because water quality is generally poor meaning that swimming or snorkelling occurs in low visibility or not at all, presenting a major economic problem for the industry. Individuals and tourist operators would benefit from clarity around this recommendation. For example, what visibility is the cut off for murky water &lt;2m? &lt;5m? This is a question that warrants future research and requires clear instruction and parameters for people to act. This is particularly true in the Whitsunday region.</p>
<p>8. <b>Don't swim in estuaries or busy anchorages.</b> When sharks associate boats with food, they are more likely to hang around busy anchorages to get a free feed. <b>Don't swim in known "sharky" areas</b></p>	<p>Several of the recent shark bites in the Whitsunday region occurred in Cid Harbour, one of the most popular overnight anchorages. During this project, reports were received of fishing, intentional shark baiting, and disposal of organic materials into the waters of Cid Harbour. These behaviours along with fish feeding, incorrect disposal of sewage/black waste, and use of fish-attracting boat lights all potentially attract sharks to boats and to this anchorage. Some locals also theorised that Cid Harbour may be a particularly attractive location for bull and tiger sharks due to proximity to nearby sandbars that provide prime habitat for these species. Further mapping of shark distribution patterns and optimal shark habitat in conjunction with mapping of human activities that might be of interest to sharks could be a useful tool to predict areas of higher risk. While the risk of a shark bite is statistically low, even in higher risk areas, these events are extremely damaging to the industry and thus careful consideration should be given to longer-term implementation of no-swim areas as well as other behavioural change projects aimed at reducing conditioning of sharks to boats and people (e.g. proper waste disposal, limitations on fishing activities particularly fishing with bait, limiting the use of boat lights, etc.)</p>
<p>9. <b>Exercise more caution during higher- risk months.</b> Sharks can be more active during the breeding season, following extreme weather, and in certain water temperatures and shark bites in the Whitsundays have mostly occurred between September and January.</p>	<p>Given the apparent seasonality of shark bites in the Whitsunday region, this is a key behaviour. It may be wise to impose stricter limitations on or further education about behaviours such as fish feeding, jumping from boats and waterslides, waste management, fishing, snorkelling conditions, etc. during the higher risk months from Sept- Dec. This topic would benefit from the additional study, particularly links between shark activity levels and optimal water temperatures, such as has been conducted elsewhere in the world.</p>

<p>10. <b>Don't go into waters containing sewage.</b> Sewage attracts bait fishes, which in turn attract sharks.</p> <p><b>Dispose of sewage waste correctly.</b> Sewage attracts fish, which in turn attract sharks</p>	<p>It is largely assumed that people who charter bareboats, private vessel users and others using the Whitsunday Islands are correctly disposing of sewage. However, tourism staff have reported boats leaving sewage systems open at anchor. As sewage may attract sharks, further research should be done to determine the degree to which improper disposal is occurring. In addition, any sewage outfalls around the island should be mapped and promoted as higher risk areas for swimming and snorkelling.</p>
<p>11. <b>Follow signage.</b> Don't swim in no- swimming areas.</p>	<p>Swim bans may be advisable permanently in some locations. Signage is important but alternative options such as mobile phone applications, printed maps, waivers and other notifications are necessary to ensure that people adhere to no-swim areas.</p>
<p>12. <b>Don't splash a lot.</b> Also, keep pets out of the water. Erratic movement may attract sharks.</p>	<p>This is a problematic behaviour for tourists in the Whitsundays as many of them are poor swimmers and as a result, tend to splash. Weather conditions are also often not suited to splash-free swimming, particularly in unsheltered snorkel locations. Finally, many of the tourist's vessels use water slides, dive platforms and generally host rowdy tourists jumping and playing in the water. At least one of the shark bites occurred while two people were rough-housing and splashing in the water. This kind of activity may attract sharks. Another challenge here is that tourism operators are reluctant to mention sharks so the "no splashing" advice is often delivered in the context of scaring off marine life. This is not as highly motivational as using a message about shark safety to promote safe swimming techniques. Further research may reveal how critical this behaviour is for the region which will inform the degree and nature of programs aimed at altering it.</p>
<p>13. <b>Don't enter the water if sharks are present.</b> Leave immediately if sharks are seen.</p> <p><b>Have spotter or lookout watching for sharks.</b> If a shark is sighted, everyone should exit the water immediately.</p>	<p>Most of the crewed tourism trips have spotters present at all times while people are swimming. This is advisable. Tourism operators also confirmed that they inform each other via radio if sharks are sighted. It was unclear how self- skippered vessels like bareboats or private vessels might be notified of a shark sighting but concepts such as mobile phone application, radio updates and online sighting portal could be used to help share shark spotting information.</p>
<p>14. <b>Always swim in a group.</b> Sharks are more likely to bites lone individuals.</p>	<p>This behaviour is mostly relevant for private recreational boaters, locals, and self-skippered boats. Most people on chartered day or overnight trips swim with a group.</p>

<p>15. <b>Swim in shallow water and avoid steep drop-offs.</b> These are favourite habitats for sharks.</p>	<p>Site selection may be an important risk reduction consideration for tourism operators. More research and habitat mapping are needed to provide clear recommendations for lower and higher risk areas. Information about particularly high-risk locations should be made publicly available so that private boaters can consider this in their own swim site selection. One approach might be to designate certain ‘safer’ areas for swimming and disallow fishing, fish feeding and all other behaviours linked to shark conditioning at these locations.</p>
<p>16. <b>Turn off boat engines when possible.</b> Sound travels far underwater and sharks may be attracted to engine sounds (because boats mean food).</p>	<p>Boat engines may attract sharks in areas where sharks associate boats with food. Additional studies in the Whitsundays to better understand the association between boats and sharks would help determine if this behaviour could be helpful in the short-term while longer-term associations and habituating activities are halted.</p>
<p>17. <b>Don’t use blue lights on boats.</b> Blue lights attract fish and squid, which in turn attract sharks.</p>	<p>Boat lights attract small fish which in turn attract big fish and predators. These lights are used at night to improve guest experience on tourism boats and create ambience. The research could be conducted to explore the attraction of sharks to boat lights. As a precautionary approach, the use of the lights could be limited to reduce unnecessary habitation of sharks to attract boats as sources of food or as attractants for potential prey.</p>

**The following behaviours were generated based on workshop feedback and background research but not ranked as part of any survey:**

<p><b>A. Don’t swim too far from shore.</b> Doing so isolates you and places you away from assistance.</p>	<p>This is mostly relevant for locals, campers, private boaters and self-skipped boats. On crewed trips, guests are carefully watched and swim in groups. This is related to number 15.</p>
<p><b>B. Don’t enter the water if bleeding.</b> Sharks can sense blood in the water and trace it back to its source.</p>	<p>Sharks can detect blood and urine in the water. A desktop study to explore the potential significance of the attraction of these body fluids in small amounts may be useful in helping quantify the importance of this. Generally speaking, most shark programs don’t suggest avoiding swimming while menstruating or not urinating in the water, however, anyone with major wounds is advised not to enter the water. It is assumed that there is already a high degree of common-sense compliance with this behaviour as well as prevention by crew on any chartered trips. Validation of this assumption may be useful.</p>
<p><b>C. Don’t wear shiny jewellery.</b> The reflected light may look like shining fish scales.</p>	<p>This is not a problem for anyone wearing the standard stinger suits or wetsuits provided by most of the tourism companies in the Whitsundays as these suits cover ears, wrists, necks and ankles. This may apply more to private boaters but in general, this behaviour is not given high priority in international shark safety programs. Further research may be warranted.</p>

<p><b>D. Avoid an uneven tan and brightly coloured clothing.</b> Sharks see contrast particularly well, so use extra caution when waters are cloudy.</p>	<p>The science behind sharks’ attraction to contrast and colour should be reviewed. Physical products such as shark safety wetsuits that reduce the impact of bites, reduce the visibility of swimmers and darkly coloured swim fins may be helpful in reducing the visibility of swimmers and decreasing risk of bites. A wetsuit or other object, regardless of the pattern or colouring, may appear as a dark silhouette when viewed from underneath.</p>
<p><b>E. Don’t try to touch a shark if you see one!</b></p>	<p>Touching sharks has resulted in several incidents on the Great Barrier Reef. Private boaters, campers, locals and others should be clearly warned not to touch sharks through signage at key locations and broader shark awareness campaigns.</p>
<p><b>F. If bitten by a shark, the general rule is “do whatever it takes to get away!”</b> Some people have successfully chosen to be aggressive, others passive. Some yelled underwater, others blew bubbles.</p>	<p>This behaviour could be helpful for people to know but is not appropriate to discuss in the context of tourism activities given the low statistical likelihood of a bite. Therefore, this message should be delivered as part of a broader shark education campaign or through alternative media channels (e.g. survivor stories, etc.).</p>

## Appendix C. Shark safety post-trip survey (delivered before and after the intervention)

### Improving swimmer safety in the Whitsundays

Reef Ecologic is working in partnership with the Queensland Government (Department of Agriculture and Fisheries), the Great Barrier Reef Marine Park Authority and the tourism industry to improve safety in the Whitsunday region. The following survey is completely anonymous.

There are three parts to the survey – your trip, your activities and your knowledge of SharkSmart. Your honest answers will be used to help improve swimmer and boater safety.

Thank you for your participation in this project, if you would like to talk to our team please email [gemma.molinaro@reefecologic.org](mailto:gemma.molinaro@reefecologic.org) or call 0480104078

**1. What is the name of the charter boat company you used for your trip?**

- Whitsunday Escape       Cumberland Charters       Whitsundays Rent A Yacht

**2. How many people were on board during your trip**

- 1 -2 people       4 -6 people  
 2 -4 people       7 or more people

**3. Where are you from**

- QLD     NSW     VIC     ACT     NT     WA     SA  
 Overseas (please specify)

**4. Did you or anyone in your group swim and/or snorkel during your trip?**

- Yes       No

**5. Where did you and/or your group swim or snorkel during your trip? Select all that apply.**

- |   |  |   |
|---|--|---|
| <input type="checkbox"/> Cid Harbour    | <input type="checkbox"/> Hook Passage  | <input type="checkbox"/> Stonehaven         |
| <input type="checkbox"/> Chalkies Beach | <input type="checkbox"/> Macona Inlet  | <input type="checkbox"/> Surprise Rock Reef |
| <input type="checkbox"/> Blue Pearl Bay | <input type="checkbox"/> Manta Ray Bay | <input type="checkbox"/> Whitehaven Beach   |
| <input type="checkbox"/> Gulnare Inlet  | <input type="checkbox"/> Nara Inlet    |   |
| <input type="checkbox"/> Hill Inlet     | <input type="checkbox"/> Saba Bay      |   |

Other (please specify location)

**6. When swimming and/or snorkelling, how often did you or your group do the following?**

	Never	Occasionally	About half of the time	Frequently	Always
Splashing or making noise while swimming	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
People swimming alone	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Swimming near (within 200 m) people who were fishing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Swimming in CID Harbour	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Swimming in locations you were advised to avoid	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



**7. Did you or anyone in your group fish during your trip?**

Yes

No

**8. Where did you fish during your trip? Select all that apply.**

Cid Harbour

Hook Passage

Stonehaven

Chalkies Beach

Macona Inlet

Surprise Rock Reef

Blue Pearl Bay

Manta Ray Bay

Whitehaven Beach

Gulnare Inlet

Nara Inlet

Hill Inlet

Saba Bay

Other (please specify location)

**9. While fishing, how often did you or your group do the following?**

	Never	Occasionally	About half of the time	Frequently
Threw fish frames / fish scraps into the water	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Disposed of fish frames / fish scraps in on-shore rubbish facilities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Chum or burley (scatter bait on the water) to attract fish	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fished near people swimming (within 200m)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**10. During your trip, how often did you or your group do the following?**

	Never	Occasionally	About half of the time	Frequently
Throw food waste into the water	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Disposed of food waste in on-shore rubbish facilities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**11. To what extent are you aware or unaware of the following SharkSmart behaviours which may minimise your risk of a negative encounter with a shark?**

	Not at all aware	Slightly aware	Somewhat aware	Moderately aware	Extremely aware
Follow local signage	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Have a buddy when swimming, diving or snorkelling	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Avoid swimming at dawn or dusk	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Avoid swimming with schools of bait fish or diving birds	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Follow local signage and swim between the flags at patrolled beaches	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Keep fish waste and food scraps out of the water where people swim	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Swim in clear water (not in murky water, anchorages, estuary mouths, or canals)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**12. Did you see information about SharkSmart behaviours before or during your trip through any of the following? Please select all that apply.**

- |  |  |
|--|--|
| <input type="checkbox"/> Signage around the Whitsunday Islands | <input type="checkbox"/> Stickers on the boat                  |
| <input type="checkbox"/> Pre-trip emails or company website    | <input type="checkbox"/> Posters \ Brochures \ Videos provided |
| <input type="checkbox"/> Pre-trip briefing                     | <input type="checkbox"/> From other passengers on the boat     |
| <input type="checkbox"/> Fact sheets or flyers on the boat     |  |
| <input type="checkbox"/> Other (please specify)                |  |

**13. How would you prefer to receive SharkSmart information? Please rank with 1 being your favourite and 6 being your least favourite.**




Signage around the Whitsunday Islands




Pre-trip emails or company website




Pre-trip briefing




Fact sheets or flyers on the boat




Stickers on the boat




Posters \ Brochures \ Videos provided

**14. Comments. Do you have any other comments or observations of boating, fishing, snorkelling activities, shark smart information, behaviour or survey design that could assist safety in the Whitsundays?**

## Appendix D. Shark safety pre-intervention phase standard operating procedure



### Shark Smart Rubbish Data Collection - Standard Operation Procedure

#### Background

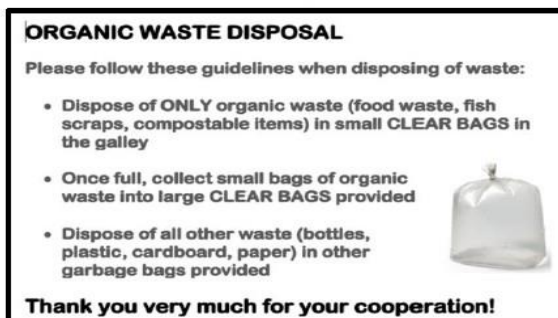
The Shark Smart project, in conjunction with the Queensland Government (Department of Agriculture and Fisheries), aims to market test behavioural change methodology to reduce the risk of shark attacks in the Whitsundays. Three bareboat operators will be involved, and information will be gathered about the activities and in and out of water behaviours people engage in on their expeditions, and how this may influence the risk of shark attacks.

A component of the project methodology revolves around collecting information about the types and amounts of waste that are accumulated and disposed of during expeditions. Clear plastic bags will be distributed to operators, and placed on boats, with instructions to dispose of organic waste (food, fish scraps, etc.) in these clear plastic bags, and other waste (plastic, bottles, paper etc.) separately. The idea is that this information will support the other component of the project, a survey sent out to guests on boats, and infer if there was waste disposal overboard, and if so, how much. The information provided by the survey and rubbish collection data, will assist researchers in providing advice (specific to the Whitsunday region) on to how to reduce the risk of shark attacks.

Thank you so much for your help with this important research.

#### Procedure- Setting up for rubbish collection

1. Distribute clear plastic bags, that have been provided, onto selected boats (we have accounted for 10 small bags and 2 large bags per boat)
2. Place instructional card, also provided, either with pre trip material, or place in a easily accessible location that boat guests will see when disposing of rubbish



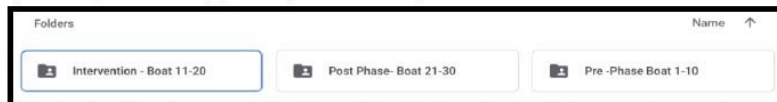
3. Provide briefing to guests (if necessary) on rubbish disposal in line with instructions on card

### Procedure – Rubbish Collection


1. Ensure rubbish handler is wearing appropriate personal protective equipment (PPE), including rubbing gloves, and ensure hand sanitizer and antibacterial wipes are available for hygiene purposes.
2. Retrieve clear plastic rubbish bags from boat, ensure full bags can be safely lifted (i.e seek assistance or use a trolley if the weight is too heavy)
3. Take two clear photographs (one of each side of the plastic rubbish bag), to ensure contents can be accurately recorded
4. Weigh plastic rubbish bag using hand scales, record weight
5. Repeat for other bags if necessary
6. Record number of full small clear plastic bags
7. Record all other appropriate trip information on the rubbish collection data sheet
8. Once all information is recorded, transport bags in a trolley, to dump site
9. Sanitize hands and use antibacterial wipes if necessary

### Procedure- Data entry/photo upload

1. Once rubbish collection is complete, data and photos will need to be uploaded online. Access the database online via the link sent through email.
2. Upload photos of the rubbish bags into the appropriate folder, based on whether the data was collected for the pre-survey phase (first 10 boats), the intervention (boats 10-20) or the post-survey phase (boats 20-30)



3. Please name each photo corresponding to the boat that the photo is from (i.e rubbish photos from the first boat you collected data from can be labelled 'Boat 1')
4. On the same link as the photo folders, there is an online version of the rubbish data collection sheet, please input all information into this and provide comments if necessary



The image shows a spreadsheet titled 'Wintourday's Shark Smart Rubbish Collection Data'. The spreadsheet has multiple columns and rows for data entry. The columns include 'Date', 'Boat', 'Number of Rubbish Bags Collected', 'Weight of Rubbish Collected (kg)', 'Number of Rubbish Bags Weighed', 'Weight of Rubbish Weighed (kg)', 'Comments', and 'Location'. The rows are numbered 1 through 30.

## Appendix E. Shark safety intervention phase standard operating procedure



### **Shark Smart Intervention Phase- Standard Operation Procedure**

#### **Background**

The Shark Smart project, in conjunction with the Queensland Government (Department of Agriculture and Fisheries), aims to market test behavioural change methodology to reduce the risk of shark attacks in the Whitsundays. Three bareboat operators will be involved, and information will be gathered about the activities and in and out of water behaviours people engage in on their expeditions, and how this may influence the risk of shark attacks.

Following initial phases of the project, the intervention stage involves providing a range of materials to operators, to be put on boats to promote Shark Smart behaviours. This includes a pre-trip briefing video, brochures and posters, and stickers. By providing this information, guests will be influenced to engage in Shark Smart behaviours, and we will measure potential behavioural changes through survey responses and rubbish collection.

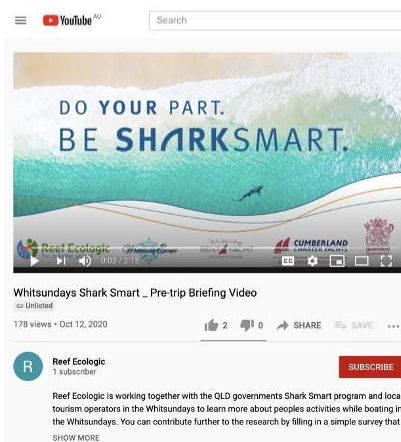
Thank you so much for your help with this important research.

**1. Please continue with rubbish collection and data entry following the same procedure as you have been.**

We will collect rubbish data and photograph clear bags of rubbish from 10 boats for this stage.




**2. Procedure- Set up for the intervention phase: Video**


- We have put together a short briefing video with local operators, outlining the Shark Smart behaviours. Please include this video as a link in a **pre-trip** email (we will send a separate email with the link).
- You may also choose to display this video on a TV in reception or on boat TV's. Please ensure that boat guests will have access to this video somehow.



### 3. Procedure- Set up for the intervention phase: stickers, posters and brochures

We have provided 3 types of stickers and posters/brochures to be placed on boats, prior to guests boarding.

Type	Image	Where to display on vessel
1. Sticker	<p><b>This bag could save a life.</b> Help prevent shark bites by bagging these items:</p> <ul style="list-style-type: none"> <li>✓ Fish frames</li> <li>✓ Unused Bait</li> <li>✓ Food scraps</li> </ul> <p><b>Be safe. Be SharkSmart.</b>  Queensland Government</p>	Placed near the rubbish bin, where organic waste is being disposed of (in provided clear bags).
2. Sticker	<p><b>Food scraps, bait and fishing may attract sharks!</b></p> <ul style="list-style-type: none"> <li>✗ Don't fish where people swim</li> <li>✗ Don't throw food scraps or fish frames overboard (especially where people swim)</li> <li>✓ Follow SharkSmart swimming guidelines</li> </ul> <p><b>Be safe. Be SharkSmart.</b>  Queensland Government</p>	The second, with the heading 'Food scraps, bait and fishing may attract sharks' should be placed on the back deck, to be visible where people may fish.
3. Sticker	<p><b>Food scraps and organic waste may attract sharks!</b></p> <ul style="list-style-type: none"> <li>✗ Don't throw food scraps (meat, fish, organic waste) overboard</li> <li>✓ Use bags and containers provided</li> <li>✓ Ensure rubbish bags aren't leaking</li> <li>✓ Dispose of sewage and approved waste properly (1 nm from land, reefs, anchorages and people)</li> </ul> <p><b>Be safe. Be SharkSmart.</b>  Queensland Government</p>	The third, with the heading 'Food scraps and organic waste may attract sharks' should be placed inside in the galley.

<p><b>4. Posters &amp; Brochures</b></p>		<p>The three different types of posters, and the brochures, should be placed inside the boat or together with pre trip information (i.e. inside a folder or clipboard).</p>
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## Appendix F. Full Survey Responses to behaviour and awareness questions

Q6.

Behaviour	Phase	Never	Occasionally	About half of the time	Frequently	Always
Splashing or making noise while swimming	Pre-Intervention	21.79%	44.87%	19.23%	11.54%	2.56%
	Intervention	30.71%	44.88%	10.24%	11.81%	2.36%
People swimming alone	Pre-Intervention	64.10%	24.36%	5.13%	3.85%	2.56%
	Intervention	65.35%	26.77%	4.72%	3.15%	0.00%
Swimming near (within 200 m) people who were fishing	Pre-Intervention	85.90%	12.82%	1.28%	0.00%	0.00%
	Intervention	86.61%	12.60%	0.00%	0.79%	0.00%
Swimming in CID Harbour	Pre-Intervention	100.00%	0.00%	0.00%	0.00%	0.00%
	Intervention	99.21%	0.79%	0.00%	0.00%	0.00%
Swimming in locations you were advised to avoid	Pre-Intervention	98.72%	0.00%	0.00%	0.00%	1.28%
	Intervention	96.85%	2.36%	0.00%	0.00%	0.79%

Q9.

Behaviour	Phase	Never	Occasionally	About half of the time	Frequently
Threw fish frames / fish scraps into the water	Pre-Intervention	67.16%	23.88%	2.99%	5.97%
	Intervention	71.57%	21.57%	1.96%	4.90%
Disposed of fish frames / fish scraps in on-shore rubbish facilities	Pre-Intervention	75.76%	3.03%	4.55%	16.67%
	Intervention	71.00%	8.00%	3.00%	18.00%
Chum or burley (scatter bait)	Pre-Intervention	94.03%	4.48%	1.49%	0.00%
	Intervention	86.67%	13.33%	0.00%	0.00%



<b>on the water) to attract fish</b>					
<b>Fished near people swimming (within 200m)</b>	Pre-Intervention	92.42%	7.58%	0.00%	0.00%
	Intervention	96.15%	3.85%	0.00%	0.00%

Q10 & 11

Behaviour	Phase	<b>Not at all aware</b>	<b>Slightly aware</b>	<b>Somewhat aware</b>	<b>Moderately aware</b>	<b>Extremely aware</b>
<b>Follow local signage</b>	Pre-Intervention	1.25%	6.25%	7.50%	20.00%	65.00%
	Intervention	0.78%	2.33%	9.30%	23.26%	64.34%
<b>Have a buddy when swimming, diving or snorkelling</b>	Pre-Intervention	3.70%	0.00%	3.70%	17.28%	75.31%
	Intervention	1.55%	3.10%	5.43%	12.40%	77.52%
<b>Avoid swimming at dawn or dusk</b>	Pre-Intervention	0.00%	1.23%	2.47%	3.70%	92.59%
	Intervention	1.55%	0.78%	1.55%	2.33%	93.80%
<b>Avoid swimming with schools of bait fish or diving birds</b>	Pre-Intervention	6.25%	2.50%	7.50%	11.25%	72.50%
	Intervention	1.55%	0.00%	5.43%	10.08%	82.95%
<b>Follow local signage and swim between the flags at patrolled beaches</b>	Pre-Intervention	0%	4%	5%	9%	83%
	Intervention	0%	1%	1%	7%	91%
<b>Keep fish waste and food scraps out of the water where people swim</b>	Pre-Intervention	0.00%	3.70%	2.47%	8.64%	85.19%
	Intervention	0.00%	0.00%	1.55%	6.20%	92.25%
<b>Swim in clear water (not in</b>	Pre-Intervention	1.23%	1.23%	6.17%	7.41%	83.95%
	Intervention	1.55%	0.78%	4.65%	11.63%	81.40%

<b>murky water, anchorages, estuary mouths, or canals)</b>						
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## Appendix G. Summary table of statical results.

Survey Question	Parameters	Statistical Analysis	Results (S – Significant, N/S – Not Significant)
Follow local signage	Pre- vs Post-, difference in proportion, difference in means	Fisher’s Exact Test, ANOVA (bottom response), ANOVA (top response)	N/S, N/S, N/S
Have a buddy, when swimming, diving or snorkelling	Pre- vs Post-, difference in proportion, difference in means	Fisher’s Exact Test, ANOVA (bottom response), ANOVA (top response)	N/S, N/S, N/S
Avoid swimming at dawn or dusk	Pre- vs Post-, difference in proportion, difference in means	Fisher’s Exact Test, ANOVA (bottom response), ANOVA (top response)	N/S, N/S, N/S
Avoid swimming with schools of baitfish or diving birds	Pre- vs Post-, difference in proportion, difference in means	Fisher’s Exact Test, ANOVA (bottom response), ANOVA (top response)	N/S, N/S, N/S
Follow local signage and swim between the flags at patrolled beaches	Pre- vs Post-, difference in proportion, difference in means	Fisher’s Exact Test, ANOVA (top response)	N/S, N/S
Keep fish waste and food scraps out of the water where people swim	Pre- vs Post-, difference in proportion, difference in means	Fisher’s Exact Test, ANOVA (top response)	N/S, N/S
Swim in clearwater	Pre- vs Post-, difference in proportion, difference in means	Fisher’s Exact Test, ANOVA (bottom response), ANOVA (top response)	N/S, N/S, N/S
Knowledge and Behaviour	Pre- vs Post-, Knowledge vs Behaviour, Difference in means	ANOVA	S – Pre-intervention Knowledge vs Pre- intervention Behaviour, S – Post-intervention Knowledge vs Post – intervention Behaviour
Splashing or making noise while swimming	Pre- vs Post-, difference in proportion, difference in means	Fisher’s Exact Test, ANOVA (bottom response), ANOVA (top response)	N/S, N/S, N/S
People swimming alone	Pre- vs Post-, difference in proportion, difference in means	Fisher’s Exact Test, ANOVA (bottom response), ANOVA (top response)	N/S, N/S, N/S

Swimming near (within 200 m) people who were fishing	Pre- vs Post-, difference in proportion, difference in means	Fisher's Exact Test, ANOVA (bottom response)	N/S, N/S
Swimming in CID Harbour	Pre- vs Post-, difference in proportion, difference in means	Fisher's Exact Test, ANOVA (bottom response)	N/S, N/S
Swimming in locations you were advised to avoid	Pre- vs Post-, difference in proportion, difference in means	Fisher's Exact Test, ANOVA (bottom response)	N/S, N/S
Threw fish frames / fish scraps into the water	Pre- vs Post-, difference in proportion, difference in means	Fisher's Exact Test, ANOVA (bottom response), ANOVA (top response)	N/S, N/S, N/S
Disposed of fish frames / fish scraps in on-shore rubbish facilities	Pre- vs Post-, difference in proportion, difference in means	Fisher's Exact Test, ANOVA (bottom response), ANOVA (top response)	N/S, N/S, N/S
Chum or burley (scatter bait on the water) to attract fish	Pre- vs Post-, difference in proportion, difference in means	Fisher's Exact Test, ANOVA (bottom response)	N/S, N/S
Fished near people swimming (within 200m)	Pre- vs Post-, difference in proportion, difference in means	Fisher's Exact Test, ANOVA (bottom response),	N/S, N/S
Rubbish disposal behavior	Pre- vs Post-, difference in proportion, difference in means	Fisher's Exact Test, ANOVA (bottom response),	N/S, N/S, N/S

## Appendix H. Summary table and in-depth results for Shark Safety Awareness & Behaviours

Overall changes in awareness of shark safety behaviours of charter boat tourists in the Whitsundays (control group pooled).

Behaviour	Pre-survey Aware (%)	Post-survey Aware (%)	Change (%)
Follow local signage	98.75	99.22	+0.47
Have a buddy, when swimming, diving or snorkelling	96.3	98.45	+2.15
Avoid swimming at dawn or dusk	100	98.45	-1.55
Avoid swimming with schools of baitfish or diving birds	93.75	98.45	+4.75
Follow local signage and swim between the flags at patrolled beaches	100	100	0
Keep fish waste and food scraps out of the water where people swim	100	100	0
Swim in clearwater	98.77	98.45	-0.32

Overall changes in risky behaviours of charter boat tourists in the Whitsundays (control group pooled).

	Pre-Phase	Intervention	Change %
Splashing or making noise while swimming	78.2%	69.3%	-8.9%
People swimming alone	35.9%	34.6%	-1.3%
Swimming near (within 200 m) people who were fishing	14.1%	13.4%	-0.7%
Swimming in CID Harbour	0.0%	0.8%	0.8%
Swimming in locations you were advised to avoid	1.3%	3.2%	1.9%
Swimming with schools of baitfish	6.25%	1.55%	-4.7%
Threw fish frames / fish scraps into the water	32.8%	28.4%	-4.4%
Disposed of fish frames / fish scraps in onshore rubbish facilities	24.3%	29.0%	4.8%
Chum or burley (scatter bait on the water) to attract fish	6.0%	13.3%	7.4%
Fished near people swimming (within 200m)	7.6%	3.9%	-3.7%

## **Follow local signage**

A total of 98.3% of survey respondents are aware of following local signage behaviour in the Pre-intervention phase (Fig. 12). During the intervention phase, the number increased by 0.6%, with a total of 98.9% of people aware of this behaviour. For controls, 100% of the survey respondents are aware in both phases. Fisher's exact analysis was used to detect differences in proportion of people aware of following local signage and no significant differences were observed ( $p$ -value = 0.3237) between those who are aware of this behaviour and those who don't in both phases. ANOVA was conducted to determine if there are differences in bottom level responses (Not at all aware-Slightly aware) between phases and found no significant differences ( $F_{1,6} = 0$ ,  $p = 1$ ). We also found no significant differences ( $F_{1,135} = 0.58$ ,  $p = 0.45$ ) in top level responses (Moderately aware-Extremely aware) between phases.

## **Have a buddy when swimming, diving or snorkelling**

A total of 95% of survey respondents are aware of having a buddy when swimming, diving or snorkelling behaviour in the Pre-intervention phase (Fig. 12). During the intervention phase, the number increased by 2.89%, with a total of 97.89% of people aware of this behaviour. For controls, 100% of the survey respondents are aware in both phases. Fisher's exact analysis was used to detect differences in proportion of people aware of having a buddy when swimming, diving or snorkelling and no significant differences were observed ( $p$ -value = 0.7542) between those who are aware of behaviour and those who don't in both phases. ANOVA was conducted to determine if there are differences in bottom level responses (Not at all aware-Slightly aware) between phases and found no significant differences ( $F_{1,7} = 4.67$ ,  $p = 0.07$ ). We also found no significant differences ( $F_{1,138} = 1.25$ ,  $p = 0.27$ ) in top level responses (Moderately aware-Extremely aware) between phases.

## **Avoid swimming at dawn or dusk**

A total of 100% of survey respondents are aware of avoiding swimming at dawn or dusk behaviour in the Pre-intervention phase (Fig. 12). During the intervention phase, the number was reduced by 2.1%, with a total of 97.9% of people aware of this behaviour. For controls, 100% of the survey respondents are aware in both phases. Fisher's exact analysis was used to detect differences in the proportion of people aware of avoiding swimming at dawn or dusk and no significant differences were observed ( $p$ -value = 0.2426) between those who are aware of this behaviour and those who don't in both phases. ANOVA was conducted to determine if there are differences in bottom level responses (Not at all aware-Slightly aware) between phases and found no significant differences ( $F_{1,2} = 1$ ,  $p = 0.42$ ). We also found no significant differences ( $F_{1,145} = 0.22$ ,  $p = 0.64$ ) in top level responses (Moderately aware-Extremely aware) between phases.

## **Avoid swimming with schools of bait fish or diving birds**

A total of 94.92% of survey respondents are aware of avoiding swimming with schools of bait fish or diving birds behaviour in the Pre-intervention phase (Fig. 12). During the intervention phase, the number increased by 2.97%, with a total of 97.89% of people aware of this behaviour. For controls, 90% and 100% of the respondents were aware of this behavior during the Pre-intervention and Intervention Phase, respectively. Fisher's exact analysis was used to detect differences in the proportion of people aware of avoiding swimming with schools of bait fish or diving birds and no significant differences were observed ( $p$ -value = 0.3386) between those who are aware of this behaviour and those who don't in both phases. ANOVA was conducted to determine if there are differences in bottom level responses (Not at all aware-

Slightly aware) between phases and found no significant differences ( $F_{1,5} = 0.95$ ,  $p = 0.37$ ). We also found no significant differences ( $F_{1,33} = 0.58$ ,  $p = 0.45$ ) in top level responses (Moderately aware-Extremely aware) between phases.

### **Follow local signage and swim between the flags at patrolled beaches**

All of the survey respondents are aware of following local signage and swim between the flags at patrolled beaches behaviour in the Pre-intervention phase (Fig. 12). During the intervention phase, all of the respondents were also aware of this behaviour. Fisher's exact analysis was used to detect differences in the proportion of people aware of following local signage and swim between the flags at patrolled beaches and no significant differences were observed ( $p$ -value = 0.3386) between those who are aware of this behaviour and those who don't in both phases. ANOVA was conducted to determine if there are differences in top level responses (Moderately aware-Extremely aware) between phases and found no significant differences ( $F_{1,145} = 0.02$ ,  $p = 0.89$ ).

### **Keep fish waste and food scraps out of the water where people swim**

All of the survey respondents from both groups are aware of keeping fish waste and food scraps out of the water where people swim in the Pre-intervention phase (Fig. 12, Table 16). During the intervention phase, all of the respondents were also aware of this behaviour. Fisher's exact analysis was used to detect differences in the proportion of people aware of keeping fish waste and food scraps out of the water where people swim in and no significant differences were observed ( $p$ -value = 0.3076) between those who are aware of this behaviour and those who don't in both phases. ANOVA was conducted to determine if there are differences in top level responses (Moderately aware-Extremely aware) between phases and found no significant differences ( $F_{1,148} = 0.40$ ,  $p = 0.53$ ).

### **Swim in clear water (not in murky water, anchorages, estuary mouths, or canals)**

A total of 98.3% of survey respondents are aware of swimming in clear water (not in murky water, anchorages, estuary mouths, or canals) behaviour in the Pre-intervention phase (Fig. 12, Table 16). During the intervention phase, the number was reduced by 0.4%, with a total of 97.9% of people aware of this behaviour. For controls, 100% of the survey respondents are aware in both phases. Fisher's exact analysis was used to detect differences in the proportion of people aware of swimming in clear water (not in murky water, anchorages, estuary mouths, or canals) and no significant differences were observed ( $p$ -value = 0.9363) between those who are aware of this behaviour and those who don't in both phases. ANOVA was conducted to determine if there are differences in bottom level responses (Not at all aware-Slightly aware) between phases and found no significant differences ( $F_{1,2} = 0.25$ ,  $p = 0.67$ ). We also found no significant differences ( $F_{1,139} = 0.07$ ,  $p = 0.79$ ) in top level responses (Moderately aware-Extremely aware) between phases.

### **Splashing or making noise while swimming**

Splashing or making noise while swimming is a risky behaviour that was identified in stakeholder workshops as potentially attracting sharks. The alternative shark safe behaviour to reduce risk is to 'avoid splashing or making a noise when swimming', which is not currently listed as one of the key SharkSmart Queensland behaviours; however, this study investigated the frequency that people engaged in this behaviour during the study. It was included in the survey to see the level that people are engaging in splashing and noisemaking while in the water.

A total of 74.1% of survey respondents partook in splashing or noisy behaviour while swimming in the Pre-intervention phase (Fig. 15). During the intervention phase, the number was reduced by 5.7%, with a total of 68.4% of people taking part in this behaviour. For controls, 87.5% and 70% of the respondents partook in this behaviour during the Pre-intervention phase and intervention phase, respectively. Fisher's exact analysis was used to detect differences in proportion of people splashing or making noise while swimming and no significant differences were observed ( $p\text{-value} = 0.6472$ ) between those who participate in this behaviour and those who don't in both phases. ANOVA was conducted to determine if there are differences in bottom level responses (Never-Occasionally) between phases and found no significant differences ( $F_{1,104} = 0.31$ ,  $p = 0.58$ ). We also found no significant differences ( $F_{1,18} = 0.9$ ,  $p = 0.36$ ) in top level responses (Frequently-Always) between phases.

## **People swimming alone**

Swimming alone is a risky behaviour that was identified in stakeholder workshops as potentially increasing the risk of a shark encounter. The alternative SharkSmart Queensland behaviour to reduce risk is to 'Have a buddy and look out for each other. This behaviour is beneficial for both general water safety and shark safety risk reduction. Always swim and snorkel with a buddy was used in the intervention pre-trip educational video, was featured in the shark safety brochures and posters and mentioned in the briefings.

A total of 33.3% of survey respondents partook in swimming alone behaviour in the Pre-intervention phase (Fig. 15). During the intervention phase, the number increased by 3.5%, with a total of 36.8% of people taking part in this behaviour. For controls, 43.5% and 30% of the respondents partook in this behaviour during the Pre-intervention phase and intervention phase, respectively. Fisher's exact analysis was used to detect differences in proportion of people swimming alone and no significant differences were observed ( $p\text{-value} = 0.7728$ ) between those who participate in this behaviour and those who don't in both phases. ANOVA was conducted to determine if there are differences in bottom level responses (Never-Occasionally) between phases and found no significant differences ( $F_{1,135} = 0.42$ ,  $p = 0.52$ ). We also found no significant differences ( $F_{1,2} = 1$ ,  $p = 0.42$ ) in top level responses (Frequently-Always) between phases.

## **Swimming near (within 200 m) people who were fishing**

Swimming near (within 200m) of people who are fishing was ranked as one of the behaviours that may increase risk of shark bite by both shark researchers and tourism operators. The alternative SharkSmart Queensland behaviours are to 'Swim in clear water away from fishers'. Emphasis on this behaviour was shown in the pre-trip educational video for swimmers, snorkelers and fishers. It was also featured on shark safety brochures and posters on board the vessel to increase awareness. Custom designed stickers were used on the back deck near fishing areas to prompt fishers not to fish near swimmers and swimmers not to enter the water near fishers.

A total of 16.7% of survey respondents partook in swimming near (within 200 m) people who were fishing behaviour in the Pre-intervention phase (Fig. 15). During the intervention phase, the number was reduced by 4.1%, with a total of 12.6% of people taking part in this behaviour. For controls, 8.3% and 16.7% of the respondents partook in this behaviour during the Pre-intervention phase and intervention phase, respectively. Fisher's exact analysis was used to detect differences in proportion of people swimming near (within 200 m) people who were fishing and no significant differences were observed ( $p\text{-value} = 0.7728$ ) between those who participate in this behaviour and those who don't in both phases.



ANOVA was conducted to determine if there are differences in bottom level responses (Never-Occasionally) between phases and found no significant differences ( $F_{1,146} = 0.72$ ,  $p = 0.4$ ).

## **Swimming in Cid Harbour and areas that were advised against**

Cid Harbour was the site of three shark bite incidents in 2018. Cid Harbour is a popular anchorage due to its sheltered location. Multiple activities which can occur in busy anchorages are people fishing, people throwing fish and food scraps overboard and using lights to attract fish. All of these factors can contribute to attracting fish and sharks. This area is characterised by low visibility water so is not used for snorkelling. However, tourists have historically used this location to jump into the water for a quick swim. One of the shark safety messages we added to the intervention which is specifically suited to the Whitsunday environment is 'Avoid swimming in busy anchorages'. In addition, it is specified to tourists in the charter boat briefing not to swim in Cid Harbour.

No respondents partook in swimming in CID Harbour behaviour in the Pre-intervention phase. During the intervention phase, the number increased to 1.1% people taking part in this behaviour (Fig. 15). Fisher's exact analysis was used to detect differences in proportion of people swimming in CID Harbour and no significant differences were observed ( $p$ -value = 1) between those who participate in this behaviour and those who don't in both phases. ANOVA was conducted to determine if there are differences in bottom level responses (Never-Occasionally) between phases and found no significant differences ( $F_{1,146} = 0.56$ ,  $p = 0.46$ ).

A total of 1.9% of survey respondents partook in swimming in locations you were advised to avoid behaviour in the Pre-intervention phase. During the intervention phase, the number increased by 2.3%, with a total of 4.2% of people taking part in this behaviour (Fig. 15, Table 16). Fisher's exact analysis was used to detect differences in proportion of people swimming in locations you were advised to avoid and no significant differences were observed ( $p$ -value = 0.6118) between those who participate in this behaviour and those who don't in both phases. ANOVA was conducted to determine if there are differences in bottom level responses (Never-Occasionally) between phases and found no significant differences ( $F_{1,145} = 1.72$ ,  $p = 0.19$ ).

## **Threw fish frames/ fish scraps into the water**

Most bareboats are on the water for multiday trips and many catch fish along the way. Storing compost, meat and fish in the tropics onboard the boat can create bad smells and take up space so many people dispose of their fish scraps overboard. This is of concern when it occurs in areas that have a crossover of swimming and snorkelling as it may attract sharks to vessels. The alternative SharkSmart Queensland behaviour is to 'Keep fish waste and food scraps out of the water where people swim'.

A total of 32% of survey respondents partook in throwing fish frames / fish scraps into the water behaviour in the Pre-intervention phase (Fig. 16). During the intervention phase, the number was reduced by 2.1%, with a total of 29.9% of people taking part in this behaviour. For controls, 35.3% and 21.7% of the respondents partook in this behaviour during the Pre-intervention phase and Intervention phase, respectively. Fisher's exact analysis was used to detect differences in proportion of people throwing fish frames / fish scraps into the water and no significant differences were observed ( $p$ -value = 0.6846) between those who participate in this behaviour and those who don't in both phases. ANOVA was conducted to determine if there are differences in bottom level responses (Never-Occasionally) between phases and found no significant differences ( $F_{1,114} = 0.08$ ,  $p = 0.78$ ). We also found no significant differences ( $F_{1,9} = 0.04$ ,  $p = 0.84$ ) in top level responses (About half the time-Frequently) between phases.

## **Chum or burley (scatter bait on the water) to attract fish**

Chumming or burley (scattering bait on the water) to attract fish may also attract sharks. The SharkSmart Queensland behaviour is to 'Keep fish waste and food scraps out of the water where people swim'. In the Whitsunday Islands there are many locations where fishing and in-water activities occur in the same

areas. At several popular tourism locations there are operators who conduct 'fish feeding' with pellets. During the workshops, local tour operators felt this behaviour was occurring mainly in anchorages, and especially in Cid Harbour. Information about avoiding chumming or burley was included in the intervention on the pre-trip educational video, on stickers on the vessels and in the shark safety materials onboard.

A total of 6% of survey respondents partook in chum or burley (scatter bait on the water) to attract fish behaviour in the Pre-intervention phase (Fig. 16). During the intervention phase, the number increased by 2.9%, with a total of 8.9% of people taking part in this behaviour. For controls, 5.9% and 25% of the respondents partook in this behaviour during the Pre-intervention phase and intervention phase, respectively. Fisher's exact analysis was used to detect differences in proportion of people taking part in this behaviour and no significant differences were observed ( $p$ -value = 0.2798) between those who participate in this behaviour and those who don't in both phases. ANOVA was conducted to determine if there are differences in bottom level responses (Never-Occasionally) between phases and found no significant differences ( $F_{1,126} = 1.05$ ,  $p = 0.31$ ).

## **Fishing near where people are swimming (within 200m)**

Similar to chumming or burley the water, the act of fishing is thought to attract sharks. Due to the multiuse zone in the Whitsunday's there are many areas where fishing and snorkelling activities cross over (Fig. 10 & 11).

A total of 6.1% of survey respondents partook in fishing near people swimming (within 200m) behaviour in the Pre-intervention phase (Fig. 16 and Table. 16). During the intervention phase, the number was reduced by 2.3%, with a total of 3.8% of people taking part in this behaviour. For controls, 11.8% and none of the respondents partook in this behaviour during the Pre-intervention phase and intervention phase, respectively. Fisher's exact analysis was used to detect differences in proportion of people fishing near people swimming (within 200m) and no significant differences were observed ( $p$ -value = 0.6755) between those who participate in this behaviour and those who don't in both phases. ANOVA was conducted to determine if there are differences in bottom level responses (Never-Occasionally) between phases and found no significant differences ( $F_{1,125} = 0.34$ ,  $p = 0.56$ ).

## Appendix I. In depth results to rubbish collected from vessels.

Changes in rubbish disposal behaviours of charter boat tourists in the Whitsunday in the pre-intervention and intervention stages.

<b>Food Scrap and disposal behaviours</b>	<b>Data collection method</b>	<b>Pre Intervention</b>	<b>Intervention</b>	<b>Change</b>
Food waste returned and weighed at marina (Per person/per day in grams)	Physical collection of rubbish data	163.47	225.49	<b>62.2(gram) increase</b>
Meat or fish scraps found in rubbish collected at the marina.	Physical collection of rubbish data	20%	20%	<b>0% no change</b>
Percentage of people who threw food scraps into the water.	Survey Response	28.4	30.71	<b>2.31 (%) increase</b>
Percentage of people who threw fish frames and scraps into the water.	Survey Response	32.84	28.71	<b>4.13 %decrease</b>
Percentage of people who disposed of food in onshore facilities (at Hamilton Island)	Survey Response	72.84	74.22	<b>1.38 (%) increase</b>

### **Fish or Meat in Rubbish**

A total of 20% of all rubbish collected during the Pre-intervention phase has fish or meat in it (Table 18). During the intervention phase, this number remained the same with not change recorded. Fisher's exact analysis showed no significant differences (p-value = 1) between phases.

### **Throwing food waste into the water**

A total of 28.39% of survey respondents partook in throwing food waste into the water behaviour in the Pre-intervention phase (Fig.18). During the intervention phase, the number increased by 2.32%, with a total of 30.71% of people taking part in this behaviour. Fisher's exact analysis was used to detect differences in the proportion of people throwing food waste into the water and no significant differences were observed (p-value = 0.7579) between those who participate in this behaviour and those who don't in both phases.

### **Threw fish frames / fish scraps into the water**

A total of 32.84% of survey respondents partook in throwing fish frames/ fish scraps into the water behaviour in the Pre-intervention phase (Fig.19). During the intervention phase, the number was reduced by 4.13%, with a total of 28.71% of people taking part in this behaviour. Fisher's exact analysis was used to detect differences in the proportion of people throwing fish frames/ fish scraps into the water and no significant differences were observed (p-value = 0.6094) between those who participate in this behaviour and those who don't in both phases.

### **Disposed of food waste in onshore rubbish facilities**

A total of 72.84% of survey respondents partook in disposing food waste in on-shore rubbish facilities behaviour in the Pre-intervention phase (Fig. 20). During the intervention phase, the number increased by 1.39%, with a total of 74.23% of people taking part in this behaviour. Fisher's exact analysis was used to detect differences in the proportion of people disposing food waste in on-shore rubbish facilities and

no significant differences were observed ( $p$ -value = 0.8725) between those who participate in this behaviour and those who don't in both phases.