QUEENSLAND GOVERNMENT
Department of Agriculture and Fisheries

Progress Report

Project	**Prevalence and behaviour of sharks in Cid Harbour**
Date	October 2019
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Summary

In response to three shark bite incidents that occurred in Cid Harbour, Whitsunday Islands, between September and November 2018, the Department of Agriculture and Fisheries commissioned a scientific study to investigate the prevalence and behaviour of sharks in the Cid Harbour region. Further funding was provided by the Australian Government to expand the project in mid 2019. The present report pertains to results obtained between December 2018 and September 2019, from the first three field trips to Cid Harbour (December 2018, June 2019 and September 2019) and from the first set of social science surveys. A range of sampling methods were used, including catch methods (single hook droplines, longlines, surface lines, rod and reel), baited underwater video cameras (BRUVs), sidescan sonar and acoustic and satellite tracking.

Overall, results to date suggest that shark numbers in Cid Harbour are not unusually high compared to other coastal locations along the Great Barrier Reef. Sharks caught/sighted were mostly spot-tail sharks, followed by tiger sharks, tawny nurse sharks. Observations to date suggest that Cid Harbour has an abundant marine life that could be shark prey. Additionally, sharks are opportunistic scavengers, and anecdotal information prior to this study suggests many of the boats using Cid Harbour throw food scraps overboard, with some intentionally attracting sharks.

Regarding tracking, 20 acoustic receivers were deployed in Cid Harbour and in key points around the Whitsunday Islands. So far, 23 sharks have been tagged with acoustic transmitters and 14 with satellite tags. Movement data suggests that sharks move through Cid Harbour as they use the broader Whitsunday region, but residency in the harbour itself is not high for most individuals. Some sharks moved large distances, including a bull shark that moved to the Torres Strait and back to the Whitsundays. The data available to date is however limited, as the number of sharks tagged is still relatively small (and effort spread across five species) and tracking data only covers a short period of time. The complete tracking dataset will be retrieved at the end of the project (April/May 2020), and coupled with the additional data to be collected in the next two field trips will greatly contribute to a better understanding of the prevalence and movement behaviour of sharks in Cid Harbour.

For the social science component of the project, an online survey on the recreational use of the Whitsundays and on the public's awareness, perception and attitudes regarding sharks and 'shark smart' behaviours was developed and implemented. A total of 218 survey responses were logged, and data are presently being analysed. Preliminary results indicate that respondents agree that sharks are important for marine ecosystems and have a place in the Whitsundays, but many also acknowledge that they pose risks. 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 'shark smart' behaviours, but do not have enough knowledge to inform their choices about risky behaviour. Results emphasize the importance of producing and disseminating easy-to-understand information on 'shark smart' practices, to allow people to make informed choices and adopt behaviours that minimize the risks in human-shark interactions.

Background

In response to three shark bite incidents that occurred in Cid Harbour, Whitsunday Islands, between September and November 2018, the Department of Agriculture and Fisheries (DAF) commissioned a scientific study to investigate the prevalence and behaviour of sharks in the Cid Harbour region. The initially one-year project was expanded to mid 2019 through additional funding provided by the Australian Government, which allowed for two further sampling trips to be undertaken, and new components added to the project (e.g. use of side-scan sonar surveys to obtain information on potential prey availability in Cid Harbour). Other stakeholders such as the tourism industry support the study and are providing assistance, in particular with the social science component of the project. The overall aim of this project was to improve our understanding of the shark species present in the area, the relative abundance of potentially dangerous species, and the behaviours of those species (including habitat use and residency within Cid Harbour and the surrounding area) and of humans that use the area for recreational purposes. This information will be useful to better understand the causes of shark bites in Cid Harbour so that appropriate, science-based, management measures can be devised and implemented to adequately address the shark bite issue in the short- and long-term. The present report covers the work undertaken and results gained from the first three sampling trips, and provides updates on the progress of the social science component of the project.

Methods

To date, three 1-week long field trips have been conducted (December 2018, June 2019 and September 2019) to investigate the occurrence, species composition and behaviour of the shark community using Cid Harbour. Although several methods were proposed to address the proposed objectives during the tender process, some of those methods were not practical or useful. For example, from personal observations, it was clear that visibility in Cid Harbour is too low for the use of automated underwater vehicles (AUVs), as AUVs require clear water to position themselves and move in relation to the surrounding environment. Also, drone surveys were trialled on first two field trips, but were unsuccessful due to poor in-water and surface visibility that resulted from high water turbidity. Underwater camera drops were also of limited use on the first field trip due to bad weather caused by ex-Tropical Cyclone Owen, when excessive rain led to extremely turbid waters. Indeed, the main study area, Sawmill Bay (Figure 1), where most boats anchor and the location where the shark bites occurred, had low in-water visibility on all three trips, and this appears to be the normal condition for the bay. However, we had better success with underwater cameras on the second and third field trips, partly due to improved water clarity, and also because we deployed cameras more broadly over the Cid Harbour area, including in clearer areas outside the shallow Sawmill Bay.

Catch methods

Single hook droplines

In each field trip, eight to ten single-hook droplines were deployed each day between sunrise and sunset (approximately 5:30 h to 18:30 h), at depths between 2 and 20 m (Figure 1c). Hook sizes were 16/0, 18/0 and 20/0, and bait was predominately a mixture of mullet, mackerel and tarpon species. In the first field trip, due to poor weather conditions, droplines were mainly set in the protected Sawmill Bay area. In the subsequent field trips, sampling effort was spread-out throughout the Cid Harbour area (Figure 1c).

Longlines

Bottom-set longlines were set in 4-7 m of water, mainly close to where the shark bites occurred (Figure 1c). Longlines consisted of 200 m led core lines with 27-30 hooks per line (12/0 circle hooks). The smaller hook size were used to target smaller sharks. Due to limiting weather conditions (too windy), longlines were only set on two days each for the first and third trips, and four days on the second trip

Supplementary night sampling

Besides the systematic use of drop- and longlines, sharks were also targeted using a surface line with bait and a berley pot (first two nights of the first trip; set for 3 h each night) and rod and reel (most nights of the second and third trips), from the back of the boat. On the third trip, two droplines were also set between 17:45 h and 22:00 h on one night in 5 m deep water amongst the boats anchored for the night.

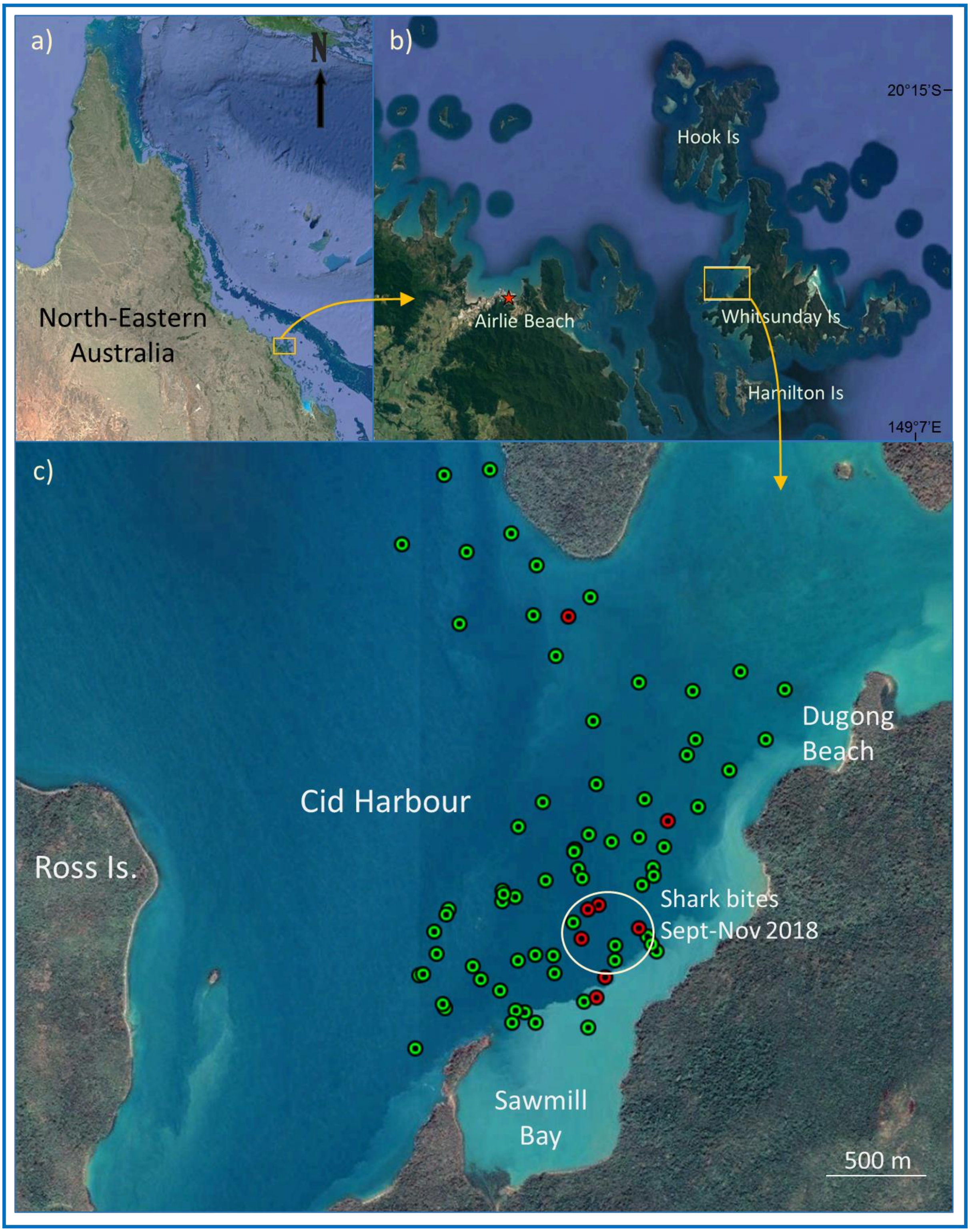

Figure 1. Study area, showing a) & b) the location of the study area in northeastern Australia, and c) the locations of the droplines (green symbols) and longline sets (red symbols) and area where the shark bites occurred. Map sources: a) Google, Landsat/Copernicus, b) Google, Terrametrics, and c) Google, CNES/Airbus.

Baited underwater video cameras (BRUVs)

Baited underwater video cameras (BRUVs) were set in the different available habitats, aiming for 1 hour deployments. BRUVs were set at least 500 m apart, at depths between 1 and 17 m. Approximately 1 kg of pilchards was used as bait per BRUV. As with the fishing methods, initial BRUV sampling focused on Sawmill Bay, where the majority of boats anchor, and where the shark bites occurred (Figure 1c). Sampling was later expanded to include the full depth range and habitats (soft bottom and hard structure) found throughout the Cid Harbour area (Figure 2), in an attempt to gain information on the species using the broader region.

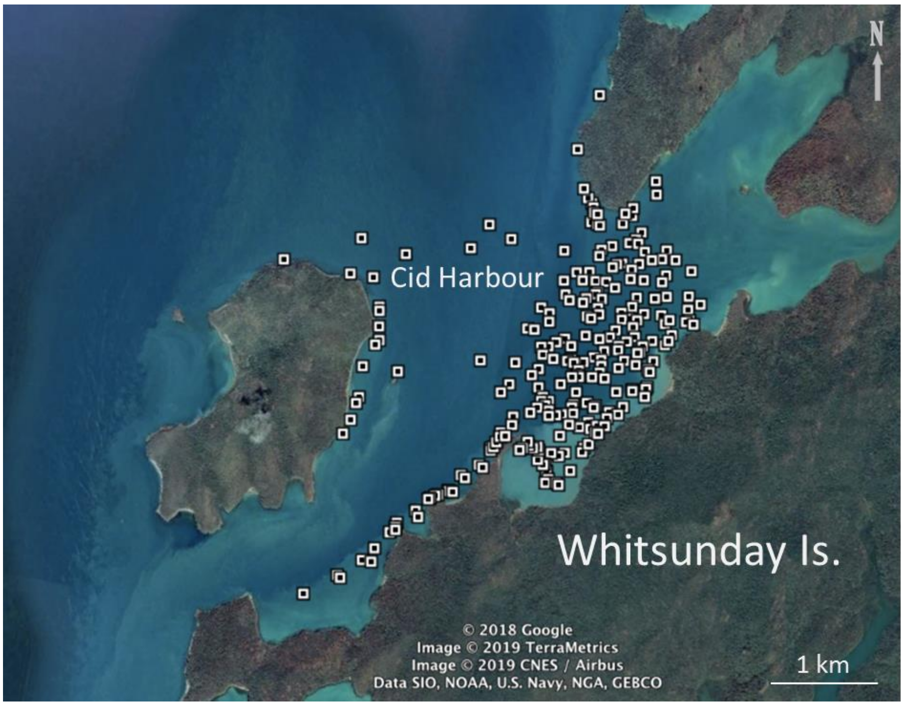

Figure 2. Cid Harbour study area, with white squares showing the locations of BRUVs deployed during the study. See Figure 1a-b for location of the mapped region within Australia.

Sidescan Sonar

For the last two field trips (planned for December 2019 and January 2020), sonar imaging will be used to determine if it is possible to quantify the presence of prey aggregations in Cid Harbour. We are currently testing the ability of this technique to detect prey animals. Sonar imaging transects (where a boat is slowly driven on a set path) have been carried out parallel to the shore using a track-line pattern to cover the whole area of the bay (resulting in approx. 10 km of sidescan track). Initial review of these tracks revealed several detections of marine mammals (dugongs), schooling fish and large-bodied fish. We plan to analyse these tracks by quantifying the encounter rates for different types of prey for each sampling period. Results of each sampling period will be compared to understand the variability in prey availability in the bay over time.

Tracking shark movements

Acoustic and satellite tagging targeted species that could potentially be responsible for shark bites.

Acoustic tracking

In December 2018, 10 acoustic receivers were deployed in Cid Harbour, including three receivers at the north entrance of the harbour and one at the south entrance (Figure 3). These receivers effectively gate Cid Harbour and therefore detect any tagged sharks leaving or entering the broader Harbour area. The remaining six receivers were deployed in the area where shark bites occurred, on the ‘Do-Not-Swim’ signs moored in response to the shark bites. This acoustic array design therefore monitors shark movement behaviour in the area where boats anchor and shark bites occurred, and will also provide information on the residency of the tagged sharks in the broader Cid Harbour area. At the request of DAF and thanks to additional funds obtained, 10 more receivers were deployed around the broader Whitsunday Islands region on the June 2019 field trip (Receivers ‘W’ in Figure 3), to better understand the broader movements of sharks in the area. The 10 additional locations were chosen based on being popular anchorages, tourist destinations, or for being channels between Islands, and therefore likely locations of transit. The movement data obtained from the 10 additional receivers will complement the satellite tracking data.

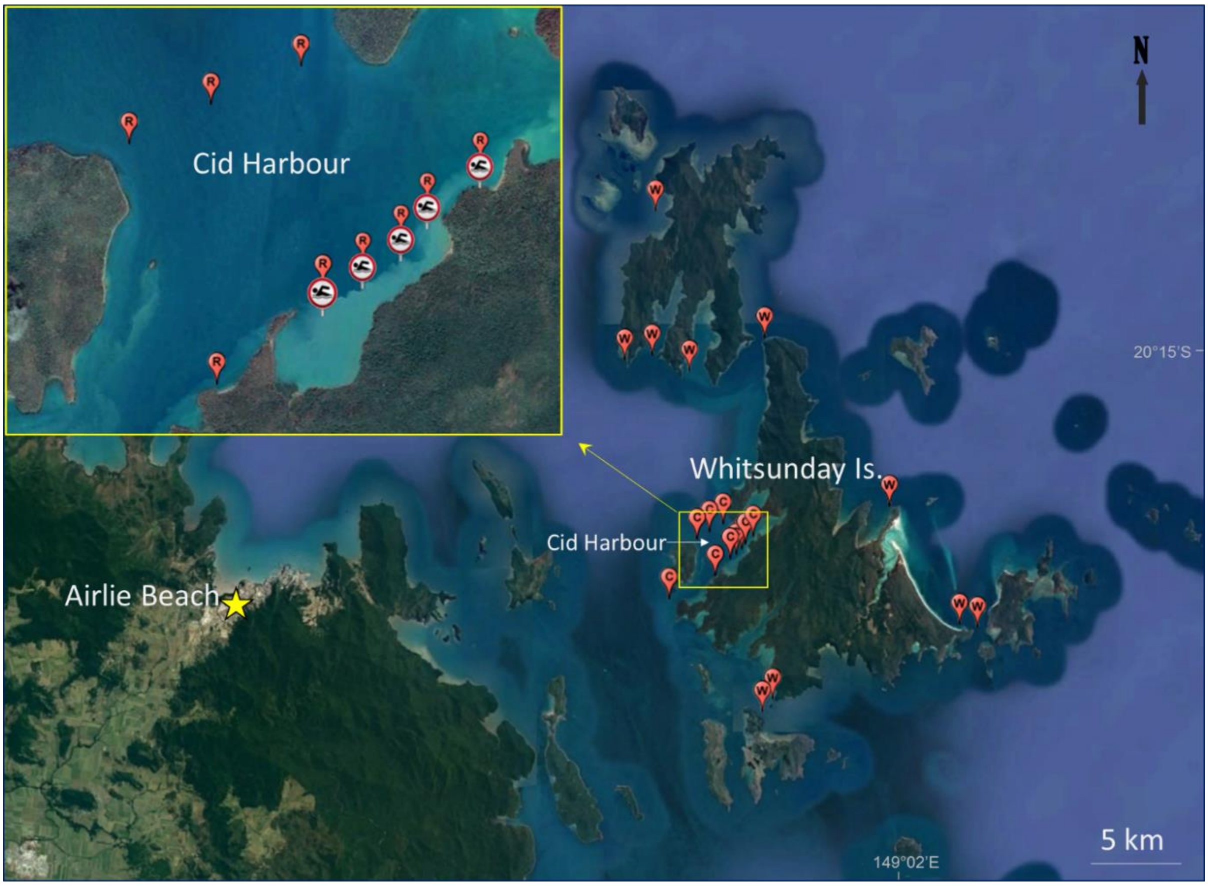

Figure 3. Location of the acoustic receivers deployed around Cid Harbour on the December 2018 trip ('C' receivers) and receivers set around the Whitsunday Islands in June 2019 ('W' receivers). Inset map shows the location of the five receivers attached to 'Do-Not-Swim' signs. See Figure 1a-b for detailed location of the mapped region within Australia, and Figure 1c for a more detailed, close-up, view of Cid Harbour. Map source: Google, CNES/Airbus.

For tagging, caught sharks were placed belly up long the side of the boat, and acoustic transmitters were surgically implanted into the body cavity through a small incision. The incision was then sealed with surgical sutures and the shark released. Preliminary tracking data from the five receivers deployed in the main study area (between Sawmill Bay and Dugong Beach) on 'Do-Not-Swim' signs (Figure 3) will be visually presented in a timeline to show residency patterns and the time spent in the area.

Satellite tracking

Satellite transmitters were attached to the dorsal fins of large shark species known to break the water surface (Figure 4). Satellite tagging data will complement acoustic telemetry data by providing information on shark's broad scale movements. This information will be useful to help determine how Cid Harbour fits into the broader movements of the species tagged.

Figure 4. Fitting a satellite transmitter to a hammerhead (left) and to a tiger shark (right).

Social science surveys: Recreational use of the Whitsundays and awareness of 'shark smart' behaviours

The social science component of the project progressed significantly since the previous report in January 2019, with ongoing consultation and collaboration with stakeholders in the Whitsunday Islands. Using feedback from the stakeholder workshop and meetings that took place in February 2019, we developed and implemented an online survey to collect information from marine recreational users about how they use the Whitsundays, their awareness of 'shark smart' behaviours, their perceptions of the efficacy and legitimacy of these measures, and their perceptions and attitudes regarding sharks following the incidents in Cid Harbour. The survey also sought to better understand how perceptions differ between different user groups, to identify any trends or patterns that could be correlated with shark behaviour.

The survey opened on 23 April 2019 and closed at the end of Whitsundays Race Week, on 24 August 2019.

Results

Catch data

Across the three field trips, single hook droplines sets were deployed over 19 days, making up a grand total of 1564 hours fished (Table 1). Fifty-seven sharks were caught in the droplines (Table 2), giving a CPUE of 0.04 sharks/hour fishing. Longlines were set for a total of 48 hours, with only eight sharks caught, making a CPUE of 0.2 sharks/hour/set (Table 1).

Overall, including both in longlines and droplines, spot-tail sharks (*Carcharhinus sorrah*) were the species most commonly caught, followed by tiger sharks (*Galeocerdo cuvier*) (Table 2). There was a total of 14 tiger shark captures, with one male caught three times, and a female caught twice. The longlines only caught one scalloped hammerhead (*Sphyrna lewini*), two tawny nurse sharks (*Nebrius ferrugineus*) and three spot-tail (*Carcharhinus sorrah*) sharks on the first trip, one bull shark (*Carcharhinus leucas*) on the second, and one great hammerhead (*Sphyrna mokarran*) on the third. The vast majority of baits in both drop- and longlines were not touched. There was no bycatch on the longline, and the only other animals caught on a dropline were five catfish (*Netuma thalassinus*), one grouper (*Epinephelus* sp.) and one black marlin (*Istiompax indica*).

Table 1. Summary of dropline fishing effort used in each trip.

Trip	No. days fished	No. hours fished	No. sharks caught
Droplines			
Trip 1	6	465	17
Trip 2	7*	572	17
Trip 3	6	527	17
Total	**19**	**1564**	**51****
Longlines			
Trip 1	2	11.3	6
Trip 2	4	23.8	1
Trip 3	2	12.7	1
Total	**8**	**47.8**	**8**

* The 8th day of fieldwork on this trip was devoted to deploying the extra 10 receivers.
** This includes three tiger shark recaptures, with one individual recaptured twice, and another once.

Table 2. Species composition and size range of sharks caught on single hook droplines and longlines combined, over the course of the three trips. *n* = number of sharks caught; TL = total length, in cm.

Species	Scientific name	Size range (TL)	n
Spot-tail shark	*Carcharhinus sorrah*	50 - 173	21
Tiger shark	*Galeocerdo cuvier*	200 - 386	14*
Tawny nurse shark	*Nebrius ferrugineus*	150 - 270	9
Bull shark	*Carcharhinus leucas*	203-283	4
Great hammerhead shark	*Sphyrna mokarran*	80 -241	3
Scalloped hammerhead shark	*Sphyrna lewini*	152-171	3
Common blacktip shark	*Carcharhinus limbatus/tilsoni*	120-195	3
		TOTAL	**57**

* note that three of the tiger shark captures were recaptures, with one individual recaptured twice, and another once.

Supplementary night sampling also led to very poor catches. The surface lines with bait and berley (set for 3 h on the first two nights of the first trip) did not catch anything, and the bait was not touched. Rod and reel fishing, used on the second and third trips, only caught one white-spotted wedgefish (*Rhynchobatus australiae*), despite fishing on most nights between 19:30 h and 22:00-23:00 h; and the two droplines, set between 17:45 and 22:00 on one night (third trip) amongst the anchored boats, caught nothing.

Baited underwater video cameras

BRUV sampling was carried out on the three field trips, resulting in high replication and high spatial coverage of Cid Harbour (Figure 2). A total of 293 deployments and approximately 372 hours of video time were obtained from the range of available depths (Figure 5). Video footage has been partially reviewed, and show that BRUV deployments were successful, as indicated by the repeated and sustained attraction of various species, including scavenger and predatory fish (e.g. golden trevally (*Gnathanodon speciosus*), giant trevally (*Caranx ignobilis*) and giant queenfish (*Scomberoides commersonnianus*)) (Figure 6). There appears to be a low frequency of shark detections, although this cannot be quantified until all footage has been analysed. Nevertheless, the preliminary review revealed several species of sharks using Cid Harbour, including tiger sharks, whitecheek sharks (*Carcharhinus dussumieri*), brownbanded bamboo sharks (*Chiloscyllium punctatum*) and blackspot shark (*Carcharhinus sealei*), as well as several batoid species including wedgefish. A trial is underway to analyse the full video dataset using weakly-supervised deep-learning techniques (Artificial Intelligence). Once the most appropriate network architecture for shark identification is developed, Artificial Intelligence will automatically detect sharks in the video footage and these detections will posteriorly be reviewed by shark biologists to identify species, greatly reducing the time needed for analysis.

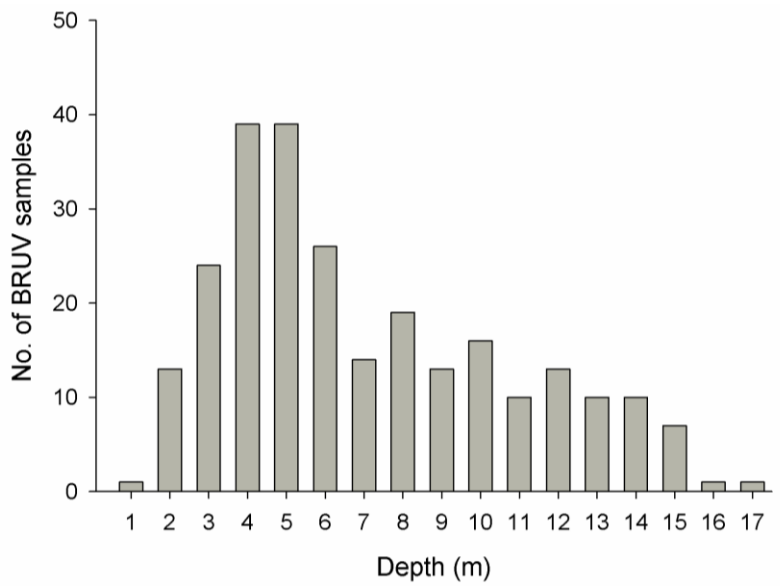

Figure 5. Number of BRUV samples taken at each depth throughout Cid Harbour.

Shark movements and residency behaviour

Acoustic tracking

Of the 54 sharks caught, 23 were tagged with acoustic transmitters (

Table **3**). Species of no potential threat to humans (e.g. tawny nurse sharks), individuals too small to hold the tag (most spot-tail sharks) or not in good condition from capture (e.g. some hammerhead and spot-tail sharks) were not tagged. On the third field trip (September 2019), acoustic data were downloaded from the receivers attached to the five "Do-Not-Swim" signs (Figure 3). Of the 23 acoustically tagged sharks, eight were tagged in the September 2019 field trip, i.e. at the same time as downloading the receivers, so detections from those sharks are not expected until receivers are downloaded in future trips.

Figure 6. Examples of images registered by the BRUVs deployed in Cid Harbour, showing a range of species and visibility conditions.

Of the 15 sharks tagged in December 2018 and June 2019, 10 were detected by the Cid Harbour inshore receivers by the time receivers were downloaded in September 2019 (five tiger sharks, two spot-tail sharks, two bull sharks and one common black tip shark;

Table **3**). Five of the eight tiger sharks returned to Cid Harbour for short periods of time throughout the year, and two out of three spot-tails also spent significant amount of time in Cid Harbour (Figure 7). One bull sharks remained around Cid harbour since it was tagged in June, while the other left immediately after tagging in June, but returned in September (Figure

7). A timeline of the occurrence of the 10 individuals that returned to Cid Harbour can be found in Figure 7. Five other individuals were not detected in the Cid Harbour inshore area following tagging. Those included three tiger sharks, a blacktip shark and a spot-tail shark (

Table **3**). For the three tiger sharks that did not return, satellite data show broad movements around the Whitsunday Islands (Figure 9 e,g,h). A detailed analysis for all individuals tagged will be undertaken when all receivers are retrieved at the end of the project (April/May 2020).

Table 3. Size (total length, in cm) and sex of sharks fitted with acoustic (AT) and satellite (ST) transmitters. For sharks tagged in December 2018 and June 2019, it is also indicated whether they were detected in Cid Harbour after tagging (i.e. by at least one of the five receivers placed in “Do-Not-Swim” signs (see Figure 3)).

Species	Sex	Size (cm)	Date tagged	AT #	ST #	Cid Harb. detection?
Tiger shark	F	242	Dec 2018	64004	175019	Yes
Tiger shark	F	285	June 2019	12809	175011	No
Tiger shark	F	300	Sept 2019	12798	178947	
Tiger shark	F	330	Sept 2019	12799	175014	
Tiger shark	F	340	Dec 2018	64003	176411	Yes
Tiger shark	F	370	Sept 2019	64005	175020	
Tiger shark	F	386	June 2019	12807	173761	No
Tiger shark	M	230	Dec 2018	28255	175018	Yes
Tiger shark	M	264	June 2019	64007	41820	Yes
Tiger shark	M	316	June 2019	64006	41821	No
Tiger shark	M	335	June 2019	12808	173762	Yes
Spot-tail shark	F	113	June 2019	28256		No
Spot-tail shark	F	120	June 2019	12814		Yes
Spot-tail shark	F	125	Sept 2019	6157		
Spot-tail shark	F	173	Dec 2018	28254		Yes
Spot-tail shark	M	137	Sept 2019	12797		
Bull shark	M	203	Sept 2019	12795		
Bull shark	M	230	Sept 2019	12796		
Bull shark	M	245	June 2019	12810		Yes
Bull shark	M	283	June 2019	12812	175012	Yes
Common blacktip shark	F	160	June 2019	12811		No
Common blacktip shark	M	195	June 2019	12813		Yes
Great hammerhead	F	241	Dec 2018		175016	No
Scalloped hammerhead	M	171	Dec 2018		175017	No
Scalloped hammerhead	M	152	Sept 2019	7438		
			TOTAL	**23**	**14**	

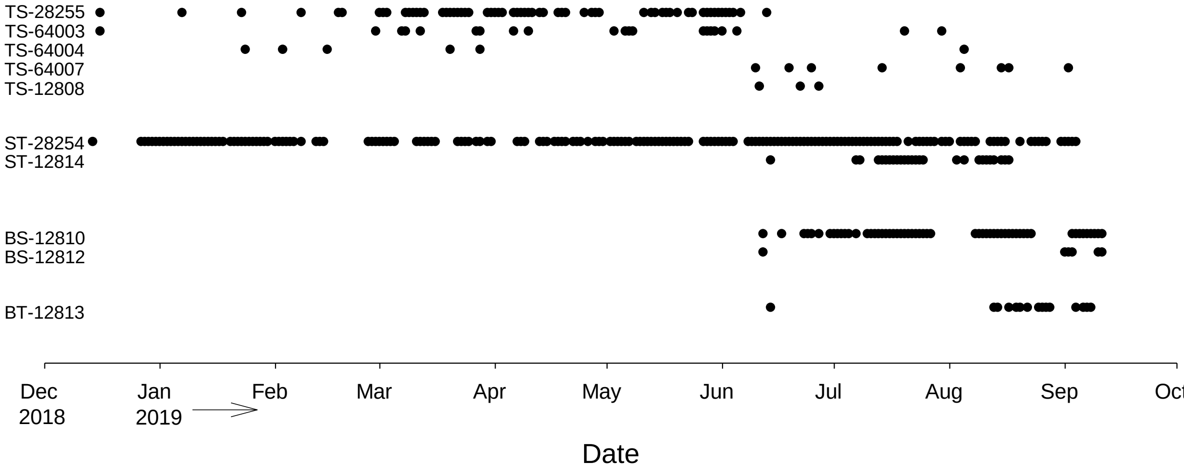

Figure 7. Timeline showing the days each acoustically tagged shark was detected on receivers deployed in the Sawmill Bay area of Cid Harbour (i.e. by one of the five receivers placed in the 'Do-Not'Swim' signs; see Figure 3). For each individual, the first day recorded on the timeline corresponds to the tagging day. Only sharks tagged in the first and second trips, and that were detected in following days/months, are included. Individuals are identified by species code (TS = tiger shark, ST = spot-tail, BS = bull shark and BT = blacktip), followed by acoustic tag number.

Satellite tracking

To date, 14 sharks have been fitted with satellite transmitters, including 11 tiger sharks, one great hammerhead, one scalloped hammerhead and one bull shark (

Table **3**). Most of these sharks spent considerable time in the broader Whitsunday Islands region, moving between the coast, islands and offshore reefs (Figure 8 and Figure **9**). The largest tiger shark tagged (a 386 cm TL female, satellite tag #173761) made the largest movements amongst the tiger sharks, leaving Cid Harbour directly after tagging (and not returning, i.e. not detected again by acoustic receivers) and moving between reefs offshore from Townsville to well south of Mackay (Figure 9e), almost 400 km away. The tagged bull shark (a 283 cm TL male, satellite tag no. 175012) moved the longest distance: it swam northwards, reaching the Torres Strait (1280 km away) 26 days after tagging, then headed south again and within two months it was detected back in Cid Harbour by the acoustic receivers (Figure 10). The scalloped hammerhead shark has not been detected. The first location data from each of the three tiger sharks tagged on the September 2019 trip has recently been received (but not presented in this report)

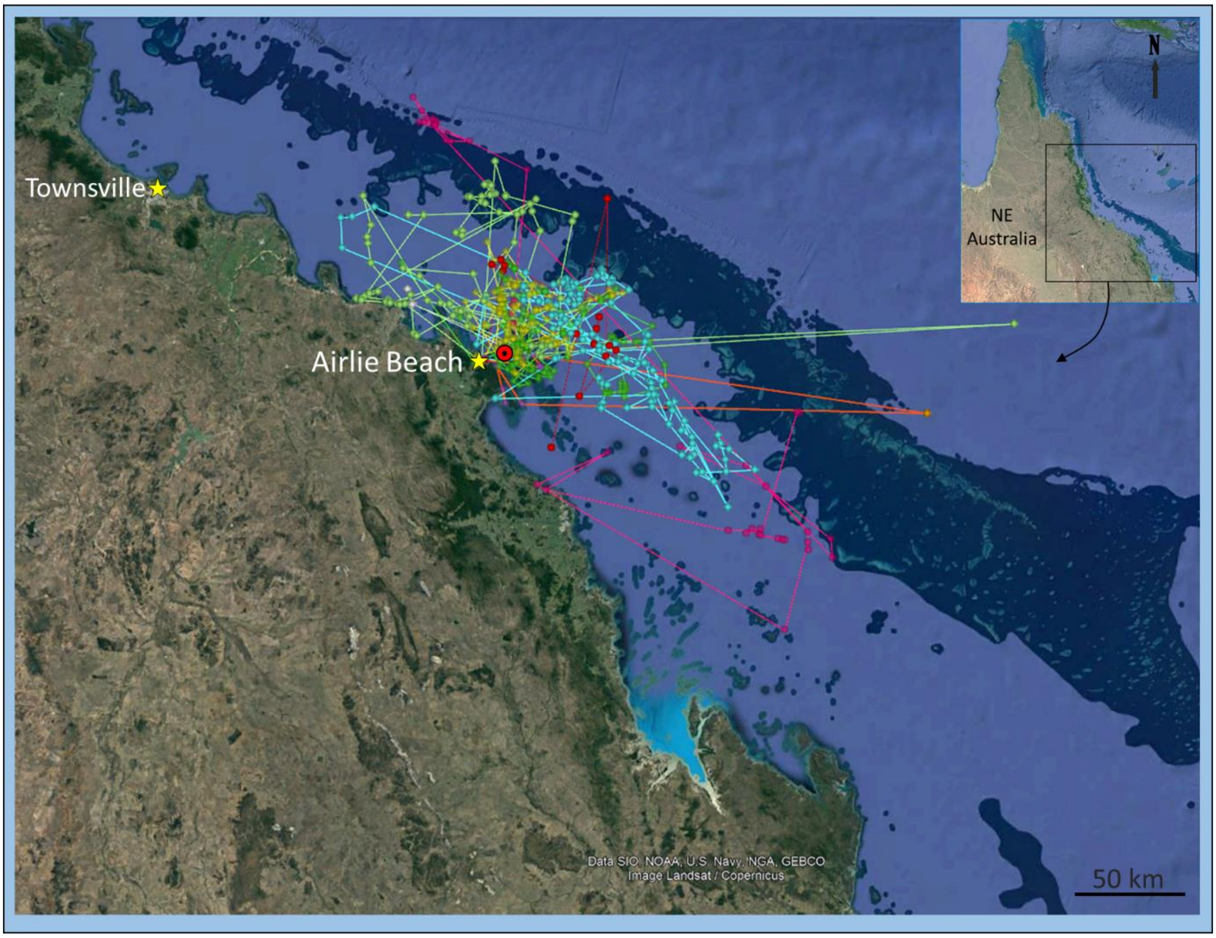

Figure 8. Satellite tracks, showing the movements of the eight tiger sharks tagged with satellite transmitters in December 2018 and June 2019. Red dot represents the tagging location (Cid Harbour).

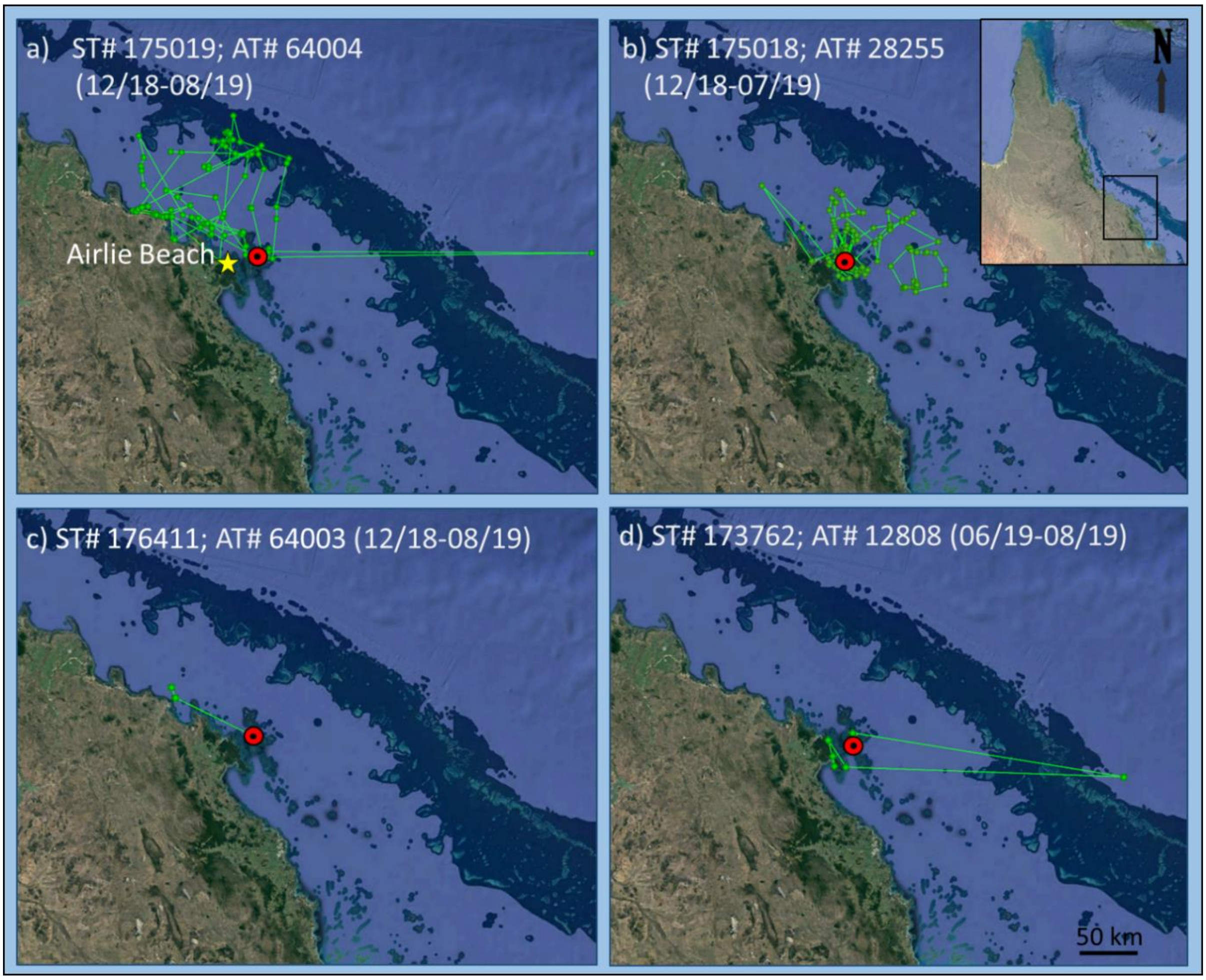

Figure 9. Satellite tracks, showing the movements of tiger sharks tagged with satellite and acoustic transmitters. Both satellite tag (ST#) and acoustic tag (AT#) numbers are presented. Date range represents the tagging month to month of last detection. Red dot represents the tagging location (Cid Harbour). Map source: Google, Landsat/Copernicus.

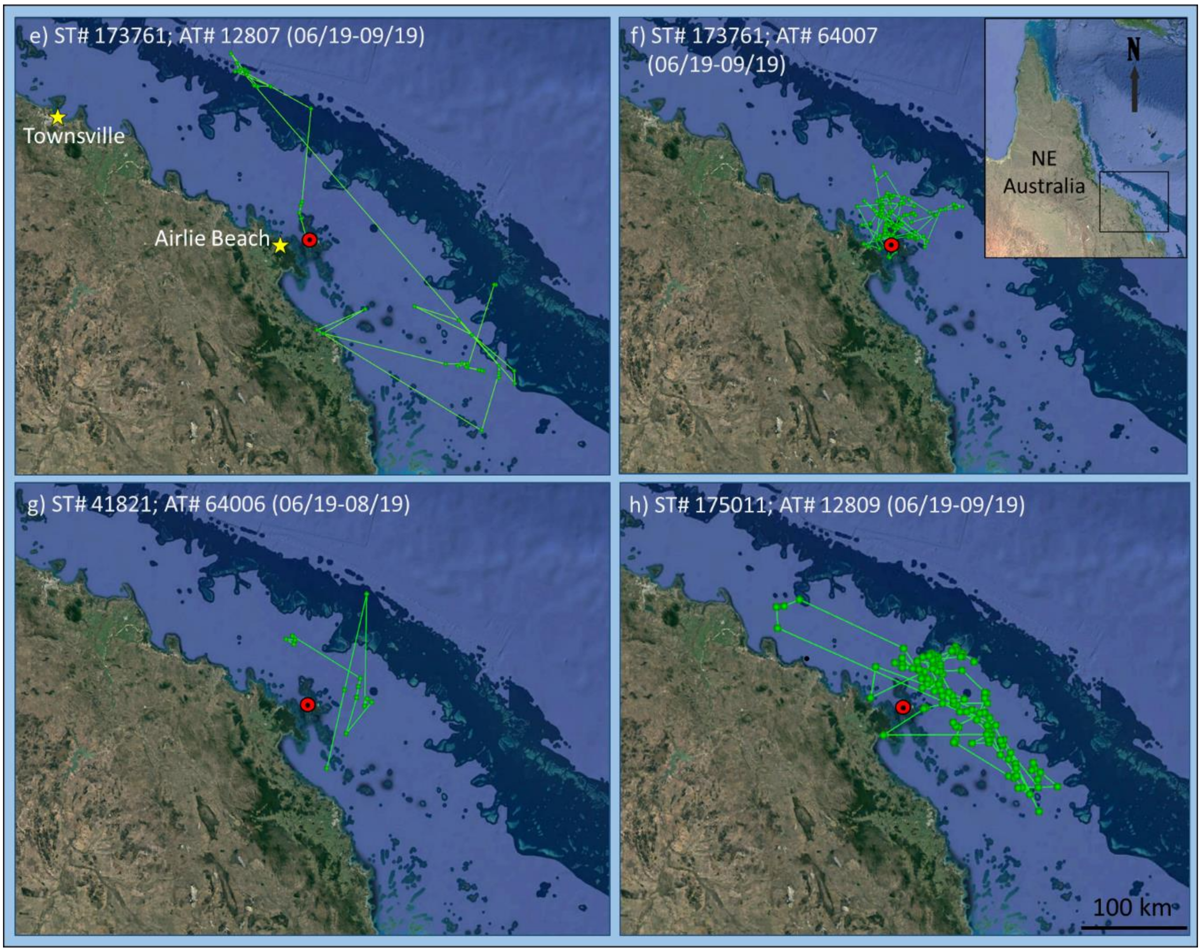

Figure 9 (cont.). Satellite tracks, showing the movements of tiger sharks tagged with satellite and acoustic transmitters. Both satellite tag (ST#) and acoustic tag (AT#) numbers are presented. Date range represents the tagging month to month of last detection. Red dot represents the tagging location (Cid Harbour). Map source: Google, Landsat/Copernicus.

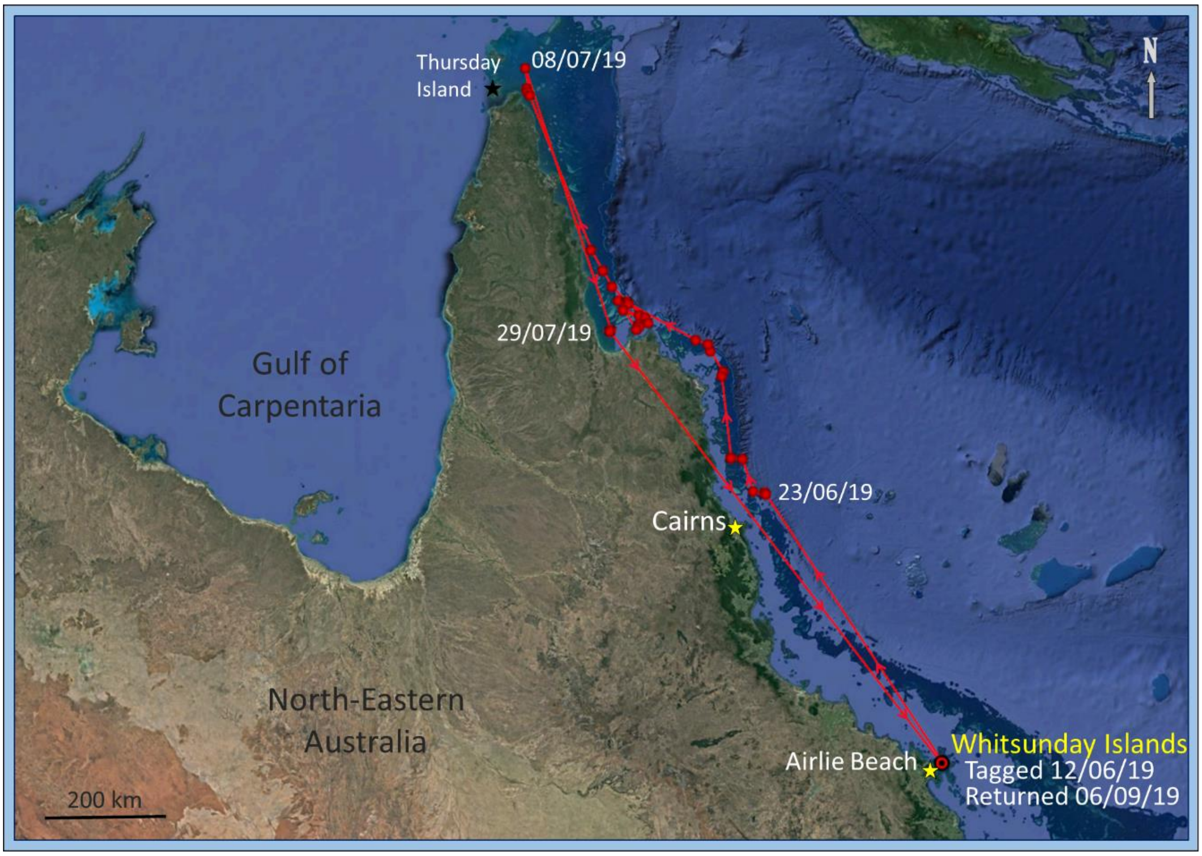

Figure 10. Movements of a satellite- and acoustic-tagged 283 cm TL male bull shark (satellite tag 175012; acoustic tag 12812), showing the long distances moved. Map source: Google, Landsat/Copernicus.

Social science surveys: recreational use of the Whitsundays and awareness of 'shark smart' behaviours

A total of 218 survey responses were received, which can be considered a very good sample size. Data are still being analysed, but some preliminary results are emerging. Some of the main points include:

- There was an equal spread of male to female respondents.
- Just over half the respondents were residents.
- Most of the visitors were visiting boat owners and charter boat guests.
- Respondents rarely encountered sharks.

- Respondents agreed that sharks are important to marine ecosystems and have a place in the Whitsundays, but many also agreed that they pose risks.
- Most respondents' views and opinions regarding sharks have not changed in the last 12 months.
- Most respondents had some knowledge of swim safe and 'shark smart' behaviours
- Few respondents learned about 'shark smart' behaviours through tourism-related information briefings. In contrast, most awareness was gained through general media and online sources.
- The increase in unwanted encounters was attributed mainly to lack of awareness and ignoring safe practices and discarding food off boats.
- Education of 'shark smart' behaviours was considered to be the most important intervention for reducing unwanted shark encounters, whereas drumlines and shark nets were generally considered to be less effective.
- When asked about what other measures could be implemented to reduce unwanted shark encounters, 'increase availability of information' was emphasised the most.
- Respondents strongly expressed the desire for more information, with the majority of respondents stating that they only know 'a little bit about what they should be doing'.

This last trend presents an interesting point, as it suggests that people are generally aware of 'shark smart' principles, but do not have enough knowledge to inform their choices about risky behaviour. This emphasizes the importance of producing and disseminating easy-to-understand information on 'shark smart' practices, to allow people to make informed choices and adopt behaviours that minimize the risks of human-shark interactions.

The last round of data collection is in the form of long format, in-depth, interviews with key informants. Interviews will be held in Airlie Beach between the 15th and 18th October 2019, to collect more in-depth information on patterns of use, values, and changes over time. In particular, interviews will explore some of the emerging trends evident in the online survey, and explore what stakeholders would like to see in terms of use patterns and behaviours into the future. Key informants will include stakeholders from government and the tourism industry, as well as local community organisations.

Discussion

Despite intense sampling effort on the three trips, shark catches and sightings (in BRUVs) were not any higher than what we would expect (based on previous projects the authors have worked on and published literature, e.g. Wirsing et al. 2006; Heupel et al. 2009; Barnett et al. 2010; Yates et al. 2015). This, coupled with the lack of empty hooks after fishing, suggests that there is not a high abundance of sharks using Cid Harbour (at least during the sampling periods). Sampling showed there are a range of different shark species that are present in and around Cid Harbour, including tiger sharks, spot tail shark, tawny nurse sharks, bull sharks, hammerhead and black tip sharks. A total of 57 sharks have been caught over the three field trips, with the most prevalent spot-tail and tiger sharks.

Observations from all field trips suggest that Cid Harbour has abundant marine life that could be shark prey. Numerous turtles were observed surfacing, along with mackerels leaping out of water, dolphins moving around the bay, and shoals of baitfish were present around the boat at night. BRUVs also recorded turtles and bony fish, along with stingrays, species known to be important shark prey. Side scan sonar will hopefully provide more information on prey availability for the Final Report.

Besides the presence of natural prey, it is also important to note that sharks are opportunistic scavengers. Up to 100 boats are known to use Cid Harbour in a day, and anecdotal information suggests many of those boats throw food scraps overboard, and some intentionally attract sharks with food. This human behaviour could attract sharks to the area, and in other parts of the world shark feeding has been shown to lead to changes in shark behaviour and movement patterns (Trave et al. 2017). Few boats used the Cid Harbour during the first field trip (likely due to bad weather from ex-Tropical Cyclone Owen), with only one other boat present in the first four days, and only six boats present in the 5th and 7th days. This means that if food supplements from boats are an issue, there would likely be a much lower amount of food attracting sharks to the area than in 'normal' conditions (i.e. when a high number of boats use the area). The number of boats using Cid Harbour was much higher in subsequent field trips, with 10 – 18 boats per night in June (average 13 boats), and 31 – 69 boats per night in September (average 51). Preliminary review of catch and camera data suggests no difference in shark catch/sightings between the three trips. Bad weather (mainly high wind speeds) on all three field trips hampered some of the planned work, in particular fishing at night safely. However, on the most recent trip (September 2019), it was possible to fish at night amongst the anchored boats using rod and reel from the mothership, and to set droplines outside of the light from our boat. Despite baitfish and other fish around the boat, no sharks were caught or seen and no baits were touched.

Movement data suggests that sharks move through Cid Harbour as they use the broader Whitsunday region, but residency in the harbour itself was low for most individuals (see Figure 7). Some sharks moved large distances, including a bull shark that moved to the Torres Strait and back to the Whitsundays. Is it however important to stress here that the movement data available to date is limited, as the number of sharks tagged is still relatively small and available tracking data only covers a short period of time. More data (more sharks tagged and longer tracking periods) is needed before a better understanding of the movement behaviour of sharks in the region can be gained. The expansion of this project through additional funding provided by the Australian Government allows the project to run until April/May 2020, when data from all receivers will be retrieved, providing valuable extra time to track sharks.

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