



Department of  
Primary Industries

# **Shark Meshing (Bather Protection) Program 2019/20 Annual Performance Report**

Prepared in accordance with the 2017 Joint Management  
Agreement and associated Management Plan

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## Contents

<b>Contents</b>	<b>i</b>
<b>List of Tables and Figures</b>	<b>ii</b>
<b>Executive Summary</b>	<b>iii</b>
<b>Introduction</b>	<b>1</b>
<b>1 SMP Management Plan Performance Assessment</b>	<b>4</b>
1.1 Controls on the activity .....	4
1.2 Observer Program .....	5
1.3 Compliance Plan .....	7
1.4 Strategic Research and Monitoring Program.....	8
1.5 Performance Indicators.....	28
1.5.1 Objective 1 - reduce the risk to humans from shark attack at beaches of the SMP..	28
1.5.2 Objective 2 - minimise the impact on non-target and threatened species.....	29
1.5.3 Objective 3 - Minimise OHS risks associated with implementing the SMP .....	33
1.5.4 Objective 4 - Transparent monitoring and reporting. ....	33
1.6 Summary of Reviews and Actions .....	33
<b>2 Changes to the Management Plan</b>	<b>34</b>
<b>3 Other Programs Complementing the SMP</b>	<b>34</b>
3.1 Aerial Surveys .....	34
3.1.1 2019/20 Results.....	35
3.1.2 Conclusions .....	35
3.2 SharkSmart Public Awareness and Education Program .....	35
<b>References</b>	<b>36</b>
<b>Appendix 1 – Monthly catch summaries for the 2019/20 meshing season</b>	<b>41</b>

## List of Tables and Figures

Table 1	The 7 regions and 51 beaches of the SMP in 2019/20.....	2
Figure 1	Location of Shark Meshing (Bather Protection) Program beaches .....	3
Table 2	Total net inspections by region during 2019/20 meshing season .....	6
Figure 2	Catch recorded by contractor during 2019/20 meshing season.....	6
Table 3	Compliance inspections by region. ....	7
Table 4	SRMP Research Topics and Current Status.....	9
Table 5	SMP Monitoring Program – Outcomes for 2019/20. ....	24
Table 6	Shark Interactions in SMP region from 2008/09 to 2019/20 .....	28
Table 7	Total SMP entanglements for the 2019/20 meshing season.....	31
Table 8	Non-target and threatened species entanglements <sup>1</sup> for 2009/10 to 2019/20 and trigger point analysis for 2019/20 .....	32
Table 9	Percentage of major faunal groups released alive from the SMP pre -JMA (5 years before) and post -JMA.....	33

## Executive Summary

Between the 2009/10 and 2016/17 meshing seasons, the Shark Meshing (Bather Protection) Program (SMP) operated in accordance with Joint Management Agreements (JMAs) and an associated Management Plan authorised by the *Fisheries Management Act 1994* (FM Act) and the *Threatened Species Conservation Act 1995* (TSC Act).

A new, single JMA under the FM Act was prepared in 2017 and the 2017/18 meshing season marked the beginning of SMP operations under the 2017 JMA. Some of the key changes to the JMA were refined trigger points and a reduction in the number of target species from 12 to three (White Shark, Bull Shark and Tiger Shark).

The objectives of the JMA are to: minimise the impact of the SMP on threatened and protected species; and ensure that the SMP does not jeopardise the survival or conservation status of threatened species or cause species that are not currently threatened to become threatened.

The JMA and the Management Plan require an Annual Performance Report to be prepared and submitted to the parties to the JMA and relevant Scientific Committees convened under the FM Act and *Biodiversity Conservation Act 2016* (BC Act) by 31 July each year.

A total of 480 marine animals were caught in the SMP during the 2019/20 meshing season, comprised of 50 target sharks and 430 non-target animals. One hundred and ninety-six animals (41%) were released alive.

The 50 target sharks comprised 42 White Sharks; 3 Bull Sharks; and 5 Tiger Sharks.

The 430 interactions with non-target animals consisted of:

- 231 non-target sharks, including Grey Nurse Sharks; Scalloped Hammerhead Sharks; a Great Hammerhead Shark; Smooth Hammerhead Sharks; Angel Sharks (Eastern Angel Sharks and an Australian Angel Shark); Port Jackson Sharks; Thresher Sharks; \*Broadnose Sevengill Sharks; \*Whaler Sharks (Bronze Whalers, Common Blacktip Sharks, Dusky Whalers, Silky Sharks; Spinner Sharks; and an unidentified whaler species), and \*Shortfin Mako Sharks; (\* reported as target sharks prior to 2017).
- 179 rays including, a Spinetail Devil Ray; Southern Eagle Rays; Australian Cownose Rays; Black Stingrays; a White Spotted Eagle Ray; a Manta Ray; Smooth Stingrays; and an unidentified ray.
- 10 marine reptiles comprised of: 8 Green Turtles; a Loggerhead Turtle; and an unidentified turtle.
- 7 marine mammals all being Common Dolphins.
- 3 interactions with other finfish (Australian Bonito, Frigate Mackerel, and a Yellowtail Kingfish).

Eighty-seven (18%) of the interactions were with threatened species comprised of: 42 White Sharks; 31 Grey Nurse Sharks; 8 Green Turtles; 4 Scalloped Hammerheads; 1 Loggerhead Turtle; and 1 Great Hammerhead Shark. Eight (2%) of the interactions were with protected species comprised of: 7 Common Dolphins; and 1 unidentified turtle species.

The observer program was implemented with observers present on 43% of all net checks (hauls) undertaken by SMP contractors. Observers continued to focus on ensuring collection of biological samples in accordance with the Strategic Research and Monitoring Program. Biological samples (or whole animals) were taken from 228 of the 284 animals found dead in the nets in 2019/20.

The trigger point for the objective of '*minimising the impact on non-target species and threatened species*' was tripped in 2019/20 for Grey Nurse Sharks, Scalloped Hammerheads, Common Dolphins, Thresher Sharks, and finfish.

During the 2019/20 meshing season there were no shark-human interactions at meshed beaches of the SMP, so the trigger point for '*reducing the risk to humans from shark attacks at beaches of the SMP*' was not tripped.

During the 1 September 2019 - 30 April 2020 meshing period, seven shark-human interactions occurred at unmeshed beaches and were investigated by the NSW Department of Primary Industries (DPI). Within the SMP region a single interaction resulting in minor injuries to a surfer's hand from an unidentified shark occurred at Wamberal Beach, an unmeshed beach, about 3km from the nearest SMP net at Terrigal Beach. Six interactions occurred outside of the SMP region: two resulted in minor injuries from Wobbegong sharks; another in minor injuries from an unidentified shark; and three interactions resulted in no injuries.

Outside of the 2019/20 meshing season, there were an additional four interactions in 2019/20, including the fatality of a 60-year-old surfer after being bitten by a White Shark at Kingscliff on the Far North Coast on 7 June 2020. In the other three interactions, an ocean swimmer suffered minor wounds to the chest after being bitten by a Greynurse Shark at Shelly Beach, Manly on 2 July 2019, a surf-ski paddler had his ski bitten by a White Shark at Macmasters beach on 13 June 2020, and two snorkelers had a close encounter with a Bronze Whaler at Bulli on 14 June 2020.

The Management Plan trigger point related to the objective of *'minimise OHS risks associated with implementing the SMP'* was tripped with two minor incidents being reported by DPI staff during the meshing season.

The trigger point for *'transparent monitoring and reporting'* was not tripped in 2019/20.

In 2019/20, DPI met all requirements of the JMA and associated Management Plan.

This Annual Performance Report has not identified a need for any amendments to the Management Plan or JMA. A trigger point review report for *'minimising the impact on non-target species and threatened species'* and *'minimise OHS risks associated with implementing the SMP'* needs to be prepared by DPI within six (6) months of this Annual Performance Report.

## Introduction

The Shark Meshing (Bather Protection) Program (SMP) is a public safety measure introduced in 1937 to reduce the risk of shark interactions at the State's most popular public bathing beaches. Surf Life Saving NSW figures indicate that about 4.8 million people visited those beaches in 2019/20. Under the current program, 51 beaches between Wollongong and Newcastle (Table 1, Map 1) are netted by contractors using specially designed mesh nets.

The aim of the SMP is to reduce the threat of shark interactions within the area of the SMP whilst minimising impacts on non-target species. The only fatality at a meshed beach occurred over 60 years ago, but the nets are not a guarantee that shark encounters will not occur at meshed beaches. Thirty-four (34) shark encounters have reportedly occurred at netted beaches within the SMP region, nine (9) of which involved target sharks: seven with White Sharks, and one with each of a Tiger and Bull Shark. Other encounters at meshed beaches were with unknown species of shark (12), Wobbegong sharks (9), and unidentified whalers (4). Although some of the shark bites have caused serious injuries, the shark bite data for the SMP and similar programs in other jurisdictions indicate that these programs have reduced the rate of interactions (Dudley, 1997).

Traditional shark bite mitigation programs such as the SMP invariably affect non-target species, and the SMP is listed as a key threatening process in the *Fisheries Management Act 1994* and the *Biodiversity Conservation Act 2016* as it adversely affects threatened species, populations or ecological communities, or cause species, populations or ecological communities that are not threatened to become threatened.

The operation and environmental impacts of the SMP were reviewed in 2009, and between 2009/10 and 2016/17 it operated in accordance with Joint Management Agreements (JMAs) and an associated Management Plan authorised under the *Fisheries Management Act 1994* (FM Act) and the *Threatened Species Conservation Act 1995* (repealed by the *Biodiversity Conservation Act 2016*). The purpose of a JMA is to manage, regulate or restrict an action that is jeopardising the survival of a threatened species, population or ecological community.

The JMAs included provisions for 5-yearly reviews, and those reviews gave rise to a single 2017 JMA between the then Minister for Primary Industries and the then Chief Executive of the Office of Environment and Heritage (now the Coordinator General for the Department of Environment, Energy & Science) in accordance with section 221W(3) of the FM Act. This Annual Performance Report was prepared in accordance with the 2017 JMA and the 2017 Management Plan for the SMP (<https://www.dpi.nsw.gov.au/fishing/sharks/management/shark-meshing-bather-protection-program>).

The objectives of the JMA are to:

1. Minimise the impact of shark meshing on fish and marine vegetation which are a threatened species, population or ecological community, and on marine mammals, marine birds and marine reptiles which are protected fauna or a threatened species, population or ecological community.
2. Ensure that shark meshing does not jeopardise the survival or conservation status of threatened species, populations or ecological communities, or cause species that are not threatened to become threatened.

To achieve the objectives of the JMA, the DPI will:

- only carry out shark meshing in accordance with the JMA and the associated Management Plan.
- only carry out shark meshing during the meshing season (1 September - 30 April of the following year).
- ensure that nets are fitted with acoustic warning devices for cetaceans.
- require that contractors comply with by-catch reduction protocols and release protocols contained in the Management Plan and any release plans.

- continue research into methods of minimising by-catch of non-target species through implementation of the Strategic Research and Monitoring Program contained in the Management Plan.
- provide comprehensive release plans to the parties to the JMA as required.

The objectives of the Management Plan are to:

1. Reduce the risk to humans from shark attack at beaches subject to the SMP, and, consistent with that objective.
2. Minimise the impact on non-target species and to ensure that the SMP does not jeopardise the survival or conservation status of threatened species, populations and ecological communities, or cause species that are not threatened to become threatened.
3. Minimise occupational health and safety risks to contractors and agency personnel associated with implementing the SMP.
4. Ensure that monitoring and reporting on the SMP is undertaken in a transparent manner.

**Table 1 The seven regions and 51 beaches of the SMP in 2019/20.**

Hunter	Central Coast North	Central Coast South	Sydney North	Sydney Central	Sydney South	Illawarra
Stockton	Blacksmiths*	Terrigal	Palm	North Narrabeen	Bondi	Wattamolla
Nobbys	Caves	North Avoca	Whale	Narrabeen	Bronte	Garie
Newcastle	Catherine Hill	Avoca	Avalon	Dee Why	Coogee	Coledale
Bar	Lakes	Copacabana	Bilgola	Curl Curl	Maroubra	Austinmer
Dixon Park	Soldiers	Macmasters	Newport	Harbord	Wanda	Thirroul
Merewether	The Entrance	Killcare	Mona Vale	Queenscliff	Elouera	North Wollongong
Redhead	Shelly	Umina	Warriewood	North Steyne	North Cronulla	South Wollongong
				Manly	Cronulla	

\* Blacksmiths was historically called Swansea-Blacksmiths



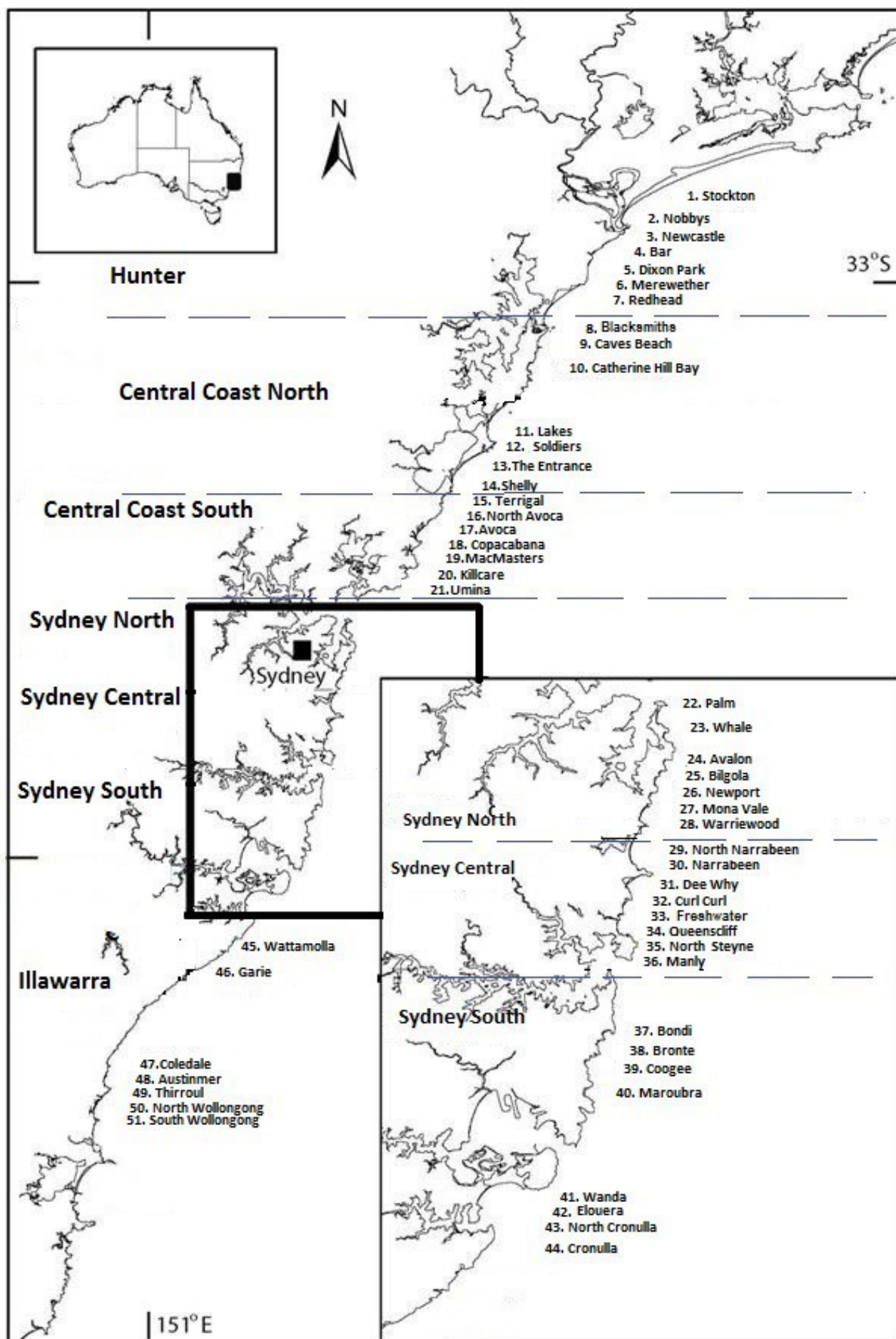


Figure 1 Location of Shark Meshing (Bather Protection) Program beaches.

# 1 SMP Management Plan Performance Assessment

In accordance with the requirements of the JMA and the Management Plan, this Annual Performance Report has been prepared for the Fisheries Scientific Committee (FSC) and the Scientific Committee (SC) to inform their annual review of the performance of all parties to the JMA. The FSC and SC will advise the Minister for Agriculture and Western NSW and the Coordinator-General-Environment, Energy and Science (EES), respectively, of any deficiencies in implementation of the JMA by either party. This report and the advice of the FSC and SC are also publicly available.

## 1.1 Controls on the activity

The Management Plan sets out the controls on the activity by specifying the operational parameters of the program including contract management, restrictions on waters, timing, gear and methods, and environmental protection provisions.

- Nets and equipment were inspected prior to the commencement of the season to ensure all contractors were complying with current contract conditions.
- All other aspects of the program related to contract management, restrictions on waters, timing, gear and methods, and environment protection provisions remained in line with the contract as per previous years.
- The 51 nets are now distributed across seven meshing regions instead of six, with net numbers and geographic size of regions more even, where possible.
- All contractor vessels are required to operate a Vessel Monitoring System (VMS) whilst undertaking meshing activities. The VMS units are owned by the Department, and live monitoring of vessels is conducted by the DPI shark meshing supervisor.
- All vessels are required to carry at least two spare nets before going to sea.
- Contractors are required to own and have inspected a minimum number of nets, depending on the number of nets in their respective region.
- More rigorous auditing processes through cross referencing of VMS data, contractor catch reports, observer reports, and compliance reports.

The SMP nets are also subject to numerous factors outside the control of the Management Plan such as weather conditions, whale strikes and human interference. The following damaged, vandalised or lost nets were reported during the 2019/20 season.

Seven nets were reportedly damaged by whales\* during the 2019/20 season:

- 3 September 2019, Sydney North contractor reported that the net at Whale Beach had been torn in half; believed to be from a whale. All net mesh and ropes were recovered.
- 4 October 2019, Central Coast North contractor reported that the net at Lakes Beach had suffered minor damage from what is believed to be from an interaction with a whale. All net mesh and ropes were recovered.
- 6 October 2019, the Central Coast North contractor reported that the net at Catherine Hill Bay had been significantly damaged; believed to be from a whale. All net mesh and ropes were recovered.
- 31 October 2019, Central Coast North contractor reported that the net at The Entrance had suffered minor damage; believed to be from a whale. All net mesh and ropes were recovered.
- Hunter contractor reported minor damage to the Newcastle, Bar and Merewether nets during November 2019.

\* Contractors report 'suspected whale damage' to nets when it is obvious that the net mesh and/or ropes have been torn, snapped or broken under strain, as opposed to being cut. These reports also coincide with the whale migration season.

Another five nets were reportedly vandalised during the 2019/20 season:

- 4 October 2019, Sydney Central contractor and DPI observer reported suspected vandalism of the net at North Steyne with approximately 60m of mesh being cut.
- 7 October 2019, Central Coast South contractor reported suspected vandalism of the net at Terrigal beach with the float-line and approximately 20m of mesh being cut.
- 11 October 2019, Sydney Central contractor and DPI observer reported suspected vandalism of the net at North Steyne with a large section of mesh being cut.
- 23 October 2019, Central Coast South contractor and DPI observer reported that the ropes of the Avoca Beach net had been cut.
- 28 October 2019, Central Coast South contractor reported that the Terrigal net had been cut in three places.

Nine nets were also reported missing after severe weather conditions in early February 2020, six of which were subsequently recovered. Three nets were not recovered, those being from North Wollongong, Queenscliff, and Harbord beaches.

## 1.2 Observer Program

The Management Plan requires an Observer Program to operate as part of the SMP.

### *Employment of Observers*

To satisfy the Observer Program requirements, four people were employed as 'observers' for the eight months of the SMP; two observer positions being fulltime (one permanent and one fulltime temporary) and two employed on a casual basis. Two of the observers conducted their duties predominantly in the Hunter, Central Coast North and Central Coast South regions, with the other two observers focused efforts in the Sydney North, Sydney Central, Sydney South and Illawarra regions; however, observers were not restricted to specific regions and were used across all regions as required and when available. Observer hours were reduced towards the end of the meshing season (approximately five weeks) with DPI implementing government COVID-19 guidelines associated with social distancing and reduced travel. Observers also assisted the Shark Scientist with collation of data, dissections, and cataloguing of collected biological samples, purchasing and maintaining acoustic alarms, and other duties associated with the SMP.

### *Training of Observers*

The duties of the observers require that they have a good general knowledge of the meshing operations as specified in the Tender Specification and are proficient at shark identification. Most importantly, observers require training and equipment to undertake the work safely, particularly with regard to seagoing skills, assisting in the release of entangled animals and performing animal dissections and tissue sampling.

On 7 August 2019 the observers and contractors attended an information session focussed on the upcoming 2019/20 meshing season. The day broadly covered management changes; contract management; administration; threatened species; new technologies; and research requirements including acoustic tag and pop-up satellite archival tag (PSAT) deployments. Any specialised sample collection techniques for new collaborative research projects are also highlighted and explained by DPI Shark Scientists.

To ensure the observers were competent and resourced to safely undertake the duties prescribed in the Observer Program for the 2019/20 meshing season, DPI conducted a training day on 22 August 2019 at the DPI Fisheries Office, Wollstonecraft. This day was a refresher for the two permanent observers who each have over five years' experience conducting these duties, and an opportunity for the new observers to gain experience in sampling procedures for the 2019/20 season. The two new observers were supervised by the Senior Shark Meshing Observer until he was satisfied that they could conduct observer duties independently.

### Number of Observer Days

Observers were present for 43% of all net inspections by contractors during the 2019/20 season. A breakdown by region of observer coverage is provided in Table 2.

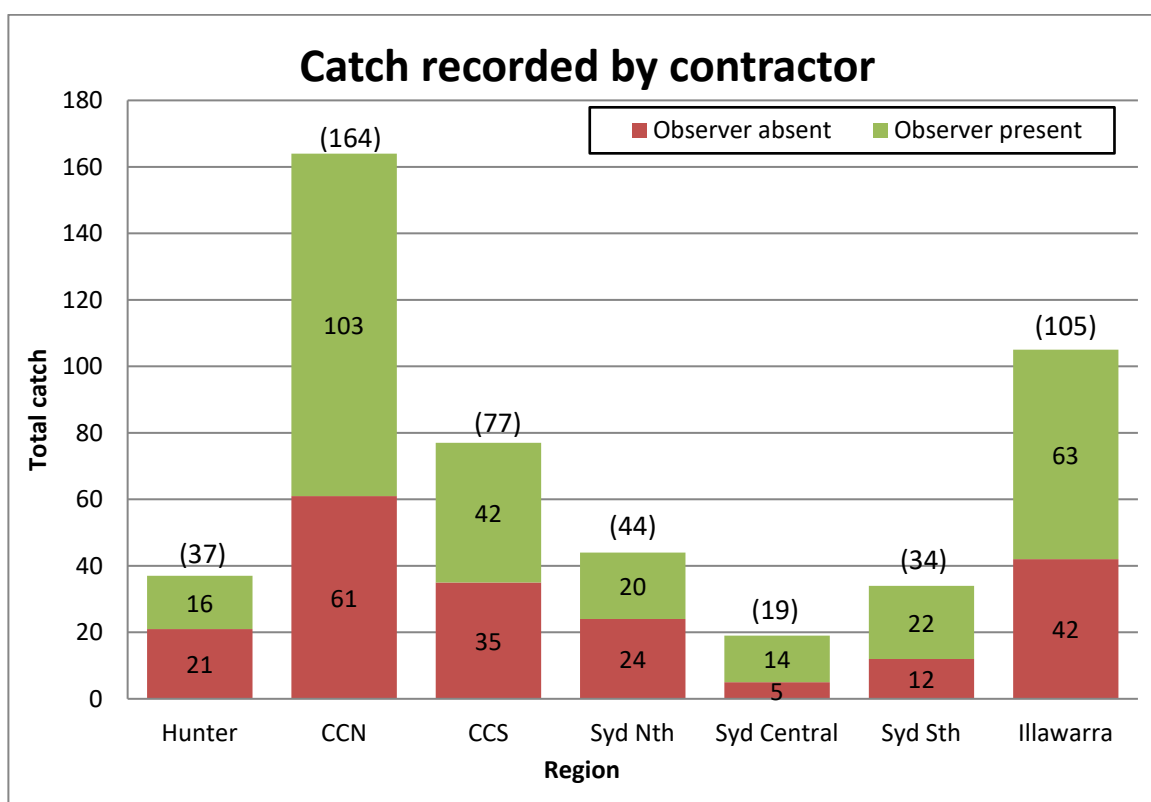
**Table 2** Total net inspections by region during 2019/20 meshing season.

Meshing Region	No. of net inspections	No. of net inspections with observer present	Percentage of net inspections observed
Hunter	723	220	30%
Central Coast North	721	286	40%
Central Coast South	728	330	45%
Sydney North	730	328	45%
Sydney Central	832	361	43%
Sydney South	832	368	44%
Illawarra	728	372	51%
<b>Total</b>	<b>5294</b>	<b>2265</b>	<b>43%</b>

### Outcomes of Observer Program

Outcomes of the Observer Program for the 2019/20 meshing season include:

1. Catches of target and non-target species taken in nets were certified by the observer where they were present at the time and included in monthly catch data sheets (records held by DPI Fisheries, Ourimbah).
2. The observers provided accurate details for all witnessed net inspections using iPhones equipped with a customised data recording application. All the data are uploaded and stored on the Fisheries Compliance Database. Figure 2 shows the catch numbers recorded by the contractors when an observer was present or absent.
3. Details for all marine mammals and reptiles captured in nets were reported to DPI and DPIE-EES via a monthly report.
4. Collection of 156 biological samples and 72 whole animals.



**Figure 2** Catch recorded by contractor when observer present or absent during 2019/20.

### 1.3 Compliance Plan

The Management Plan requires a Compliance Plan to be implemented as part of the SMP.

#### Audit and Compliance Checks in 2019/20

Compliance inspections were undertaken prior to and during the 2019/20 meshing season.

- Pre-season checks of the contractors' nets were conducted by the DPI Shark Meshing Observers and/or DPI Fisheries Officers. A small number of minor issues were detected during these inspections with all being rectified on the spot. All nets complied with current contract conditions prior to the commencement of the 2019/20 meshing season.
- Fisheries Officers physically inspected mesh nets off 34 of the 51 SMP beaches from offshore patrol vessels or on board the contractor's vessels.
- Fisheries Officers and the Shark Meshing Program Supervisor conducted several overt and covert inspections of the contractors' operations throughout the meshing season. Fisheries Officers were encouraged throughout the season to carry out random, thorough inspections of the mesh nets during their routine offshore patrol work. All inspections were recorded on smart devices using a customised data recording application. All the data are uploaded and stored on the Fisheries Compliance Database.

Table 3 displays the number of inspections by Fisheries Officers per region and whether the outcome was a 'comply' or 'non-comply' for the contracts.

**Table 3 Compliance data by region during 2019/20.**

Region	Pre-season		Meshing season		Inspection Count	% Comply
	comply	non-comply	comply	non-comply		
Hunter	16	-	4	1	21	95%
Central Coast North	16	-	-	1	17	94%
Central Coast South	16	-	3	-	19	100%
Sydney North	16	-	12	1	29	96%
Sydney Central	16	-	17	-	33	100%
Sydney South	16	-	14	-	30	100%
Illawarra	16	-	8	-	24	100%
<b>Total</b>	112	0	58	3	173	<b>98%</b>

Contractors are required to check their set nets every 72 hours weather permitting. This commitment was met on most occasions with 93% of set net inspections taking place within the 72-hour timeframe. The occasions where this requirement was not met, was due to severe weather conditions. The intention of the 72-hour inspection timeframes is to potentially increase the chances of survival of any marine life caught in the nets.

#### Overall compliance

Compliance with contractual arrangements must be greater than 80% under the Compliance Plan.

Compliance by all contractors exceeded 80% for the following tasks:

- The compliance rate for the size, length and marking of nets was 100%. Minor issues detected and rectified on the spot during the pre-season inspections of the contractors' nets were not recorded as non-compliance issues. The three non-compliance issues recorded during the meshing season (Table 3) involved floats being dirty on two occasions, and one net not being inspected correctly by the contractor (based on length of time the contractor was observed servicing the net by Fisheries Officers).
- The compliance rate for dolphin pinger and whale alarms presence and their placement on nets was 100%.



- The overall compliance rate by contractors was 98% in accordance with the Shark Meshing (Bather Protection) Program Compliance Plan, which specifies that the rate of compliance will be calculated on a per/100 basis (e.g. if there is non-compliance detected in one of every ten inspections the compliance rate will be recorded at 90%).
- The 98% compliance rate includes pre-season 'on land' net inspections, before the nets were set. A small number of minor issues were detected and immediately rectified during pre-season inspections and therefore not reported as non-compliance issues.
- The contractors must comply with a range of specifications under the contract outside of routine overt and covert inspections. During the 2019/20 meshing season all contractual requirements were met by all contractors, with no instances of non-compliance detected.

All non-compliance issues in 2019/20 were resolved to the satisfaction of the DPI Shark Meshing Supervisor.

#### **1.4 Strategic Research and Monitoring Program**

The Management Plan requires a Strategic Research and Monitoring Program to be implemented as part of the SMP. The purpose of the Strategic Research and Monitoring Program (SRMP) is to provide information that will lead to continuous improvement in the operation of the SMP and in achieving the objectives of the Management Plan.

- Table 4 provides details of the SRMP research topics and their current status.
- Table 5 provides the outcomes of the SMP Monitoring Program for 2019/20.

Table 4 SRMP Research Topics and Current Status.

Level 1: Identify information gaps and research needs	
Level and Topic	Status and Comment
1.1 Review and report on research and information needs, funding requirements and possible sources of funding.	<p>Status: <b>Complete</b></p> <p><i>Activities in 2019/20:</i> none</p> <p>Provided in the 2010/11 Report.</p>
Level 2: Data collection and review of existing data	
Level and Topic	Status and Comment
2.1 Review and refine data collection methods	<p>Status: <b>Ongoing.</b></p> <p><b>2.1.1: Review data collection methods used in the SMP.</b></p> <p><i>Activities in 2019/20:</i></p> <p>No change to data collection methods as onboard photography for species confirmation has proved efficient and effective.</p> <p><i>Previous:</i></p> <p>Data collection methods are regularly reviewed and adapted as technology and applicable uses are identified. Following the successful implementation of photographing each animal captured during the 2015/16 SMP season, this technique to confirm species identification continued during the period reported herein.</p> <p><b>2.1.2: Develop refined catch data forms and identification resources.</b></p> <p><i>Activities in 2019/20:</i></p> <p>Mobulid (Manta and Devil Ray) identification resources were updated.</p> <p><i>Previous:</i></p> <p>Catch data forms and instructions for use were dispensed at the pre-season training days for observers and contractors. New skate and ray, dolphin, and sea turtle identification aids was supplied to contractors in 2016/17, 2017/18, and 2018/19, respectively. These identification guides aim to assist in correct identification for the catch records at sea. Weekly catch reporting to the Shark Meshing Program Supervisor continued in the 2019/20 meshing season. The Hammerhead Shark identification guide developed by NSW DPI Fisheries was redistributed to all contractors.</p>

**Level 2: Data collection and review of existing data****2.1.3: Identify associated training programs for observers and contractors.***Activities in 2019/20:*

The most important training required for the 2019/20 meshing season for observers and contractors was reiterating tagging procedures for nominated shark species, especially regarding deployment of acoustic tags on the three target shark species and pop-up satellite archival tags (PSATs) on Grey Nurse Sharks. PSATs and acoustic tags were supplied to each contractor to ensure every opportunity of deployment on sharks released alive. The release of 41% of animals alive from the SMP nets highlights the relevance and importance of protocol reviews. Disentanglement procedures for non-target species from DPIE-EES were reviewed, and options for retrieval of dead Leatherback Turtles were discussed considering input from Dr Colin Limpus on potential methods to retrieve such large animals.

DPI received two new requests for samples during the reported year: (1) A request from the Macquarie University Neurobiology Lab for fresh eyes of Lamnid sharks (White and Mako sharks) and (2) a request from a University of Sydney PhD candidate for microbial swabs and parasites from six species of shark encountered in the SMP. The relevant research teams spent a necropsy day training the SMP observers how to safely excise a shark eye and prepare it for preservation, and how to take non-contaminated microbial samples and collect external parasite from sharks.

**2.2 Review genetic samples to compare with reported species identification.**

Status: **Ongoing.**

**2.2.1: Review shark genetic samples held by DPI and cross-reference with reported species identification.***Activities in 2019/20:*

No further review of reported catch using genetic identification was conducted during the period being reported on following the 100% correct identification of various Hammerhead Shark catches in the SMP as reported in the 2017/18 Annual Performance Report.

*Previous:*

General research has continued into molecular forensics for Hammerhead Shark captures in the SMP and led to analyses of species composition and reporting for the 2016/17 SMP season. The 100% correct identification of Hammerhead Shark species was reported on in the 2017/18 Annual Performance Report. Genetic samples are also used for longer term projects and are made available on request to researchers from around the world. The 100% record in correct species identification for Hammerhead sharks through the use of catch photography to confirm species ID and the ability to obtain good quality photographs and sharing via mobile phone technology for rapid confirmation by scientists has exceeded genetic technique capabilities for rapid confirmation of catch data accuracy.

**2.2.2: Identify associated training programs/resources for observers and contractors.***Activities in 2019/20:*

Although training of observers and contractors reiterated shark, ray, dolphin, and turtle identification accuracy, as per previous years, the training day for the 2019/20 shark meshing season particularly focused on species of the family Mobulidae (Manta and Devil Rays).

*Previous:*

Training of contractors and observers is designed to improve accuracy of catch identification. The use of the DPI publication '*Identifying Sharks and Rays, A Guide for Commercial Fishers*' was revisited during the pre-season training day for observers and contractors. Each contractor was provided with an updated copy of the identification book incorporating the new information added for groups of species identification and/or research project sampling protocols. Each observer was also issued with an updated version of our SMP Marine Species Identification Guide.



## Level 2: Data collection and review of existing data

### 2.3 Review data on temporal and spatial factors affecting the operation of the SMP.

Status: **Ongoing.**

#### **2.3.1: Review research being conducted on White Shark movements.**

##### *Activities in 2019/20:*

Sixty-six White Sharks were tagged by NSW DPI between 01 Sept 2019 and 01 May 2020, 14 of which were animals released from the SMP nets and the rest from SMART Drumlines as part of the NSW Shark Management Strategy, a separate program administered by NSW DPI Fisheries. Eight of these 14 SMP-released White Sharks were subsequently detected on acoustic listening stations administered through DPI Fisheries and/or the IMOS Animal Tracking Facility.

Tracking the movements of White Sharks along NSW beaches with drones found that they have relatively predictable patterns of slow ( $\sim 2.2\text{km}\cdot\text{hr}^{-1}$ ) movement parallel to the shoreline and typically behind the surfbreak (Colefax *et al.* 2020).

##### *Previous:*

DPI works closely with the CSIRO White Shark Project, supplying data from White Sharks caught in the SMP and data of tagged sharks detected on DPI arrays of underwater acoustic listening stations. Although the CSIRO research is yet to be finalised, the results of these studies to date show that the main aggregations of juvenile White Sharks in NSW occur north of Stockton Beach and therefore outside the SMP area of operation. Juvenile White Sharks appear to be resident in the Stockton Bight region from mid-August through early January, and resident in Victoria from January through April. A post-doctoral scientist working with the DPI shark scientists analysed White Shark movement data with CSIRO (Bruce *et al.*, 2019). These analyses will be incorporated in the analysis of White Sharks fitted with acoustic tags and released from SMART Drumline trials as part of the NSW Shark Management Strategy (SMS), and White Sharks tagged and released from the SMP. In September 2015, NSW DPI initiated a new \$16 million Shark Management Strategy (SMS) which incorporates tagging and tracking of the three target shark species (White, Tiger and Bull sharks). More than 450 White Sharks have been tagged since August 2015. The success of external deployment of acoustic tags by contactors on White Sharks released from the SMART Drumlines led to development of similar tags and tagging procedures to implement in the SMP during 2018/19. Seven White Sharks released alive from the SMP during 2018/19 were tagged with acoustic tags, and four individuals were detected post-tagging.

#### **2.3.2: Review existing data on other species (e.g. Tiger Shark, Bull shark).**

##### *Activities in 2019/20:*

There have been no substantial increases in knowledge or research on Tiger Sharks occurring in NSW during 2019/20 that would affect the operations of the SMP. Tiger Sharks released alive from the SMP are to be externally tagged with acoustic tags, as per procedures used by SMART Drumline contractors in northern NSW, but only one Tiger Shark was alive, tagged, and released from the shark nets during the 2019/20 season. Unfortunately, the contractor did not tag it with an acoustic tag, only with a conventional dart tag. Contractors were subsequently reminded that all White, Tiger and Bull Sharks were to be released carrying an acoustic tag.

During the 8-month reporting period 36 Tiger Sharks were tagged with acoustic tags as part of the NSW SMS. Two individuals were also equipped with pop-up satellite archival tags (PSATs). To date sixteen Tiger Sharks carrying PSATs will provide data about movements and potential risk to bathers in NSW waters.

Bull Shark movement research continued in 2019/20 with four individuals acoustically tagged during the meshing season. A total of 155 Bull Sharks are currently acoustically tagged by NSW DPI Fisheries. The data has been used to determine the factors driving Bull Shark movements, leading to publication of two scientific manuscripts during the past year: one publication details long-term patterns of abundance, residency and movements of Bull Sharks in Sydney Harbour (Smoothey *et al.*, 2019) and highlights the role of water temperature in predicting seasonal movements and return to this estuary, suggesting increased water temperatures as a result of climate change may lead to higher shark abundance and possibly longer periods of residency in Sydney Harbour, potentially increasing risk of shark bites and increased catch in the SMP nets in years ahead. The second publication

**Level 2: Data collection and review of existing data**

examined environmental factors affecting Bull Shark movements and abundance along the south-east coast of Australia (Lee *et al.*, 2019). This research highlights the role of philopatry to estuaries, but also that Bull Sharks use mid-shelf habitats between 20m and 60m depth. This may be a reason why catch numbers are relatively small in the SMP. Bull Sharks were detected in sub-tropical waters almost year-round, but in higher latitudes (where the SMP operates) only during the austral summer and autumn. Smaller sharks (<2m total length) have longer residency times in estuaries whilst sea surface temperature (SST) regulated residency time. Peak Bull Shark abundance occurs when SST is 24°C and Chlorophyll *a* is low. These results contribute to enabling prediction of when Bull Shark abundance may be greater, helping management authorities deploy appropriate mitigation strategies for human-shark interactions with this species.

*Previous:*

There have been no substantial increases in knowledge or research on Tiger Sharks occurring in NSW that would affect the operations of the SMP; however, SMP samples did contribute to the first study of population structure and connectivity of Tiger Sharks for the east coast of Australia (Holmes *et al.*, 2017). This study indicated that there was no genetic structuring within the Indo-Pacific Ocean basin. Small annual Tiger Shark catch in the SMP is unlikely to substantially affect the viability of this large homogeneous east Australian population. These results corroborate the findings of large-scale movements of tagged Tiger Sharks in eastern Australia with individuals of all size classes moving between the SMP region, southern Queensland and New Caledonia (Holmes *et al.*, 2014). A manuscript examining environmental effects on shark catches in the SMP has been published in the scientific journal Marine Ecology Progress Series (Lee *et al.*, 2018) but Tiger Shark catches were too small to develop mathematical models of their catch in relation to seasonal, spatial, or environmental correlates.

DPI has continued Bull Shark movement research using acoustic tags and over 700 listening stations that DPI has established along the NSW coast. Results have been displayed at both the Sydney Aquarium and National Maritime Museum and have been presented at various scientific symposia and workshops and in the public media via several presentations and television documentaries. A scientific manuscript detailing patterns of occurrence of sharks in Sydney Harbour was published in 2016 in the international journal, PLOS ONE (Smoothey *et al.*, 2016). The number of tagged Bull Sharks is increasing as a result of the tagging research component of the Shark Management Strategy with all tagged target sharks being reported in real-time via the 21 VR4G listening stations moored off beaches along the coast of NSW. Analyses of tagged Bull Shark movements and habitat use in relation to life history stage and environmental conditions will considerably enhance our understanding of factors affecting bather safety from potential shark interactions.

In an effort to increase cross-jurisdictional collaboration and understanding of large-scale movements of Bull Sharks, DPI scientists are collaborating with Queensland shark scientists tagging and tracking Bull Sharks. This collaboration has revealed that Bull Sharks tagged by DPI in the Sydney region are travelling beyond Townsville, while Bull Sharks tagged in Queensland are likely to travel into the SMP region. This collaboration has resulted in publication of a manuscript in the scientific journal Frontiers in Marine Science (Heupel *et al.*, 2015) with a second manuscript submitted.

**2.3.3: Review existing data on spatial and temporal movements of non-target species.***Activities in 2019/20:*

A PhD on Broadnose Sevensharks (*Notorynchus cepedianus*) was completed through University of Tasmania (Schmidt-Roach, 2018). Acoustic tracking data indicate that both neonate and other life-stages tagged in Port Philip Bay, Victoria, travel to NSW and Tasmania. These results corroborate their genetic findings that there is likely a single population for the south-east coast of Australia. Genetic material collected from the SMP will contribute to publication of these data. These results imply that few catches of this species in the SMP is likely to have minimal impact on the population viability of Broadnose Sevensharks.

Several projects linked to the NSW DPI testing of drone technology as an aerial surveillance tool for mitigating shark interactions have led to publications incorporating abundance and distribution of non-target species (Kelaher *et al.*, 2019; Tagliafico *et al.*, 2019), but these studies were not within the SMP region.

**Level 2: Data collection and review of existing data***Previous:*

The scientific literature on spatial and temporal movements of non-target species is reviewed where possible given available resources. A study using the SMP catch data to investigate ecological and environmental drivers for juvenile Smooth Hammerhead Shark distribution in temperate NSW was completed as a chapter in a Master's Degree through the University of Newcastle (Wray-Barnes, 2017). This new information will not affect the operation of the SMP.

**2.4 Review data on shark interactions and beach usage.**

Status: **Ongoing.**

**2.4.1: Access / review data collection by various organisations**

DPI cross-references data held by the Australian Shark Attack File and the International Shark Attack File to report on any incidents associated with meshed beaches.

**Number of sharks sighted by Surf Life Saving (SLS) NSW**

Shark sightings								
Region	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Hunter	21	33	60	28	8	1	4	18
Central Coast	12	38	29	24	1	3	0	8
Sydney	46	46	46	58	8	1	9	25
Illawarra	3	7	4	7	0	1	0	3
Total	82	124	139	117	17	6	13	54

A decline in the number of shark sightings in the SLSNSW database between 2016/17 and 2018/19 reflects a change in the way SLSNSW records shark sightings on patrolled beaches. This was because the number of reported sightings impacted the incident management process within the State Operations Centre (SOC). Patrollers and the general public, presumably following heightened awareness from media focus, were communicating several **unconfirmed** sightings daily. As a result, SLSNSW started recording only sightings where a lifesaver or lifeguard was able to confirm the presence of a shark by a second sighting.

The increased number of shark sightings for the period in this report reflects the use of drones by SLSNSW to conduct aerial surveillance over patrolled beaches in NSW as part of the three years of trials for this technology. This increase is unlikely to represent an increase in sharks along NSW beaches, but more likely to highlight the value of drone aerial surveillance in detecting sharks (Butcher *et al.*, 2019).

**2.4.2: Review data on beach usage rates and future usage predictions.**

From 2006 to 2036 the NSW population is projected to grow by over 2.3 million due to natural increase and net overseas migration, while Sydney's population is projected to grow by 1.7 million people (DECCW, 2009). An increase in beach usage in the area of the SMP is expected into the foreseeable future given these predictions and recent data collected by SLS NSW.

SLS NSW provided the following beach visitation figures for the past ten years for the regions listed. The recorded beach visitation is the combined total of attendance as assessed in the morning at the start of each patrol, the mid patrol point (1pm) and in the evening at the end of each patrol for

**Level 2: Data collection and review of existing data**

the period 25 September to 25 April of the next consecutive year. The summer beach visitation within the area of the SMP over the last ten years averaged over 5 million people per annum. The slight drop in beach attendance in 2019/20 may be related to reduced outdoor activities and travel in the latter months of this period as a result of government initiatives to reduce the spread of COVID-19.

Visitations										
Region	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Hunter	152,788	286,798	360,549	741,444	690,343	728,803	764,529	729,592	714,965	656,794
Central Coast	295,034	412,764	1,095,724	1,260,034	1,241,243	1,145,309	1,173,890	736,021	1,182,741	943,798
Sydney	2,051,599	1,783,692	2,483,113	3,488,837	3,897,491	3,681,255	3,743,419	3,526,008	4,679,380	2,970,793
Illawarra	82,543	105,273	132,628	304,703	392,447	363,194	380,299	343,473	297,351	252,013
<b>Total</b>	<b>2,581,964</b>	<b>2,588,527</b>	<b>4,072,014</b>	<b>5,795,018</b>	<b>6,221,524</b>	<b>5,918,561</b>	<b>6,062,137</b>	<b>5,335,094*</b>	<b>6,874,437</b>	<b>4,823,398</b>

\* Patrol period for 2017-2018 was between the 23 September to 29 April

NSW DPI supported research into unmanned aerial vehicle applicability for marine and coastal research has demonstrated that drones are an effective assessment tool to quantify beach users across a range of environmental conditions and thereby improve coastal management decisions (Provost *et al.*, 2019). NSW DPI have supported SLSNSW with drones and training of lifesavers and it is envisaged that these will be used for beach management purposes, including beach counts, as well as water safety.

**2.5 Review effectiveness of fishing operations used in shark control programs**

Status: **Ongoing.**

**2.5.1: Review NSW shark meshing net configurations.***Activities in 2019/20:*

Analysis of catch trends in the far north coast shark net trials has been completed and published as Broadhurst and Cullis (2020). They conclude that nets should be checked every 72-96 hours to optimise efficiency for target species whilst minimising the absolute mortality of rays. This implies that no changes in the current JMA are required regarding regularity of checking the SMP shark nets.

*Previous:*

Amendments to net configurations would be outside the scope of existing contracts for the SMP, however, further research on SMP net configurations will be undertaken pending contractor cooperation.

## Level 2: Data collection and review of existing data

**2.5.2: Review the application of other shark control measures for use in NSW (e.g. drumlines).***Activities in 2019/20:*

The NSW Shark Management Strategy has continued trialling alternative non-lethal shark bite mitigation measures, including SMART Drumlines (SDLs) which are designed to alert contractors as soon as a shark is captured on the gear (<https://www.dpi.nsw.gov.au/fishing/sharks/management/smart-drumlines>), thereby reduce marine wildlife mortalities whilst providing bather protection. The SMP scientist assisted colleagues in Reunion Island with analysis and drafts of a manuscript assessing the impact of SDLs (baits) on movement and abundance of Bull Sharks and found no evidence that Bull Shark nearshore presence was linked to the deployment of SDLs and their baited hooks (Guyomard *et al.*, 2020). This is an important finding as historically there has been concerns in many sectors of beach going public that the presence of baits would attract target sharks inshore. These results support use of drumlines (SMART Drumlines or traditional drumlines, as used in QLD and South Africa) to capture sharks already within the area without attracting them from further away and increasing the risk to beachgoers.

*Previous:*

The SMP scientist was involved in a study analysing data from Reunion Island, the 'home' of SMART Drumlines which highlighted the benefit of this technology in reducing impact of non-target species in coastal shark-control programs when using SDLs (Guyomard *et al.*, 2019). These results, plus those from the far north coast of NSW where SDLs were compared to shark nets in two 6 month trials (<https://www.sharksmart.nsw.gov.au/shark-nets>) led to a proposal to extend trials of SDLs within the SMP region (see Section 2.5.3 below).

Representatives from SharkSafe Barrier™ technology, a product developed to simulate kelp forest but including barium-ferrite permanent magnets (O'Connell *et al.*, 2017), met with NSW DPI to discuss potential sites to conduct a trial in NSW; however, no agreement was reached. Since that meeting, research has indicated that White Sharks will enter kelp forests while foraging (Jewell *et al.*, 2019) implying that this technology may not have the barrier efficacy initially believed.

The DPI shark scientist has over 30 years of experience in electro-repelling of sharks and regularly reviews any new technologies that may assist in developing non-lethal shark control measures. All data to date suggests that the electric shark repelling technology presently available may be of limited effectiveness in NSW coastal waters; however, collaboration with the KwaZulu-Natal Sharks Board (KZNSB, South Africa) has been ongoing with the aim to test their newly developed electric cable in NSW waters. Representatives from the KwaZulu-Natal Sharks Board and Ocean Guardian met with SMP representatives during May 2019 to discuss potential sites to trial a new electric cable barrier for sharks; however, the KZNSB subsequently opted to run trials of their prototype off Western Australia beaches.

The use of drumlines is not currently permitted under the operation of the SMP through the JMA and Management Plan, which prohibit contractors from using baits or lures. The DPI Shark Scientist has however remained in regular contact during 2018-19 with colleagues in both Brazil and Reunion to keep updated on the success of shark attack mitigation products such as the new 'Catch-A-Live'™ drumline system being developed by the Reunion Island Regional Committee for Sea Fisheries and Aquaculture (CRPMEM) (Perry *et al.*, 2014; Guyomard *et al.*, 2019). This technology has been rebranded as the SMART (Shark Management Alert in Real Time) drumline under the NSW Shark Management Strategy and has been successfully tested in estuarine and coastal waters with no turtle or marine mammal bycatch fatalities during initial trials. The SMART drumlines did successfully capture Bull, Tiger and White Sharks of different sizes (largest was a 3.6m White Shark) as part of scientific testing of this technology. The SMART drumline trials on the NSW far north coast were extended by another 18 months in 2018 and will continue until 30 June 2020. All sharks captured, tagged, and translocated offshore before release have subsequently been detected via their tag, indicating they survived the process of capture and release from the SMART Drumlines.

## Level 2: Data collection and review of existing data

**2.5.3: Use the outcomes of those reviews to trial gear-related modifications of the SMP.***Activities in 2019/20:*

SMART Drumline (SDL) trials were continued off some of the SMP beaches during 2019 in both the Newcastle and Sydney regions (<https://www.sharksmart.nsw.gov.au/technology-trials-and-research/smart-drumlines>). As per the NSW far north coast trials, these SDLs were positioned adjacent to the existing SMP nets to enable comparison of catch between the two fishing gears (see table below).

**SMART Drumline versus SMP shark net trials in 2019**

	February				March				April				September				October				November				Total
	Net		SD		Net		SD		Net		SD		Net		SD		Net		SD		Net		SD		
Species	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D	
Australian Cownose Ray					2				3	1									1					7	
Broadnose Sevengill Shark														1				1						2	
Bronze Whaler													1	2	3		1	1	2				1	11	
Common Blacktip Shark				1		1																		2	
Common Dolphin														1										1	
Dusky Whaler			5				5				1								3			1	2	17	
Eastern Angel Shark									1									1				1		3	
Green Turtle														1				3						4	
Grey nurse Shark													1	1			1					1		4	
Indo-Pacific Bottlenose										1												1		2	
Leatherback Turtle					1																			1	
Loggerhead Turtle		1																						1	
Port Jackson Shark																	1							1	
Scalloped Hammerhead						1																		1	
Shortfin Mako							1								1				1			1	1	1	6
Smooth Hammerhead						3	1	1		1				2				2						10	
Smooth Stingray																	2							2	
Southern Eagle Ray									1					1			1	1				6		10	
Spinner Shark						1																		1	
Thresher Shark														1										1	
Tiger Shark											1												3	4	
Unidentified Whaler			1																					1	
White Shark										2			1	1	1			2	7		1	1	4	20	
Yellowtail kingfish																	1							1	
Grand Total		1	6	1	3	6	7	1	5	5	2		3	11	5		6	12	13		8	6	11	1	113

\* A- Released Alive

\* D - Dead

Although the overall number of animals caught was similar between nets and adjacent SDLs (66 vs 47, respectively), the significant difference is in the direct capture of the three 'target shark' species by SDLs (34%) versus nets (12%). Additionally, 94% of animals caught on SDLs were released

**Level 2: Data collection and review of existing data**

alive, whereas 38% were released alive from the shark nets adjacent to the SDLs. Although overall catch of target sharks in this trial was small, with no Bull Sharks caught in either gear type and no Tiger Sharks in the nets, the results underscore the value of using SDLs as a shark bite mitigation measure.

SMART Drumlines in NSW appear to catch small numbers of Bull Sharks, yet in Reunion Island they are effective in catching this species. The NSW gear configuration is slightly different to Reunion in that the baits are set 3m from the surface, whereas in Reunion the baits are on the seabed. Additionally, SDLs are set within daylight hours, whereas in Reunion they are set over a full 24-hour period. NSW DPI therefore initiated a night-set trial of SDLs in Sydney Harbour. Unfortunately, the outbreak of COVID-19 led to this trial being ceased before any Bull Sharks were caught. However, SDL contractors on the NSW far north coast have been supplied with different snood lengths to test whether the position of bait in the water column does affect capture rates of target shark species. This trial will continue for the foreseeable future.

*Previous:*

DPI representatives participated in a stakeholder meeting during 2014-15 to discuss new alternative technologies to the currently used shark mesh nets. Although several new technologies were highlighted as potential candidates for replacing shark nets, these have not been scientifically tested in a robust manner, either against free-ranging sharks nor the large surf frequently encountered off the NSW coast. Following the NSW Government announcement of support for investigations into alternative methods to mitigate shark attack, an independent review of currently available technologies was conducted by Cardno Pty Ltd

[https://www.dpi.nsw.gov.au/data/assets/pdf\\_file/0011/578999/cardno-review-of-bather-protection-technologies.pdf](https://www.dpi.nsw.gov.au/data/assets/pdf_file/0011/578999/cardno-review-of-bather-protection-technologies.pdf)

This independent review was followed by a stakeholder workshop to identify potential candidate technologies that may be trialled off NSW beaches in future. The NSW Shark Management Strategy was subsequently announced by the NSW Government which has incorporated testing of several innovative approaches to provide the most effective shark attack mitigation measures at NSW beaches

<https://www.sharksmart.nsw.gov.au/technology-trials-and-research>

Following the successful trials of SDLs on the NSW far north coast and their reduced impact on non-target species while still catching target sharks SMART Drumlines were deployed for 3 months, from February to April 2019, in three of the SMP regions (Hunter, Sydney North and Sydney Central) during 2018/19. Although catches were low and precluded statistical scientific analysis comparing catch between the SDLs and shark nets, results highlighted the benefits of SMART Drumlines over nets particularly regarding non-target species catch. The envisaged trials of this technology for a second period within the SMP region were initiated during 2019 and reported on above.

**2.6 Develop methodologies for standardising fishing effort and analysing comparative CPUE data.****Status: Completed****2.6.1: Investigate the feasibility of standardising soak-times for shark nets.**

Soak times were standardised in 2014/15 as part of the season contracts with contractors required to check their set nets every 72 hours weather permitting. These standardised procedures were continued throughout the 2019/20 season.

**2.6.2: Develop alternative approaches to standardised soak-times.**

No alternative approaches were developed.



## Level 3 Establish/support collaborative research (e.g. CSIRO, other government agencies and universities)

Level and Topic	Status and Comment
<b>3.1 Research needs identified (e.g. environmental impacts of shark meshing).</b>	<p>Status: <b>Ongoing</b></p> <p><b>3.1.1: <i>Distribution, abundance, biology and ecology of target species affected by the SMP.</i></b></p> <p><i>Activities in 2019/20:</i></p> <p>The University of Sydney PhD on white shark foraging ecology continued to collect stomach and isotope samples from SMP-caught animals. Analysis of stomach contents has been completed and are being prepared for publication.</p> <p>One of the PhDs linked to the NSW Shark Management Strategy has been investigating the role of cetaceans, especially whales, in the abundance and distribution of White Sharks.</p> <p>The Macquarie University PhD entitled 'Sharks in the Anthropocene' includes research into determining drivers for movements of Bull and Tiger Sharks using telemetry, plus the use of isotopes to determine ontogenetic changes in foraging strategies of Bull Sharks.</p> <p>Two NSW DPI manuscripts on Bull Shark abundance and distribution were published during the past year: Lee <i>et al.</i> (2019) and Smoothey <i>et al.</i> (2019).</p> <p>Two manuscripts investigating pollutant levels in animals caught in the NSW Shark Management Strategy trials of nets on the far north coast have been published during the past year (Cagnazzi <i>et al.</i>, 2019a &amp; b) and indicate that persistent organochlorine pollutants may have negative effects on longer-term health of large sharks such as Bull and White Sharks sampled. These sharks also exhibited levels of mercury concentrations in the muscle that exceeded thresholds potentially damaging biomechanical processes, whilst arsenic and cadmium levels were within the range previously shown to have negative effects including potential deformity of embryos (Cagnazzi <i>et al.</i>, 2019a). These findings validate the importance of continuing research into pollutants and their potential impact on the life history of large sharks in NSW, such as being undertaken through Griffith University using samples from the SMP.</p> <p>Parasite samples from sharks caught in the SMP, plus live animals caught in NSW DPI research activities, continue to contribute to a PhD through the University of Sydney.</p> <p><i>Previous:</i></p> <p>The NSW Research Attraction &amp; Acceleration Program (RAAP) funding to NSW IMOS has allowed several analyses to determine environmental factors driving abundance, distribution and movements of target shark species in NSW coastal waters (Lee <i>et al.</i>, 2018, Lee <i>et al.</i>, 2019).</p> <p>The PhD on White Shark foraging ecology used data from stomach and isotope samples collected from SMP-caught animals to win the 'best poster' award at the University of Sydney annual Higher Degree Showcase (Grainger <i>et al.</i>, 2019).</p> <p>Population genetics for White Sharks has been boosted by the new innovative techniques of close-kin genetics developed by CSIRO and in which samples obtained through the SMP have played a key role (Hillary <i>et al.</i>, 2018). Genetic relatedness reveals total population size of White Sharks in eastern Australia and New Zealand. This study is currently the world's leading effort to ascertain population size for this species. Genetic samples from SMP-caught animals continue to be collected to assist these CSIRO-led studies in further attempts using next-of-kin genetics (cousins and aunts/uncles) to determine whether the population is stable, increasing or decreasing.</p> <p>Collaborative research initiatives have been established with the CSIRO White Shark Research Project investigating inter-annual variability in White Shark presence on the NSW coast using microchemistry of vertebrae. This collaboration led to completion of a BSc (Hons) thesis through the University of Technology entitled: 'Age, growth and movement signatures of the White Shark (<i>Carcharodon carcharias</i>) in southern Australia'. This research is being prepared for publication in a scientific journal.</p>



**Level 3 Establish/support collaborative research (e.g. CSIRO, other government agencies and universities)**

Following on from the first estimation of effective population sizes for Australian White Sharks (Blower *et al.*, 2012), collaboration with CSIRO using samples from White Sharks caught in the SMP has led to a novel technique to estimate the total population size for eastern Australia and New Zealand using close-kin mark-recapture via genetic methods (Hillary *et al.*, 2018).

The PhD on White Shark foraging ecology has led to several conference presentations and one publication in 2018 (Grainger *et al.*, 2018, 2019; Machovsky-Capuska *et al.*, 2019).

An analysis of environmental, spatial and temporal influences on the occurrence of White Sharks along the NSW coast using tagged animal data collected from VR4G listening stations as part of the NSW Shark Management Strategy was presented at the Sharks International Conference in 2018 (Spaet *et al.*, 2018).

Samples from White Sharks caught in the SMP have also contributed to a Southern Cross University study in 2014-15 investigating levels of metal and metalloid pollution in sharks (Gilbert *et al.*, 2015b) and polychlorinated biphenyls (PCBs) (Gilbert *et al.*, 2015a).

In collaboration with Macquarie University, aerial surveys were conducted between Seal Rocks and Stockton which represent the nursery grounds for White Sharks on the Australian east coast. These surveys were primarily focused on determining effective aircraft speed for marine wildlife surveys, but data will contribute to the CSIRO and University of Technology Sydney aerial survey database. This work led to a MRES degree being awarded with Distinction (Dupont, 2016).

Collaboration is ongoing with the South East Queensland Tiger Shark Research Project being conducted through the University of Queensland and the Queensland Department of Primary Industries (QDPI). Vertebrae from Tiger Sharks caught in the SMP have contributed to an investigation into the age and growth of Tiger Sharks for eastern Australia (Holmes *et al.* 2015). The specialist fish ageing facilities of DPI have been pivotal in this study. Samples from NSW have contributed to an understanding of the population structure and connectivity of tiger sharks across the Indo-Pacific Ocean basin (Holmes *et al.*, 2017).

The DPI research project investigating the ecology and movements of Bull Sharks in NSW has described the patterns of occurrence of sharks in Sydney Harbour (Smoothey *et al.*, 2016) and forged strong links with researchers from Griffith University, James Cook University and QDPI, leading to one published manuscript (Heupel *et al.* 2015) and several international conference presentations. A second submitted manuscript investigates seasonal linkages of bull sharks using network analysis of telemetry data (Esponiza *et al.*).

Research projects investigating whaler (Dusky, Spinner and Blacktip) sharks in NSW and Queensland waters are ongoing with collaborations via Macquarie University, James Cook University, Southern Cross University, Carleton University (Canada), New England Aquarium, and QDPI (Geraghty *et al.*, 2013; Geraghty *et al.*, 2014; Barnes *et al.*, 2016; Butcher *et al.*, 2016; Pleizer *et al.*, 2015).

A study investigating age, growth and movements of Shortfin Mako sharks was completed in 2014-15 through collaboration with UTS, CSIRO and SARDI (Kanyasi 2014).

***Distribution, abundance, biology and ecology of non-target species affected by the SMP.******Activities in 2019/20:***

Samples for Great Hammerhead Sharks (*Sphyrna mokarran*) caught in the SMP contributed to research in collaboration with colleagues at Newcastle University investigating resource use this species off eastern Australia. This work has now been published as Raoult *et al.*, (2019).

All necropsies of marine mammals and sea turtles caught in the SMP were conducted by veterinary pathologists from the Taronga Zoo. Catch data for marine mammals continues to contribute to the Australian Registry for Wildlife Health database administered by the Taronga Zoo.

All deceased Grey Nurse Sharks are retrieved whole and contribute to the ongoing NSW DPI Fisheries research program on this species.

Deceased Australian Cownose rays (*Rhinoptera neglecta*) and Southern Eagle Rays (*Myliobatis australis*) were retained for examination by a new Master in Research project through Macquarie University.

**Level 3 Establish/support collaborative research (e.g. CSIRO, other government agencies and universities)**

Seven Grey Nurse Sharks released alive from the shark nets were tagged with pop-up satellite archival tags (PSATs) (see Table below). There appears to have been a manufacturing failure in an entire batch of PSATs that affected tags deployed both in the SMP and on sharks tagged through the Shark Management Strategy. However, several of the tags were recovered after washing ashore. Overall, only one tag was silent post-release while a second one was recovered but data are unavailable due to this fault. Two of the seven released sharks are known to have died after release (see Table below). Of the three sharks that are known to have survived, one had a PSAT that transmitted data while another two tags were recovered and will provide full track data to be incorporated into the database of historical NSW DPI Grey Nurse Shark projects.

**Summary table of Grey Nurse Shark PSAT deployments**

Date Tagged	Tag #	Tag Location	Date Tag Released	Location Tag Released	Result
06.09.19	84921	Stockton	06.12.19	Unknown	Tag recovered - time at depth varied significantly over 90 days, individual <b>survived</b>
27.09.19	84910	Copacabana	30.09.19	Copacabana	Tag recovered – time at depth varied significantly over 5 days, <b>likely survived</b> . Pin intact, anchor dislodged possibly due to shallow tag application
20.12.19	84915	North Avoca	22.12.19	Avoca	Tag recovered – spent 100% of time soaking at 20m, <b>likely deceased</b>
13.01.20	84919	Garie	-	-	Tag not activated and not recovered – tag from batch that were found to have faulty batteries
28.01.20	84912	Bondi	09.02.20	Malua Bay	Tag not recovered – time at depth varied significantly over 12 days, <b>likely survived</b> . Pin intact, anchor dislodged possibly due to shallow tag application
02.03.20	84929	Stockton	-	Hunter River Mouth	Tag release date unknown. Tag not recovered. 100% of time soaking at 20m, <b>likely deceased</b>
12.04.20	84920	Umina	17.04.20	Unknown	Tag recovered – unable to extract data as tag was from batch that were found to have faulty batteries

*Previous:*

Genetic samples of Grey Nurse Sharks caught in the SMP contributed to a new estimate of the effective population size for the endangered east Australian stock for this species (Reid-Anderson *et al.*, 2019). The low estimated effective number of 400 breeders in the population highlights the need to effectively conserve this species and reduce human-induced impacts on the population such as mortalities from fishing activities, including the SMP. As such, the SMP has initiated a program to tag released Grey Nurse Sharks with pop-up satellite archival tags (PSATs) to determine the post-release survivorship of these animals. Due to late arrival of the PSATs only one Grey Nurse shark was tagged during the 2018/19 season. This shark was released from Bondi and seen and filmed off the Long Reef, Dee Why, aggregation site 18 km away by one of our PhD students 47 days after release. The shark was swimming strongly with no evidence of distress due to the PSAT. The PSAT popped off and surfaced after 107 days. Unfortunately, this occurred during a strong weather front with powerful winds and >3m swell. As a result, the tag was not able to establish a strong connection with the overhead ARGOS satellites and no accurate location was provided. Unfortunately, this inclement weather precluded attempts to retrieve the tag at sea and it was last heard of travelling south off Jervis Bay. The weather also impeded the number of successful data uploads to satellite, but data collected will contribute to the NSW DPI Fisheries database on Grey Nurse Shark movements. It is particularly pleasing that these data indicate that this shark survived capture and release from the Bondi shark net.

**Level 3 Establish/support collaborative research (e.g. CSIRO, other government agencies and universities)**

Samples for Great Hammerhead Sharks (*Sphyrna mokarran*) caught in the SMP are contributing to a new research program through Newcastle University investigating the trophic ecology and geographic patterns of this species. A manuscript is being prepared for submission to a scientific journal.

Genetic samples from Dusky Whaler Sharks (*Carcharhinus obscurus*) caught in the SMP have contributed to a national-scale comparative study of population genomics of Sandbar and Dusky whaler sharks caught in Australian fisheries (Junge *et al.*, 2019). Dusky Shark tissue samples from the NSW SMP have also been included in genetic research into the effective population size of dusky sharks as part of NSW DPI investigations into the NSW large shark commercial fishery through support of the FRDC on behalf of the Australian Government (Blower *et al.*, 2019).

All deceased Grey Nurse Sharks are retrieved whole and contribute to the ongoing NSW DPI Fisheries research program on this species.

The Spinetail Devil Ray caught during the reported period was sampled by Mobulid researchers from the Sydney Institute of Marine Science and Okeanos Research Centre of the University of the Azores, Horta, Portugal.

Although non-target species have not formed the focus of DPI research efforts to date, research into Wobbegong Shark distribution, ecology and movements has been conducted in collaboration with Macquarie University, Sydney Aquarium and NSW OEH. Two wobbegong shark collaborative manuscripts were published in 2014-15 (Lee *et al.*, 2014; Lee *et al.*, 2015).

Research into Australian Cownose Rays (*Rhinoptera neglecta*) and Southern Eagle Rays (*Myliobatis australis*) was initiated through Macquarie University, however low sample numbers due to the high release of live animals caught in the SMP led to postponement of this Masters degree.

Research initiated through Newcastle University investigating Smooth Hammerhead (*Sphyrna zygaena*) biology and fishery interactions as this species represents one of the highest shark catch species in the SMP. The catch data were presented at the scientific conference 'Sharks International', held in South Africa in 2014. An M.Phil was awarded (Wray-Barnes, 2017) and chapters are being prepared for publication.

Genetic samples of Smooth Hammerhead Sharks (*Sphyrna zygaena*) caught in the SMP contributed to a study of the global genetic population structure of this species (da Silva Ferrette, *et al.*, 2018 - Poster presentation ID69 at Sharks International 2018, 3-8 June 2018, João Peso, Brazil).

SMP samples contributed to research into better understanding processes involved in growth of sharks and the laying down of cartilage during this process (Raoult *et al.*, 2018).

Research into the fishery, biology and ecology of Australian Angelsharks through Macquarie University has provided new information for Australian Angelsharks in NSW that will be of direct relevance to the SMP (Raoult *et al.*, 2016).

The DPI shark scientist has been involved in advising on some Macquarie University cetacean research initiatives and, in collaboration with Macquarie University and OEH, has been involved in research into the efficacy of whale alarms on shark nets (Harcourt *et al.*, 2014; Pirota *et al.*, 2016). As an international expert on acoustic dolphin deterrents (ADDs) popularly known as 'pingers' and previous member of the international World Wildlife Fund (WWF) Cetacean Bycatch Task Force, the DPI shark scientist has assisted in reviewing the efficacy of pingers in reducing dolphin bycatch in the South African shark nets in collaboration with the KwaZulu-Natal Sharks Board. The results of this work have been reviewed with respect to implications for the SMP leading to the deployment of alternative (70kHz) pingers in the NSW shark nets. These 'new' pingers have recently been designed to be more targeted to the hearing range of dolphins, rather than the historically available 10kHz pingers that were originally designed for porpoises. Additionally, the DPI shark scientist has assisted in trials of an alternative active acoustic device, the DDD pinger, in the experimental shark nets off the NSW far north coast. Results from these trials will be assessed for potential transfer to the SMP.

Catch data for marine mammals has contributed to the National Assessment of Cetacean Entanglements in Fishery Gear in Australia (Tulloch *et al.*, 2019).

**Level 3 Establish/support collaborative research (e.g. CSIRO, other government agencies and universities)**
**3.2 Establish DNA library of shark species taken in the SMP to improve accuracy of identification.**

Status: **Ongoing**

**3.2.1: Conduct collaborative research with relevant research institutions.**

*Activities in 2019/20:*

No new collaborations for genetic analysis were established during the past year, but samples were collected to contribute to the CSIRO-led studies using next-of-kin genetics (cousins and aunts/uncles) to determine whether the east Australian population of White Sharks is stable, increasing or decreasing. Similarly, genetic samples for Broadnose Sevengill Sharks were collected for incorporation into a larger analysis of population structure of this species in Australia.

*Previous:*

SMP-caught Greynurse Shark genetic samples were included in the first determination of effective population size for the east Australian stock of this critically endangered species (Reid-Anderson *et al.*, 2019).

An analysis of historical DNA samples taken from sharks caught in the SMP has been completed in collaboration with Macquarie University in 2010. Since then, DNA samples from sharks caught in the SMP have been incorporated in studies investigating east coast stock structure of various whaler sharks in collaboration with the University of Adelaide, Macquarie University, University of Queensland and James Cook University. Genetic samples from Dusky Whaler Sharks (*Carcharhinus obscurus*) caught in the SMP have contributed to a national-scale comparative study of population genomics of Sandbar and Dusky whaler sharks caught in Australian fisheries (Junge *et al.*, 2019). Dusky Shark tissue samples from the NSW SMP have also been included in developing a new modelling tool, NeOGen, to determine effective population size for sharks (Blower *et al.*, 2019).

Studies into Smooth Hammerhead Shark stock structure have been made by UQ and UNIFESP (Brazil). Collaboration has been initiated with UTAS and JCU to conduct genetic analysis of Seven-gill Sharks. Genetic samples of Smooth Hammerhead Sharks (*Sphyrna zygaena*) caught in the SMP contributed to a study of the global genetic population structure of this species (da Silva Ferrette, *et al.*, 2018) and this work is now being prepared for publication.

The world's first population assessment for White Sharks using close-kin genetics was published in collaboration with CSIRO (Hillary *et al.*, 2018).

**3.3.2: Develop SMP DNA library.**

A shark DNA library incorporating material from the SMP has been developed by DPI and currently contains over 1,000 samples. Accessioning of new material from the SMP is ongoing.

Through collection of genetic data the Australian Blacktip Shark, *Carcharhinus tilstoni*, which was previously not known from NSW waters was identified in the SMP catch (Boomer *et al.*, 2010). Samples from the SMP have contributed to genetic population analyses of Spinner Sharks (*C. brevipinna*) (Geraghty *et al.*, 2013), plus Dusky (*C. obscurus*) and Sandbar (*C. plumbeus*) Sharks (Geraghty *et al.*, 2014; Blower *et al.*, 2019), and Shortfin Mako Sharks. In collaboration with University of Queensland scientists, SMP-sourced genetic samples from Dusky and Sandbar sharks have been used to develop new genetic tools to determine the effective population sizes for these species (Blower *et al.*, 2019). Tiger shark genetic samples have contributed to a recent assessment of population structure and connectivity for this species (Holmes *et al.*, 2017). White shark samples have been incorporated in analyses of the east coast population by CSIRO (Bruce *et al.*, 2018; Hillary *et al.*, 2018).

**3.3 Conduct scientifically-based shark attack risk assessment.**

Status: **Ongoing**

**3.3.1: Compile data from research relating to identified high-risk elements.**

*Activities in 2019/20:*

The NSW Shark Management Strategy (SMS) has initiated substantial research effort into better understanding factors influencing shark attacks (<https://www.dpi.nsw.gov.au/fishing/sharks>). Data streams include aerial survey data on marine wildlife abundance and distribution, beach user data,

**Level 3 Establish/support collaborative research (e.g. CSIRO, other government agencies and universities)**

tagged target shark movements (acoustic tags and satellite tags), target shark behavioural studies especially with respect to their foraging, shark behaviour and movements in relation to beached whales. All these studies and data streams are being collected to identify high-risk elements and will be analysed during the life of the SMS. A suite of publications on these topics have been published during the past year (see 2019 and 2020 publications in the supplied list of References).

A review of alternative systems to shark nets has been conducted as part of the NSW SMS (Cardno, 2015) and updated for publication in a peer-reviewed scientific journal (McPhee *et al.*, submitted).

*Previous:*

Data are regularly being reviewed and assessed for potential inclusion in a database proposed to incorporate all activities and environmental conditions in both temporal and spatial fields. It is anticipated that further research in this area will be initiated in due course.

**3.3.2: Apply standard risk assessment model (i.e. AS/NZ: 4360).***Activities in 2019/20:*

More data has been collected to assist in this application. An agreement has been reached with an independent company, Risk Frontiers, to use NSW DPI data for modelling potential risk to shark attack. This project stalled due to the COVID-19 pandemic.

*Previous:*

Discussions were held with APOLA representatives from NSW to adopt a similar risk assessment process as developed to assist Lake Macquarie City Council lifeguards in managing procedures for suspected and confirmed shark sightings.

Ongoing data collection on abundance, distribution and movements of potentially dangerous sharks are being collected for use in the development of future risk assessment models. As any future models for risk assessment of shark attack will need to include data on bather use of NSW coastal waters, it is imperative that these data be collected in a scientifically robust manner.

**3.4 Conduct morphometrics on sharks and other species caught in the SMP.**

Status: **Ongoing**

**3.4.1: Identify need for morphometrics in meeting the needs of the SMP.**

Quality morphometric data is needed to assess the efficacy of the shark nets in reducing interactions with target sharks. The data provides information on the size classes and any possible size-based stock structuring of sharks off NSW.

Morphometric data are included in ongoing assessments of shark bite to determine species and size of shark involved in the interaction and contribute to data collected during research activities linked to the management of NSW commercial shark fisheries.

All catches are measured, plus a full set of 52 morphometrics recorded for all whole carcasses collected.

**3.4.2: Include in research priorities document (1.1) if considered appropriate.**

All research priorities are detailed in the Strategic Research and Monitoring Plan.

Table 5 SMP Monitoring Program – Outcomes for 2019/20.

SMP Monitoring Program – Outcomes for 2019/20																																															
<b>1. Shark Meshing Contractor Catch Report</b>	All contractors provided daily reports of catches by email and/or telephone and submit a monthly catch data summary sheet with all details of meshing operations and catch during that reporting period.																																														
<b>2. Shark Meshing DPI Catch Summary Report</b>	Monthly catch summary reports were submitted to the Fisheries Scientific Committee, the NSW Scientific Committee and DPIE-EES (Appendix 1)																																														
<b>3. Tagging program.</b>	The tagging program continued in 2019/20, with 51 sharks released alive from the SMP nets. Tagged sharks included; 15 White Sharks (14 tagged with acoustic tags); 3 Bronze Whalers; 1 Broadnose Sevengill Shark; 1 Shortfin Mako Shark; 1 Tiger Shark; and 8 Greynurse Shark (7 with mini-PSATs). Prior to 2019 DPI Fisheries protocols did not support the tagging of Greynurse Sharks, however, with the purchase of mini-PSATs the tagging of Greynurse Sharks commenced in February 2019. Eight Greynurse Sharks released from the shark nets were tagged with mini-PSATs to date. No marine turtles were tagged in 2019/20. For further details refer to Appendix 1.																																														
<b>4. Routine DNA sampling and verification.</b>	<p>Routine DNA sampling of all dead animals was undertaken in 2019/20. This included 228 genetic samples of which 72 comprised collection of the entire animal for research purposes (for further details refer to 'monitoring parameter 5' below).</p> <p>Sampling DNA from live sharks was not undertaken in 2019/20.</p> <p>Species identification was not genetically verified during 2019/20 following the Australian Museum analysis indicating 100% correct identification of hammerhead sharks (Frankham, 2017).</p>																																														
<b>5. Shark vertebral and other tissue samples. Historically no samples have been taken from Skates and Rays</b>	<p>Biological samples were taken from 228 (all dead) of the 284 animals deceased in the 2019/20 season, and are listed below:</p> <table border="1"> <thead> <tr> <th>Common Name</th><th>Sample Type and Number</th><th>Total Number Dead</th></tr> </thead> <tbody> <tr> <td>Australian Angel Shark</td><td>Genetics &amp; vertebrae = 1</td><td>1</td></tr> <tr> <td>Australian Cownose Ray</td><td>Whole = 7</td><td>11</td></tr> <tr> <td>Black Stingray</td><td>Whole = 1</td><td>1</td></tr> <tr> <td>Broadnose Sevengill Shark</td><td>Genetics &amp; vertebrae = 1; Whole = 2</td><td>3</td></tr> <tr> <td>Bronze Whaler</td><td>Genetics &amp; vertebrae = 21; Whole = 3</td><td>29</td></tr> <tr> <td>Bull Shark</td><td>Genetics &amp; vertebrae = 1; Whole = 2</td><td>3</td></tr> <tr> <td>Common Blacktip</td><td>Genetics &amp; vertebrae = 16; Whole = 1</td><td>17</td></tr> <tr> <td>Common Dolphin</td><td>Genetics &amp; vertebrae = 2; Whole = 5</td><td>7</td></tr> <tr> <td>Dusky Whaler</td><td>Genetics &amp; vertebrae = 9; Whole = 1</td><td>10</td></tr> <tr> <td>Eastern Angel Shark</td><td>Genetics &amp; vertebrae = 1</td><td>3</td></tr> <tr> <td>Green Turtle</td><td>Whole = 3</td><td>6</td></tr> <tr> <td>Greynurse Shark</td><td>Genetics &amp; vertebrae = 3; Whole = 10</td><td>14</td></tr> <tr> <td>Scalloped Hammerhead</td><td>Whole = 3</td><td>4</td></tr> <tr> <td>Shortfin Mako</td><td>Genetics &amp; vertebrae = 5; Whole = 2</td><td>8</td></tr> </tbody> </table>		Common Name	Sample Type and Number	Total Number Dead	Australian Angel Shark	Genetics & vertebrae = 1	1	Australian Cownose Ray	Whole = 7	11	Black Stingray	Whole = 1	1	Broadnose Sevengill Shark	Genetics & vertebrae = 1; Whole = 2	3	Bronze Whaler	Genetics & vertebrae = 21; Whole = 3	29	Bull Shark	Genetics & vertebrae = 1; Whole = 2	3	Common Blacktip	Genetics & vertebrae = 16; Whole = 1	17	Common Dolphin	Genetics & vertebrae = 2; Whole = 5	7	Dusky Whaler	Genetics & vertebrae = 9; Whole = 1	10	Eastern Angel Shark	Genetics & vertebrae = 1	3	Green Turtle	Whole = 3	6	Greynurse Shark	Genetics & vertebrae = 3; Whole = 10	14	Scalloped Hammerhead	Whole = 3	4	Shortfin Mako	Genetics & vertebrae = 5; Whole = 2	8
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	Silky Shark	Genetics & vertebrae = 3	3
	Smooth Hammerhead	Genetics & vertebrae = 77; Whole = 8	99
	Southern Eagle Ray	Genetics & vertebrae = 2; Whole = 2	23
	Spinetail Devil Ray	Genetics & vertebrae = 1	1
	Spinner Shark	Genetics & vertebrae = 2	3
	Thresher Shark	Genetics & vertebrae = 2; Whole = 2	4
	Tiger Shark	Genetics & vertebrae = 2; Whole = 2	4
	White Shark	Genetics & vertebrae = 6; Whole = 18	24
	White Spotted Eagle Ray	Genetics & vertebrae = 1	1
<b>6. Monitoring of all shark attacks.</b>	<p>When an attack occurs in NSW the DPI Shark Scientist or delegate interviews the victims, where they are willing to cooperate, and seeks as much information and evidence of shark identification as can be attained. This includes scale-bar photography of wounds requested from responders/surgeons, examination of wounds and damage to surf craft or clothing/diving materials that show evidence of bite marks and collection of any tooth fragments for analysis to help determine shark species.</p> <p>The DPI Shark Scientist also provides key media support following shark attacks in NSW providing balanced information to the community on the reasonable level of threat.</p> <p>There was one shark-inflicted fatality in the past year in NSW waters, and another five instances where surfers suffered minor injuries</p> <p>A total of eleven shark interactions were reported and investigated in NSW waters during 2019/20. These interactions included: three interactions with White Sharks (Macmasters Beach, Central Coast, Salt Beach, Far North Coast, and Seal Rocks, Mid North Coast); two with Bull Sharks (Gallows Beach, Coffs Harbour and Surf Beach, Kiama); two with Wobbegong Sharks (Killalea Beach, Shell Cove and Killick Creek, Crescent Head); one with a Grey nurse Shark (Shelly Beach, Manly); one with a Bronze Whaler (Bulli); and two with unidentified shark species (Windang Beach and Wamberal Beach).</p> <p>Four of these interactions occurred within the SMP region of NSW coastline, but only one was during the eight-month netting season and that one was at an un-netted beach. The other three interactions occurred outside of the meshing season (one at a beach that would be netted during the meshing season and two at non-netted beaches).</p>		
<b>7. Monitor technological advances in shark control measures.</b>	<p>Under the SMS, several studies have been initiated to investigate alternative measures to mitigate against shark bite. As the SMP is an 'area-based' methodology, only initiatives addressing area-protection will be discussed in this Annual Report.</p> <p>Drumlines have been used in shark management strategies in Queensland and South Africa for many decades (Cliff and Dudley, 2011; Sumpton <i>et al.</i>, 2011). Although these passively fishing baited hooks are more selective and reduce mortalities of bycatch, they still impact several species particularly threatened or protected species (Sumpton <i>et al.</i>, 2010). A new improvement to classical drumlines that incorporates a real-time 'Catch Alert System' using satellite communication has been invented in Reunion Island, with the aim of increasing chances of survival of catch (Perry <i>et al.</i>, 2014; Guyomard <i>et al.</i>, 2019). Acoustically tagged shark movements, abundance and distribution in Reunion have been used to show that drumline baits do not attract sharks from elsewhere but that they also do not necessarily catch all nearshore sharks in the region (Guyomard <i>et al.</i>, 2020). These new drumlines have been trialled in NSW and the term SMART Drumlines has now been coined (<u>Shark Management Alert in Real Time</u>). To date, all three target shark species have been caught and successfully tagged and released, with extremely limited bycatch during operational deployment on the NSW far north coast (<a href="https://www.sharksmart.nsw.gov.au/technology-trials-and-research/smart-drumlines">https://www.sharksmart.nsw.gov.au/technology-trials-and-research/smart-drumlines</a>). Survivorship has been exceptionally high as all White Sharks released have subsequently been detected through telemetry, with only one White Shark dying during capture (after entangling itself in the gear). Although one White Shark washed up after apparently succumbing to post-release stress, blood physiology from White Sharks caught on SMART Drumlines in NSW suggests that the capture proves is relatively benign (Tate <i>et al.</i>, 2019) and corroborates the high survivorship detected through acoustic telemetry.</p>		

	<p>SMART Drumline (SDL) trials were continued off some of the SMP beaches during 2019/20 in both the Newcastle and Sydney regions (<a href="https://www.sharksmart.nsw.gov.au/technology-trials-and-research/smart-drumlines">https://www.sharksmart.nsw.gov.au/technology-trials-and-research/smart-drumlines</a>). As per the NSW far north coast trials, these SDLs were positioned adjacent to the existing SMP nets to enable comparison of catch between the two fishing gears (see table below).</p> <p>Although the overall number of animals caught was similar between nets and adjacent SDLs (66 vs 47, respectively), the significant difference is in the more direct capture of the three 'target shark' species by SDLs (34%) versus nets (12%). Additionally, 94% of animals caught on SDLs were released alive, whereas 38% were released alive from the shark nets. Although overall catch of target sharks in this trial was low, with no Bull Sharks caught in either gear type and no Tiger Sharks in the nets, the results underscore the value of using SDLs as a shark bite mitigation measure.</p> <p>SMART Drumlines in NSW appear to catch low numbers of Bull Sharks, yet in Reunion Island they are effective in catching this species. The NSW gear configuration is slightly different to Reunion in that the baits are set 3m from the surface, whereas in Reunion the baits are on the seabed. Additionally, SDLs are set within daylight hours, whereas in Reunion they are set over a full 24-hour period. In NSW, the dangerous bar crossings for much of the coast preclude response to triggered SDLs at night. NSW DPI therefore initiated a night-set trial of SDLs in Sydney Harbour where it is safe to respond to trigger alerts at night. Unfortunately, the outbreak of COVID-19 led to this trial being ceased before any Bull Sharks were caught. However, SDL contractors on the NSW far north coast have been supplied with different snood lengths to test whether the position of bait in the water column does affect capture rates of target shark species. This trial will continue for the foreseeable future.</p> <p>A project investigating the efficacy of sonar technology to detect and accurately assess potential shark threat (based on size of the shark) was completed by NSW DPI and the University of Technology, Sydney, during 2016-17. The experiment provided additional useful understanding of the capabilities of the Clever Buoy (CB) system developed by Shark Mitigation Systems. Overall, the experiment showed that the CB was able to detect White Sharks and the length estimates were not significantly different from the lengths independently estimated by BRUVS (<a href="https://www.sharksmart.nsw.gov.au/_data/assets/pdf_file/0007/815866/evaluation-of-clever-buoy-shark-detection-system-summary.pdf">https://www.sharksmart.nsw.gov.au/_data/assets/pdf_file/0007/815866/evaluation-of-clever-buoy-shark-detection-system-summary.pdf</a>). Sharks were not detected further than 28m from the CB, however, this may have been due to the sonar configuration not being appropriate or calibrated for the water depth used. Almost two-thirds of CB 'detections' were deemed to be false positives when checked against BRUVS video. The presence of BRUVS and schools of fish appeared to influence incorrect identification of an object. It is likely that sharks travelling within 1.5m of the seabed were not detected due to being below the CB beam.</p> <p>Several experiments and trials using Unmanned Aerial Vehicles (UAVs popularly known as 'drones') have been conducted by NSW DPI and Southern Cross University (Butcher <i>et al.</i>, 2019; Colefax <i>et al.</i>, 2019; Kelaher <i>et al.</i>, 2020). Results indicate that this technology may provide aerial support suitable for detection of sharks in clear waters, with sighting efficacy on par with observers in helicopters (Kelaher <i>et al.</i>, 2020). A review of the potential for UAVs to conduct marine fauna surveys has been published as part of this research (Colefax <i>et al.</i>, 2017).</p> <p>A review of alternative, non-lethal, shark management technologies has been prepared and submitted for publication in a peer-reviewed scientific journal (McPhee <i>et al.</i>, submitted).</p>
<b>8. Patterns of movements of non-target marine animals.</b>	<p>DPI continues working with relevant agencies and reviewed available information during 2019/20 and is not aware of any new information that would necessitate any changes to the SMP.</p>
<b>9. Population trends and patterns of movements of dangerous sharks and attack behaviour.</b>	<p>DPI has sourced information from relevant agencies during 2019/20 and is continuing collaborative research into trends and patterns of movements of target sharks (refer to Table 4 section 2.3). Information available to date does not necessitate any changes to the SMP.</p> <p>The only species for which a population estimate now exists is the White Shark. Close-kin genetic techniques were used by CSIRO to estimate adult White Shark abundance for the eastern Australasian population to be 750 individuals in 2017 (uncertainty range of 470 to 1,030) with a high survivorship of approximately 93% (Bruce <i>et al.</i>, 2018). The trend in abundance was not significantly different from zero (i.e. no trend so an apparently stable population where births = deaths, on average). Trends in the juvenile portion of the population were not able to be calculated at this stage, but acoustic tagging data suggest that juvenile survival probabilities are about 73% (Bruce <i>et al.</i>, 2018). Total population size was estimated at 5,460 individuals (uncertainty range 2,909-12,802) in 2017 (Bruce <i>et al.</i>, 2018).</p>



<b>10. Patterns of recreational water contact activities in marine waters.</b>	DPI has reviewed the information that is available from relevant agencies for 2019/20 (refer to Table 4 section 2.4). DPI collected some data on recreational water contact activities at SMP beaches during aerial surveys conducted during 2019/20. Information collected to date does not necessitate any changes to the SMP.
<b>11. Threatened Species recovery plan reviews.</b>	No new threatened species recovery plans were reviewed in 2019/20 and DPI is not aware of any new information that would necessitate any changes to the SMP.
<b>12. Contractor compliance.</b>	Three non-compliance issues were reported by Fisheries Officers during the 2019/20 season. Two reports related to nets having dirty floats while the third was associated with a contractor possibly not inspecting his net as per the requirements of the JMA. All non-compliance issues in 2019/20 were investigated and resolved to the satisfaction of the DPI Shark Meshing Supervisor (for further details refer to section 1.3 Compliance Plan).
<b>13. Monitor net locations by GPS.</b>	GPS location of nets was completed during the 2019/20 meshing season and all nets were in similar positions to those reported in previous years.
<b>14. Shark Meshing Program Annual Performance Evaluation.</b>	The 2019/20 Annual Performance Report provides an evaluation of the performance of the SMP under the Management Plan. No modifications to the SMP are recommended.

## 1.5 Performance Indicators

Performance indicators and trigger points from the Management Plan are assessed below to determine the extent to which the SMP met its four objectives in 2019/20.

### 1.5.1 Objective 1 - reduce the risk to humans from shark bites at beaches of the SMP

The trigger point for this objective is: *one fatality or serious injury per meshing season on a meshed beach*. Serious injuries are those that result in a threat to life or limb. There were no shark-human interactions at meshed beaches of the SMP during the September-April meshing period, and so the trigger point was not tripped during the 2019/20 meshing season. Of the two interactions within the SMP region in 2019/20, one occurred at an unmeshed beach and the other occurred in July, outside of the meshing season (Table 6).

**Table 6 Shark interactions in the SMP Region 2008/09 to 2019/20**

Meshing Period	Fatal	Serious	Minor	No injury	Total Fatal / Serious	Total interactions in SMP region
2008-09 (pre-JMA)	0	3	0	0	3	3
2009-10	0	0	2	0	0	2
2010-11	0	0	0	0	0	0
2011-12	0	1	2	1	1	4
2012-13	0	0	0	1	0	1
2013-14	0	0	1	0	0	1
2014-15	0	0	3	0	0	3
2015-16	0	0	2	2	0	4
2016-17	0	0	0	1	0	1
2017-18	0	1	1	0	1	2
2018-19	0	0	2	0	0	2
2019-20	0	0	2	2	0	4

Note: Interaction information was cross-referenced with shark incident log records held by SLS NSW (Surf Life Saving Manager) and the Australian Shark Attack File.

During the September-April meshing period, there were seven substantiated shark-human interactions at unmeshed beaches investigated by DPI. One of those seven was within the SMP region - a surfer suffered minor injuries to his hand after being bitten by a small unidentified shark species at Wamberal Beach on the Central Coast of NSW. The nearest netted beach is Terrigal Beach, approximately 3km south of Wamberal.

The six interactions outside of the SMP region occurred at: Seal Rocks, Gallows Beach and Crescent Head in the Mid North Coast region; and Killalea Beach, Windang Beach and Surf Beach in the Illawarra region. Three resulted in minor injuries and there were no injuries sustained in the other three interactions.

Outside of the 2019/20 meshing season, there were an additional four interactions in 2019/20, including the fatality of a 60-year-old surfer after being bitten by a White Shark at Kingscliff on the Far North Coast on 7 June 2020. In the other three interactions, an ocean swimmer suffered minor wounds to the chest after being bitten by a Greynurse Shark at Shelly Beach, Manly on 2 July 2019, a surf-ski paddler had his ski bitten by a White Shark at Macmasters beach on 13 June 2020, and two snorkellers had a close encounter with a Bronze Whaler at Bulli on 14 June 2020.

There were four unsubstantiated shark interactions reported through third party sources. These incidents could not be confirmed by DPI, SLS NSW, NSW Police or local councils and have not been included.

### 1.5.2 Objective 2 - minimise the impact on non-target and threatened species.

The trigger point for this objective is:

- *Trigger Point 1: Entanglements of Endangered or Critically Endangered Species, Populations or Ecological Communities in a single meshing season exceed the annual average catch plus two standard deviations of the preceding 10 years for those species;*
- *Trigger Point 2: Entanglements of Vulnerable species or ecological communities in a single meshing season exceed the annual average catch plus three standard deviations of the preceding 10 years for those species;*
- *Trigger Point 3: Entanglements of other non-target species over 2 consecutive meshing seasons exceed twice the annual average catch of the preceding 10 years for those species.*

Catch records indicate that 480 animals were reported entangled in the nets during the period from 1 September 2019 to 30 April 2020 (Table 7), and that 430 (91%) were non-target animals (Tables 7 and 8) under the new categorisation of only White, Bull and Tiger Sharks constituting 'target' species.

Ninety-five of those 480 interactions were with threatened or protected species, including:

- 42 White Sharks (24 dead, 18 released alive);
- 31 Grey Nurse Sharks (14 dead, 17 released alive);
- 8 Green Turtles (6 dead, 2 released alive);
- 7 Common Dolphins (dead);
- 4 Scalloped Hammerheads (dead);
- 1 Loggerhead Turtle (released alive);
- 1 Great Hammerhead (released alive);
- 1 unidentified turtle species (released alive).

In addition, there were 377 interactions with other non-target species, including:

- 179 Rays (38 dead, 141 released alive);
- 99 Smooth Hammerheads (dead);
- 35 Bronze Whalers\* (29 dead, 6 released alive);
- 17 Common Blacktips\* (dead);
- 10 Dusky Whalers\* (dead);
- 9 Shortfin Makos\* (8 dead, 1 released alive)
- 6 Broadnose Sevengill Sharks\* (3 dead, 3 released alive);
- 6 Angel Sharks (4 dead; 2 released alive);
- 4 Thresher Sharks (dead);
- 3 Spinner Sharks\* (dead);
- 3 Silky Sharks\* (dead);
- 2 Port Jackson Sharks (released alive);
- 1 unidentified whaler shark\* (dead)
- 1 Frigate Mackerel (dead);
- 1 Yellowtail Kingfish (dead);
- 1 Australian Bonito (dead).

\* prior to 2017/18 meshing season, these species were reported as 'target species'

Batoids (rays and skates) continue to comprise the greatest proportion of catches in the SMP at 37%, followed by Smooth Hammerheads at 21%, the collective group of 'target sharks' (Bull, White, and Tiger sharks) accounted for approximately 10%, and Grey Nurse Sharks accounted for 6.5%.

The trigger point for the objective of '*minimising the impact on non-target species and threatened species*' was tripped in 2019/20 for Grey Nurse Shark, Scalloped Hammerhead Shark, Thresher Shark, Common Dolphins, and finfish-combined (Table 8). A review report for tripped trigger points

will be prepared within six months of the publication of the Annual Performance Report in accordance with clause 8.4 of the JMA and Part 7 of the Management Plan for the SMP.

Although not a formal trigger point or performance indicator, an increase in the number of animals released alive (albeit with fate unknown) since the JMAs were implemented in 2009-10 could provide some indication of the effectiveness of reducing the time between checking the nets from 96 to 72 hours. Table 9 compares the proportion of animals released alive pre - JMA (5 years before) and post – JMA (10 years after) for some major faunal groups and the total numbers of releases and captures. The data suggest that since the JMAs were implemented in 2009, there was a significant increase in the total number of animals released alive, from 27% before the JMA to a 43% average over the 11-year period from 2009 - 2020. It is important to note, however, that many of these animals are caught in very small numbers, and small changes can be reflected in greater percentages.

Table 7 Total SMP entanglements for the 2019/20 meshing season.

Scientific Name	Common Name	Hunter	Central Coast North	Central Coast South	Sydney North	Sydney Central	Sydney South	Illawarra	Released alive/fate unknown	Dead	Total	% of Total Catch
<b>Target Sharks</b>												
<i>Galeocerdo cuvier</i>	Tiger Shark		2		1		1	1	1	4	5	1.0%
<i>Carcharodon carcharias</i>	White Shark	3	11	11	3		4	10	18	24	42	8.8%
<i>Carcharhinus leucas</i>	Bull Shark	1	2						0	3	3	0.6%
<b>Non-Target Sharks and Rays</b>												
<i>Notorynchus cepedianus</i>	Broadnose Sevengill Shark				1	1		4	3	3	6	1.3%
<i>Carcharhinus brachyurus</i>	Bronze Whaler	2	11	3	3	1	4	11	6	29	35	7.3%
<i>Carcharhinus obscurus</i>	Dusky Whaler		2	4	1			3	0	10	10	2.1%
<i>Isurus oxyrinchus</i>	Shortfin Mako		1	1	1	1	1	4	1	8	9	1.9%
<i>Carcharhinus falciformis</i>	Silky Shark		3						0	3	3	0.6%
<i>Carcharhinus brevipinna</i>	Spinner Shark	3							0	3	3	0.6%
<i>Carcharhinus sp.</i>	unidentified whaler sp.		1						0	1	1	0.2%
<i>Carcharhinus limbatus</i>	Common Blacktip		3	4	1	1	1	7	0	17	17	3.5%
<i>Squatina australis</i>	Australian Angel Shark							1	0	1	1	0.2%
<i>Squatina albipunctata</i>	Eastern Angel Shark				1	1	3		2	3	5	1.0%
<i>Heterodontus portusjacksoni</i>	Port Jackson Shark			1	1				2	0	2	0.4%
<i>Sphyrna zygaena</i>	Smooth Hammerhead Shark	4	44	21	10	5	6	9	0	99	99	20.6%
<i>Sphyrna mokarran</i>	Great Hammerhead Shark				1				1	0	1	0.2%
<i>Alopias vulpinus</i>	Thresher Shark		1		1			2	0	4	4	0.8%
<i>Carcharias taurus</i>	Grey Nurse Shark	6		18	2		2	3	17	14	31	6.5%
<i>Sphyrna lewini</i>	Scalloped Hammerhead Shark	1	1		2				0	4	4	0.8%
<i>Manta birostris</i>	Manta Ray		1						1	0	1	0.2%
<i>Myliobatis australis</i>	Southern Eagle Ray	5	5	8	11	5	8	48	67	23	90	18.8%
<i>Rhinoptera neglecta</i>	Australian Cownose Ray	5	70	2		1			67	11	78	16.3%
<i>Dasyatis thetidis</i>	Black Stingray		2	1				1	3	1	4	0.8%
<i>Dasyatis brevicaudata</i>	Smooth Stingray				2				2	0	2	0.4%
<i>Mobula japonica</i>	Spinetail Devil Ray							1	0	1	1	0.2%
<i>Aetobatus ocellatus</i>	Whitespotted Eagle Ray		1	1					1	1	2	0.4%
	unidentified rays		1						0	1	1	0.2%
<b>Non-Target Marine Mammals, Reptiles and Birds</b>												
<i>Delphinus delphis</i>	Common Dolphin	2			2		3		0	7	7	1.5%
<i>Chelonia mydas</i>	Green Turtle	3		2		2	1		2	6	8	1.7%
<i>Caretta caretta</i>	Loggerhead Turtle	1							1	0	1	0.2%
	unidentified turtles					1			1	0	1	0.2%
<b>Non-Target Finfish</b>												
<i>Seriola lalandi</i>	Yellowtail Kingfish	1							0	1	1	0.2%
<i>Auxis thazard</i>	Frigate Mackerel		1						0	1	1	0.2%
<i>Sarda australis</i>	Australian Bonito		1						0	1	1	0.2%
	<b>TOTAL</b>	<b>37</b>	<b>164</b>	<b>77</b>	<b>44</b>	<b>19</b>	<b>34</b>	<b>105</b>	<b>196</b>	<b>284</b>	<b>480</b>	<b>100%</b>

**Table 8 Non-target and threatened species entanglements<sup>1</sup> for 2009/10 to 2019/20 and trigger point analysis for 2019/20.**

Scientific Name	Common Name	Preceding 10 years catch data										Current reporting year	Endangered	Vulnerable	Other species	Trigger tripped (True/False)
		09-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	+ 2 Std Devs	+ 3 Std Devs	2 x 10 Year Annual Avg in 2 consecutive years	
Endangered																
<i>Carcharias taurus</i>	Greynurse Shark	2	3	4	9	4	4	19	17	20	9	34	23.2	-	-	TRUE
<i>Sphyrna lewini</i>	Scalloped Hammerhead	0	0	0	1	0	0	0	1	0	1	4	1.3	-	-	TRUE
<i>Dermochelys coriacea</i>	Leatherback Turtle	0	0	0	0	2	0	2	1	2	4	0	3.8	-	-	FALSE
<i>Caretta caretta</i>	Loggerhead Turtle	0	0	0	1	0	0	4	1	0	6	1	5.4	-	-	FALSE
<i>Dugong dugon</i>	Dugong	1	0	0	0	0	0	0	0	0	0	0	0.7	-	-	FALSE
<i>Eudyptula minor</i>	Little Penguin	0	0	0	0	0	0	1	0	0	0	0	0.7			FALSE
Vulnerable																
<i>Sphyrna mokarran</i>	Great Hammerhead	0	0	0	0	0	0	1	1	3	1	1	-	3.5	-	FALSE
<i>Carcharodon carcharias</i>	White Shark	5	6	15	3	6	10	31	22	26	17	42	-	43.3	-	FALSE
<i>Chelonia mydas</i>	Green Turtle	0	5	1	0	10	4	13	6	9	8	8	-	19.0	-	FALSE
<i>Megaptera novaeangliae</i>	Humpback Whale	0	0	0	2	1	0	0	0	0	0	0	-	2.3	-	FALSE
Pinnipedia	Seals	1	0	0	0	0	0	0	1	0	0	0	-	1.5	-	FALSE
Procellariidae	Shearwater	0	0	0	0	0	0	1	0	0	0	0		1.0		FALSE
Other Protected or Non-Target Species																
<i>Pseudorca crassidens</i>	False Killer Whale	0	0	0	0	0	0	0	0	0	0	0	-	-	0.0	FALSE
<i>Balaenoptera acutorostrata</i>	Minke Whale	0	0	0	0	0	0	0	0	0	0	0	-	-	0.0	FALSE
<i>Tursiops aduncus</i>	Indo-Pacific Bottlenose Dolphin	1	2	0	0	1	0	9	2	3	2	0	-	-	4.2	FALSE
<i>Delphinus delphis</i>	Common Dolphin	1	0	0	0	4	3	4	2	4	3	7	-	-	4.2	TRUE
<i>Squatina spp</i>	Angelshark sp	12	19	14	3	6	1	9	5	7	7	6	-	-	16.6	FALSE
<i>Heterodontus portusjacksoni</i>	Port Jackson Shark	6	0	4	4	2	0	2	2	3	1	2	-	-	4.6	FALSE
<i>Sphyrna zygaena</i>	Smooth Hammerhead	16	18	36	22	22	42	112	71	78	87	99	-	-	101.0	FALSE
<i>Alopias vulpinus</i>	Thresher Shark	7	3	0	0	0	1	2	1	4	0	4	-	-	3.6	TRUE
<i>Eretmochelys imbricate</i>	Hawksbill Turtle	0	0	0	0	0	1	5	2	2	4	0	-	-	2.8	FALSE
<i>Lepidochelys olivacea</i>	Olive Ridley Turtle	0	0	0	0	0	0	0	0	1	0	0	-	-	0.2	FALSE
	Rays – combined	44	60	42	35	90	86	425	166	172	158	179	-	-	255.6	FALSE
	Finfish – combined	0	0	0	0	1	0	6	1	0	4	3	-	-	2.4	TRUE
	Pre 2017 JMA 'target species' <sup>2</sup>	22	35	33	26	30	30	96	66	61	77	84	-	-	95.2	FALSE

<sup>1</sup>: 'entanglements' includes mortalities and animals released alive.<sup>2</sup>: 'Pre 2017 JMA 'target species' include: broadnose seven-gill shark, bronze whaler, dusky whaler, unknown whaler, shortfin mako, silky shark, and common blacktip

**Table 9 Percentage of major faunal groups released alive from the SMP pre-JMA and post-JMA.**

Faunal Group or Species	% released alive pre-JMA (2004-2009)	Annual percentage released alive over last five years					Overall % released alive post-JMA (2009/10 - 2019/2020)
		2015/16	2016/17	2017/18	2018/19	2019/20	
Target sharks*	5%	17%	17%	25%	33%	13%	15%
White Shark	11%	32%	36%	46%	53%	43%	35%
Grey Nurse Shark	25%	74%	65%	50%	56%	55%	53%
All hammerheads	0%	2%	0%	1%	1%	1%	1%
Other non-target sharks**	48%	54%	75%	13%	13%	15%	21%
All rays	62%	77%	72%	82%	77%	79%	77%
All dolphins	0%	0%	0%	0%	0%	0%	0%
All turtles	24%	21%	40%	29%	32%	40%	29%
Released/Interactions	223/826	385/750	161/373	180/403	157/395	196/480	1420/3320
<b>Total % released alive</b>	<b>27%</b>	<b>51%</b>	<b>43%</b>	<b>45%</b>	<b>40%</b>	<b>41%</b>	<b>43%</b>

### 1.5.3 Objective 3 - Minimise OHS risks associated with implementing the SMP.

The trigger point for this objective is: *one major or two minor OHS incidents.*

A major incident is one that results in five or more compensable days off work, and a minor incident is one that is reportable to NSW WorkCover or results in between 2 – 4 days off work.

The trigger point for the objective of '*minimise OHS risks associated with implementing the SMP*' was tripped during the 2019/20 season with two minor incidents being reported by DPI staff during the meshing season. The first incident resulted in a staff member requiring medical treatment and subsequent stitches to a laceration on the hand, and the second a minor back strain while the staff member was lifting.

### 1.5.4 Objective 4 - Transparent monitoring and reporting.

The trigger point for this objective is: *Annual performance report submitted to the Scientific Committee, the Fisheries Scientific Committee, OEH and parties to the JMA by 31 July each year.*

This requirement was met in 2019/20 in accordance with clause 8.3 of the JMA.

## 1.6 Summary of Reviews and Actions

This section summarises the trigger points which have been tripped and the status of any actions since the 2017 JMA and Management Plan came into effect in the 2018/19 meshing season.

**2017/18:** The trigger point for the objective of '*Minimise the impact on non-target species and to ensure that the SMP does not jeopardise the survival or conservation status of threatened species*' was tripped for three species during 2017/18 following the entanglement of twenty Grey Nurse Sharks, three Great Hammerheads, and two Hawksbill Turtles. DPI completed the review report for those trigger points within six months of the publication of the 2017/18 Annual Performance Report.

**2018/19:** The trigger point for the objective of '*Minimise the impact on non-target species and to ensure that the SMP does not jeopardise the survival or conservation status of threatened species*' was tripped for three species during 2018/19 following the entanglement of six Loggerhead Turtles, four Leatherback Sea Turtles, four Hawksbill Turtles, and 87 Smooth Hammerheads. DPI completed the review report for those trigger points within six months of the publication of the 2018/19 Annual Performance Report.

**2019/20:** The trigger point for the objective of '*Minimise the impact on non-target species and to ensure that the SMP does not jeopardise the survival or conservation status of threatened species*' was tripped for four species during 2019/20 following the entanglement of thirty-one Grey Nurse Sharks, four Scalloped Hammerhead Sharks, eight Common Dolphins, and four



Thresher Sharks. The trigger point for the objective of '*Minimise OHS risks associated with implementing the SMP*' was tripped with two 'minor' OHS incidents being reported. **DPI will prepare the review report for those trigger points within six months of the publication of this 2019/20 Annual Performance Report.**

## 2 Changes to the Management Plan

This Annual Performance Report has not identified a need for any amendments to the Management Plan or JMA but noting that trigger point review reports for threatened species and OHS incidents need to be prepared by DPI within six months of the publication of this Annual Performance Report.

DPI Fisheries implemented the use of PSAT tagging for Greynurse Sharks at the end of the 2018/19 season and continued this throughout the 2019/20 season to determine to post-release survivorship of Greynurse Sharks caught in SMP nets.

## 3 Other Programs Complementing the SMP

### 3.1 Aerial Surveys

As in previous years, a series of aerial surveys were flown along the coast over the SMP region from Wollongong to Stockton. All surveys were flown by helicopter.

United Aero Helicopters were contracted through an open tender process to conduct one flight on Wednesday, plus each weekend day and all public holidays during NSW School holidays in September/October (hereafter termed 'spring'), December/January ('summer'), and April ('autumn').

All aircraft were required to have a trained observer on board to collect data via the purpose-built SharkSmart PRO (SSPRO) application for onboard iPads. Using SSPRO, all sightings of marine wildlife are immediately submitted to a linked database, whilst sightings of target species (White, Bull and Tiger, unidentifiable or Whaler Sharks larger than 2m total length) were tweeted and submitted to public via alerts on the SharkSmart App for iOS and Android mobile devices directly from the helicopter in real time. The charter company was required to provide a photographer who was able to take high resolution digital photographs. The specified duties of the aerial surveillance observer were to:

- Use the supplied iPad loaded with the purpose-built SharkSmart PRO App to record all sightings.
- Record all sightings and environmental conditions on the supplied Dictaphone using local beach names to record position of the sightings/change in conditions.
- Record weather and environmental conditions for each flight, including recording the positions where these may have changed.
- If problems are experienced with the SharkSmart PRO App, log all sightings using the supplied hand-held GPS and record all sightings data, including the GPS waypoint, using the Dictaphone.
- Provide timely and adequate records of sightings to DPI, SLS NSW and the Australian Professional Ocean Lifeguards Association (APOLA).
- Report all sightings of potentially dangerous situations using the supplied radios preloaded with SLS NSW channels, or by mobile phone if no response using the radio, to the relevant surf lifesaving groups (SLS NSW and APOLA) and DPI contact person.
- Report any sightings of shark meshing contractor vessels or nets out of alignment following storms and heavy seas.



### 3.1.1 2019/20 Results

To maximise the observers focus on searching during flight, a world-first data recording application for iOS was built in 2016 to allow all sightings to be recorded in real time, including geolocation using the iPad GPS. Observers send sightings of marine wildlife directly into the database or, in the case of large, target shark species, submit in real time alerts to the NSW SharkSmart App (iOS and Android) and Twitter. Analysis of environmental parameters affecting shark and prey abundance and distribution along the NSW coast will be completed; however, as the SMP Annual Performance Report is focused on assessing the ability of this program to provide bather safety, all shark sightings have been assessed independently.

A total of 60 shark sightings of approximately 149 individuals were made between 30 September 2019 and 27 April 2020. No sharks were seen over the seven days flown during the spring school holidays. Sixty-nine percent of shark sightings were Hammerhead Sharks, considered harmless. A total of 11 sharks greater than 2m in length were seen during these flights, of which five were Grey Nurse Sharks and therefore not reported 'live' on the SharkSmart App. Thirteen of 18 sightings of Grey Nurse Sharks occurred in close proximity to the aggregation site off Marley Beach in the Royal National Park south of Sydney.

Eight target sharks were recorded, including four White Sharks, two Bull Sharks, one large Whaler Shark, and one unidentified shark. Only a single water evacuation occurred during this period when a 2m White Shark was seen off Soldiers Point, Wyong. Both Bull Shark sightings were seen in the Swansea Channel at the entrance to Lake Macquarie. All four White Shark sightings were made during summer in the northern region of the SMP, which also records the greatest catch in the SMP nets (Reid *et al.*, 2011). No Tiger Sharks were observed.

Like 2018/19, but unlike previous years, there was no area of relatively higher shark sightings.

### 3.1.2 Conclusions

As seen in previous years very few target sharks are seen from aircraft within the SMP region. This is attributed to the water turbidity in this region of the NSW coastline which limits the visibility of sharks in the water. This highlights one of the limitations of aerial surveillance using observers searching with the naked eye (Butcher *et al.*, 2019). Deploying drones with hyperspectral cameras in regions with lifesavers/guards may substantially improve the efficacy of aerial surveillance to detect target shark species.

Analysis of shark and prey abundance and distribution in relation to biotic and abiotic conditions at the sightings will provide a unique ability to investigate the impact of inter-annual and seasonal variation in environmental conditions on potential risk to bathers due to nearshore shark presence.

## 3.2 SharkSmart Public Awareness and Education Program

DPI continued ongoing work during 2019/20 on the SharkSmart public awareness and education program including releases of updated versions of the SharkSmart App for iPhone and Android. Additionally, the NSW DPI Stakeholder Engagement team and shark scientists visited each area where SMART Drumline trials were being held within the SMP region, plus manned an educational stall at the 2020 NSW Surf Life Saving Championships held at Blacksmiths Beach and at the 2020 Surfest at Merewether Beach, Newcastle. Further information can be found on the DPI website at: <https://www.sharksmart.nsw.gov.au/>

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## Appendix 1 – Monthly catch summaries for the 2019/20 meshing season

Appendix 1 Table 1: Detailed Catch Report - 1 September 2019 to 28 September 2019

Region	Beach	Date	Scientific Name	Common Name	Status	Samples taken (yes/no/whole)	Tagged	Size (m) FL	Sex
Hunter	Stockton	4/09/2019	<i>Carcharias taurus</i>	Greynurse Shark	Dead	Whole	No	2.13	F
	Stockton	6/09/2019	<i>Carcharias taurus</i>	Greynurse Shark	Alive & Released	No	Yes	2.6	F
	Stockton	23/09/2019	<i>Carcharodon carcharias</i>	White Shark	Dead	Whole	No	2.47	F
	Stockton	27/09/2019	<i>Carcharodon carcharias</i>	White Shark	Alive & Released	No	Yes	1.48	F
Central Coast North	Blacksmiths	5/09/2019	<i>Carcharodon carcharias</i>	White Shark	Alive & Released	No	Yes	2.15	M
	Blacksmiths	5/09/2019	<i>Carcharodon carcharias</i>	White Shark	Alive & Released	No	Yes	1.7	F
	Lakes	19/09/2019	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Yes	No	2.35	M
	Soldiers	20/09/2019	<i>Carcharodon carcharias</i>	White Shark	Alive & Released	No	Yes	1.54	F
	Blacksmiths	23/09/2019	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Yes	No	3	M
	Blacksmiths	23/09/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Dead	No	No	0.43	M
	Caves Beach	24/09/2019	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Alive & Released	No	No	2.5	M
	Soldiers	27/09/2019	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Whole	No	2.04	F
Central Coast South	Soldiers	27/09/2019	<i>Carcharodon carcharias</i>	White Shark	Dead	Whole	No	2.1	M
	Copacabana	2/09/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	0.8	M
	North Avoca	2/09/2019	<i>Carcharodon carcharias</i>	White Shark	Dead	Whole	No	1.54	F
	McMasters	4/09/2019	<i>Chelonia mydas</i>	Green Turtle	Dead	Whole	No	0.49	Unk.
	Avoca	19/09/2019	<i>Carcharodon carcharias</i>	White Shark	Alive & Released	No	Yes	1.85	M
	Terrigal	19/09/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Dead and decomposed	No	No	-	F
	Terrigal	23/09/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.2	F
	McMasters	25/09/2019	<i>Carcharhinus obscurus</i>	Dusky Whaler	Dead	Whole	No	1.69	M
	Umina	25/09/2019	<i>Carcharias taurus</i>	Greynurse Shark	Dead	Whole	No	2.35	F
	Copacabana	27/09/2019	<i>Carcharias taurus</i>	Greynurse Shark	Alive & Released	No	Yes	2.2	F
Sydney North	Copacabana	27/09/2019	<i>Carcharias taurus</i>	Greynurse Shark	Alive & Released	No	No	3	Unk.
	Avalon	5/09/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Dead and decomposed	No	No	1.2	Unk.
	Palm	14/09/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.93	F
	Warriewood	19/09/2019	<i>Delphinus delphis</i>	Common Dolphin	Dead	Whole	No	1.8	Unk.
	Palm	20/09/2019	<i>Alopias vulpinus</i>	Thresher Shark	Dead	Whole	No	1.23	M
	Bilgola	26/09/2019	<i>Notorynchus cepedianus</i>	Broadnose Sevengill Shark	Dead	Yes	No	1.52	M
	Bilgola	26/09/2019	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Yes	No	2.21	M
	Palm	26/09/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.02	F
Sydney Central	Bilgola	27/09/2019	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Yes	No	2.02	Unk.
	North Narrabeen	4/09/2019	<i>Chelonia mydas</i>	Green Turtle	Dead	Whole	No	0.7	Unk.
Sydney South	North Steyne	20/09/2019	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Alive & Released	No	Yes	3	F
	Maroubra	6/09/2019	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Alive & Released	No	Yes	2.3	F
	Maroubra	6/09/2019	<i>Carcharodon carcharias</i>	White Shark	Alive & Released	No	Yes	2.3	F



Region	Beach	Date	Scientific Name	Common Name	Status	Samples taken (yes/no/whole)	Tagged	Size (m) FL	Sex
	Cronulla	13/09/2019	<i>Squatina albipunctata</i>	Eastern Angel Shark	Alive & Released	No	No	0.7	M
	Bondi	25/09/2019	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Yes	No	2.6	F
	Coogee	27/09/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.4	F
	Coogee	27/09/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.2	F
	Maroubra	27/09/2019	<i>Delphinus delphis</i>	Common Dolphin	Dead	Whole	No	1.9	M
	Wanda	27/09/2019	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Yes	No	2.2	F
	Wanda	27/09/2019	<i>Squatina albipunctata</i>	Eastern Angel Shark	Alive & Released	No	No	1	M
Illawarra	South Wollongong	2/09/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.95	F
	Garie	4/09/2019	<i>Carcharodon carcharias</i>	White Shark	Alive & Released	No	No	1.5	Unk.
	South Wollongong	4/09/2019	<i>Carcharodon carcharias</i>	White Shark	Dead	Whole	No	1.6	M
	North Wollongong	6/09/2019	<i>Carcharodon carcharias</i>	White Shark	Dead	Whole	No	1.97	F
	Garie	12/09/2019	<i>Carcharodon carcharias</i>	White Shark	Alive & Released	No	No	1.5	M
	Thirroul	12/09/2019	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Alive & Released	No	No	2.5	M
	Thirroul	12/09/2019	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Yes	No	2.1	F
	Garie	16/09/2019	<i>Carcharodon carcharias</i>	White Shark	Alive & Released	No	No	1.5	M
	South Wollongong	16/09/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1	F
	Thirroul	19/09/2019	<i>Notorynchus cepedianus</i>	Broadnose Sevengill Shark	Dead	Whole	No	1.4	M
	Garie	23/09/2019	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Yes	No	2	M
	Garie	23/09/2019	<i>Alopias vulpinus</i>	Thresher Shark	Dead	Yes	No	1.45	M
	Garie	23/09/2019	<i>Alopias vulpinus</i>	Thresher Shark	Dead	Yes	No	1.35	F
	Garie	23/09/2019	<i>Carcharodon carcharias</i>	White Shark	Dead	Yes	No	2	F
	North Wollongong	23/09/2019	<i>Notorynchus cepedianus</i>	Broadnose Sevengill Shark	Alive & Released	No	Yes	1.8	M
	North Wollongong	23/09/2019	<i>Notorynchus cepedianus</i>	Broadnose Sevengill Shark	Alive & Released	No	No	1.5	Unk.
	North Wollongong	23/09/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.8	F
	North Wollongong	23/09/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.1	F
	Coledale	27/09/2019	<i>Notorynchus cepedianus</i>	Broadnose Sevengill Shark	Alive & Released	No	No	1.6	Unk.
	Coledale	27/09/2019	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	No	No	2	Unk.
	Garie	27/09/2019	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	No	No	2.25	F

Appendix 1 Table 2: Detailed Catch Report - 29 September 2019 to 26 October 2019

Region	Beach	Date	Scientific Name	Common Name	Status	Samples taken (yes/no/whole)	Tagged	Size (m) FL	Sex
Hunter	Newcastle	1/10/2019	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Alive & Released	No	Yes	2.6	F
	Stockton	4/10/2019	<i>Seriola lalandi</i>	Yellowtail kingfish	Dead	No	No	1.01	Unk.
	Stockton	11/10/2019	<i>Chelonia mydas</i>	Green Turtle	Dead and decomposed	No	No	0.42	M
	Stockton	13/10/2019	<i>Chelonia mydas</i>	Green Turtle	Dead	No	No	0.52	M
	Stockton	25/10/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	0.75	Unk.

Region	Beach	Date	Scientific Name	Common Name	Status	Samples taken (yes/no/whole)	Tagged	Size (m) FL	Sex
	Newcastle	25/10/2019	<i>Chelonia mydas</i>	Green Turtle	Dead and decomposed	No	No	0.59	Unk.
Central Coast North	Lakes	30/09/2019	<i>Alopias vulpinus</i>	Thresher Shark	Dead	Whole	No	2.07	F
	The Entrance	30/09/2019	<i>Carcharodon carcharias</i>	White Shark	Dead	Whole	No	1.65	F
	Shelly	15/10/2019	<i>Dasyatis thetidis</i>	Black Stingray	Alive & Released	No	No	0.95	M
	Blacksmiths	17/10/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.28	M
	Soldiers	19/10/2019	<i>Isurus oxyrinchus</i>	Shortfin Mako	Dead	Yes	No	2.64	F
	Blacksmiths	22/10/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.98	F
Central Coast South	North Avoca	30/09/2019	<i>Carcharias taurus</i>	Greynurse Shark	Alive & Released	No	No	1.7	M
	McMasters	30/09/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Dead	No	No	0.7	F
	McMasters	30/09/2019	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Whole	No	1.83	F
	North Avoca	30/09/2019	<i>Carcharias taurus</i>	Greynurse Shark	Dead	Whole	No	2.13	F
	North Avoca	30/09/2019	<i>Carcharias taurus</i>	Greynurse Shark	Dead	Whole	No	1.87	M
	North Avoca	30/09/2019	<i>Carcharias taurus</i>	Greynurse Shark	Alive & Released	No	No	1.5	F
	North Avoca	30/09/2019	<i>Carcharias taurus</i>	Greynurse Shark	Dead	Whole	No	2.27	F
	Terrigal	2/10/2019	<i>Carcharodon carcharias</i>	White Shark	Alive & Released	No	Yes	1.6	F
	Terrigal	4/10/2019	<i>Carcharias taurus</i>	Greynurse Shark	Alive & Released	No	No	2.3	F
	Avoca	4/10/2019	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Yes	No	2	F
	Avoca	4/10/2019	<i>Carcharodon carcharias</i>	White Shark	Alive & Released	No	Yes	1.8	F
	Avoca	4/10/2019	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Yes	No	1.79	F
	Terrigal	6/10/2019	<i>Carcharias taurus</i>	Greynurse Shark	Dead	No	No	2	F
	Umina	12/10/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Whole	No	1.07	M
	North Avoca	14/10/2019	<i>Carcharodon carcharias</i>	White Shark	Dead	Whole	No	1.61	F
	McMasters	18/10/2019	<i>Heterodontus portusjacksoni</i>	Port Jackson Shark	Alive & Released	No	No	0.65	M
	Umina	23/10/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Whole	No	0.94	M
Sydney North	Bilgola	4/10/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Dead	No	No	1.1	F
	Whale	7/10/2019	<i>Carcharodon carcharias</i>	White Shark	Dead	Whole	No	2.14	M
	Bilgola	8/10/2019	<i>Heterodontus portusjacksoni</i>	Port Jackson Shark	Alive & Released	No	No	1	F
	Palm	17/10/2019	<i>Carcharodon carcharias</i>	White Shark	Dead	Whole	No	1.99	F
	Newport	24/10/2019	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Yes	No	2.14	M.
	Newport	24/10/2019	<i>Dasyatis brevicaudata</i>	Smooth Stingray	Alive & Released	No	No	1.2	Unk.
	Whale	25/10/2019	<i>Carcharias taurus</i>	Greynurse Shark	Alive & Released	No	No	2.2	F
	Mona Vale	25/10/2019	<i>Dasyatis brevicaudata</i>	Smooth Stingray	Alive & Released	No	No	1.1	Unk.
Sydney Central	Harbord	4/10/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.24	M
	North Steyne	11/10/2019	<i>Squatina albipunctata</i>	Eastern Angel Shark	Dead	Yes	No	1	Unk.
	North Steyne	11/10/2019	<i>Notorynchus cepedianus</i>	Broadnose Sevengill Shark	Dead	Whole	No	2	M
Sydney South	North Cronulla	14/10/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead and decomposed	No	No	1	Unk.
	Cronulla	14/10/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Dead	Yes	No	1.32	F
	Maroubra	16/10/2019	<i>Carcharodon carcharias</i>	White Shark	Dead	Whole	No	1.9	F
	Maroubra	23/10/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.05	F
	Elouera	23/10/2019	<i>Squatina albipunctata</i>	Eastern Angel Shark	Dead	Yes	No	0.93	F
Illawarra	Coledale	30/09/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.13	F

Region	Beach	Date	Scientific Name	Common Name	Status	Samples taken (yes/no/whole)	Tagged	Size (m) FL	Sex
	Coledale	14/10/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.2	Unk.
	Coledale	14/10/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	0.7	Unk.
	Wattamolla	15/10/2019	<i>Carcharodon carcharias</i>	White Shark	Alive & Released	No	Yes	2	M
	Thirroul	15/10/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.2	M
	Austinmer	22/10/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.1	F
	Austinmer	25/10/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.2	F

Appendix 1 Table 3: Detailed Catch Report - 27 October 2019 to 23 November 2019

Region	Beach	Date	Scientific Name	Common Name	Status	Samples taken (yes/no/whole)	Tagged	Size (m) FL	Sex
Hunter	Stockton	1/11/2019	<i>Delphinus delphis</i>	Common Dolphin	Dead	Yes	No	1.73	F
	Stockton	4/11/2019	<i>Carcharias taurus</i>	Grey nurse Shark	Dead and decomposed	Yes	No	2.58	F
	Stockton	14/11/2019	<i>Carcharodon carcharias</i>	White Shark	Alive & Released	No	Yes	2.38	M
Central Coast North	Lakes	28/10/2019	<i>Carcharodon carcharias</i>	White Shark	Dead	Whole	No	1.8	F
	Soldiers	4/11/2019	<i>Carcharodon carcharias</i>	White Shark	Dead	Whole	No	1.68	F
	Blacksmiths	4/11/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Whole	No	1.08	F
	Blacksmiths	21/11/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Dead	Whole	No	0.92	F
	Blacksmiths	21/11/2019	<i>Dasyatis thetidis</i>	Black Stingray	Dead	Whole	No	0.97	M
	Blacksmiths	23/11/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.94	F
Central Coast South	Avoca	28/10/2019	<i>Isurus oxyrinchus</i>	Shortfin Mako	Dead	Yes	No	2.5	F
	McMasters	31/10/2019	<i>Carcharhinus limbatus</i>	Common Blacktip	Dead	Yes	No	2.6	F
	Umina	4/11/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.09	M
	Terrigal	8/11/2019	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.8	F
	Umina	14/11/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Whole	No	1.09	M
	Umina	14/11/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Whole	No	1.09	M
	Umina	17/11/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.1	M
	Copacabana	19/11/2019	<i>Carcharodon carcharias</i>	White Shark	Dead	Whole	No	1.8	F
Sydney North	Palm	31/10/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.96	F
	Palm	4/11/2019	<i>Isurus oxyrinchus</i>	Shortfin Mako	Dead	Whole	No	1.15	M
	Palm	6/11/2019	<i>Squatina albipunctata</i>	Eastern Angel Shark	Dead	Yes	No	1.1	F
	Whale	7/11/2019	<i>Carcharodon carcharias</i>	White Shark	Dead	Whole	No	1.94	M
	Newport	14/11/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.2	Unk.
	Palm	21/11/2019	<i>Carcharhinus obscurus</i>	Dusky Whaler	Dead	Yes	No	2.59	M
Sydney Central	Harbord	15/11/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1	F
	North Narrabeen	21/11/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.1	F
Sydney South	Bronte	28/10/2019	<i>Delphinus delphis</i>	Common Dolphin	Dead	Yes	No	2.1	M
	Maroubra	1/11/2019	<i>Delphinus delphis</i>	Common Dolphin	Dead	Whole	No	2.1	F
	Maroubra	11/11/2019	<i>Isurus oxyrinchus</i>	Shortfin Mako	Dead	Whole	No	1.84	F
	Wanda	14/11/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Whole	No	1.1	F
Illawarra	Wattamolla	28/10/2019	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	No	No	2.5	Unk.

Region	Beach	Date	Scientific Name	Common Name	Status	Samples taken (yes/no/whole)	Tagged	Size (m) FL	Sex
	South Wollongong	8/11/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Dead	No	No	0.8	Unk.
	Wattamolla	11/11/2019	<i>Carcharodon carcharias</i>	White Shark	Dead	Yes	No	2.5	F
	North Wollongong	15/11/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.2	F
	North Wollongong	15/11/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Dead	No	No	0.7	M
	North Wollongong	15/11/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Dead	No	No	1.2	F
	Wattamolla	18/11/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	0.65	F
	North Wollongong	20/11/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1	F
	Coledale	22/11/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	0.85	F

Appendix 1 Table 4: Detailed Catch Report - 24 November 2019 to 21 December 2019

Region	Beach	Date	Scientific Name	Common Name	Status	Samples taken (yes/no/whole)	Tagged	Size (m) FL	Sex
Hunter	Stockton	25/11/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	0.8	F
	Stockton	26/11/2019	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.5	F
	Stockton	29/11/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	0.8	F
	Nobbys	29/11/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	0.75	F
	Stockton	17/12/2019	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.7	F
Central Coast North	Caves Beach	29/11/2019	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Yes	No	2.39	M
	The Entrance	29/11/2019	<i>Carcharodon carcharias</i>	White Shark	Dead	Yes	No	1.69	M
	The Entrance	29/11/2019	<i>Carcharodon carcharias</i>	White Shark	Dead	Yes	No	1.68	M
	Shelly	5/12/2019	<i>Carcharodon carcharias</i>	White Shark	Dead	Whole	No	1.56	F
	Blacksmiths	10/12/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.83	F
	Blacksmiths	10/12/2019	<i>Carcharodon carcharias</i>	White Shark	Alive & Released	No	Yes	1.9	F
	Soldiers	13/12/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Dead	No	No	0.65	M
	Soldiers	13/12/2019	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Yes	No	2.63	M
	Blacksmiths	13/12/2019	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.84	F
	Blacksmiths	13/12/2019	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	1.1	F
	Blacksmiths	13/12/2019	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Dead	No	No	0.92	F
	Blacksmiths	17/12/2019	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.97	M
	Blacksmiths	17/12/2019	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Dead	Whole	No	1	F
Central Coast South	North Avoca	24/11/2019	<i>Carcharias taurus</i>	Grey Nurse Shark	Dead	Whole	No	2.19	F
	McMasters	28/11/2019	<i>Dasyatis thetidis</i>	Black Stingray	Alive & Released	No	No	1	M
	North Avoca	28/11/2019	<i>Carcharodon carcharias</i>	White Shark	Alive & Released	No	Yes	1.94	F
	Umina	4/12/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead and decomposed	No	No	0.7	Unk.
	McMasters	6/12/2019	<i>Carcharodon carcharias</i>	White Shark	Dead	Whole	Yes	1.76	F
	North Avoca	9/12/2019	<i>Carcharhinus limbatus</i>	Common Blacktip	Dead	Whole	No	1.65	M
	Avoca	12/12/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Dead	No	No	1.25	F
	Avoca	12/12/2019	<i>Carcharodon carcharias</i>	White Shark	Alive & Released	No	Yes	1.9	M

Region	Beach	Date	Scientific Name	Common Name	Status	Samples taken (yes/no/whole)	Tagged	Size (m) FL	Sex
	Avoca	12/12/2019	<i>Carcharodon carcharias</i>	White Shark	Dead	Whole	No	1.67	F
	Kilcare	15/12/2019	<i>Carcharias taurus</i>	Greynurse Shark	Dead	Whole	No	2.4	F
	North Avoca	15/12/2019	<i>Carcharias taurus</i>	Greynurse Shark	Alive & Released	No	No	1.6	F
	North Avoca	20/12/2019	<i>Carcharias taurus</i>	Greynurse Shark	Alive & Released	No	Yes	1.7	M
Sydney North	Bilgola	9/12/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1	F
	Bilgola	18/12/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1	Unk.
Sydney Central	Curl Curl	14/12/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.3	F
Sydney South	Maroubra	11/12/2019	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Yes	No	2.38	M
	Bondi	13/12/2019	<i>Carcharhinus limbatus</i>	Common Blacktip	Dead	Yes	No	1.97	M
	Cronulla	13/12/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	0.75	F
	Bondi	21/12/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.8	F
Illawarra	Austinmer	25/11/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.2	F
	Austinmer	25/11/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.05	F
	Austinmer	25/11/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1	F
	Wattamolla	25/11/2019	<i>Isurus oxyrinchus</i>	Shortfin Mako	Dead	Yes	No	1.95	M
	North Wollongong	28/11/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.3	F
	Garie	2/12/2019	<i>Isurus oxyrinchus</i>	Shortfin Mako	Dead	Yes	No	1.2	F
	Austinmer	6/12/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.2	F
	Austinmer	9/12/2019	<i>Carcharias taurus</i>	Greynurse Shark	Dead	Whole	No	2.15	F
	Wattamolla	9/12/2019	<i>Carcharodon carcharias</i>	White Shark	Alive & Released	No	Yes	2.2	F
	Austinmer	9/12/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.2	F
	Wattamolla	19/12/2019	<i>Isurus oxyrinchus</i>	Shortfin Mako	Dead	Yes	No	1.03	M
	North Wollongong	20/12/2019	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Yes	No	2.05	M
	South Wollongong	20/12/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.25	F
	North Wollongong	21/12/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.4	F

Appendix 1 Table 5: Detailed Catch Report - 22 December 2019 to 18 January 2020

Region	Beach	Date	Scientific Name	Common Name	Status	Samples taken (yes/no/whole)	Tagged	Size (m) FL	Sex
Central Coast North	The Entrance	27/12/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.27	M
	The Entrance	27/12/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.25	F
	Lakes	30/12/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	0.7	M
	Shelly	7/01/2020	<i>Carcharhinus obscurus</i>	Dusky Whaler	Dead and decomposed	No	No	3	Unk.
	Blacksmiths	8/01/2020	unidentified ray	unidentified ray	Dead and decomposed	No	No	-	Unk.
	Lakes	13/01/2020	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Whole	No	1.9	M
	Blacksmiths	13/01/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	1.07	F
Central Coast South	Umina	27/12/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.87	F
	Avoca	2/01/2020	<i>Carcharias taurus</i>	Greynurse Shark	Alive & Released	No	No	2.1	F



Region	Beach	Date	Scientific Name	Common Name	Status	Samples taken (yes/no/whole)	Tagged	Size (m) FL	Sex
	Terrigal	2/01/2020	<i>Carcharodon carcharias</i>	White Shark	Dead	Yes	No	1.75	F
	Terrigal	7/01/2020	<i>Carcharhinus limbatus</i>	Common Blacktip	Dead	Yes	No	2.32	M
	Umina	8/01/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Whole	No	0.84	M
	Umina	13/01/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.78	M
Sydney North	Warriewood	23/12/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1	F
	Bilgola	27/12/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.2	Unk.
	Newport	30/12/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	0.5	F
	Palm	30/12/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.25	M
	Warriewood	30/12/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.37	M
	Avalon	2/01/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	Yes	No	1.1	Unk.
	Bilgola	2/01/2020	<i>Carcharhinus limbatus</i>	Common Blacktip	Dead	Yes	No	1.76	M
Sydney Central	Queenscliff	27/12/2019	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.3	F
	Manly	1/01/2020	unidentified turtle	unidentified	Alive & Released	No	No	-	Unk.
	Narrabeen	7/01/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.2	F
	Narrabeen	7/01/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Dead	Yes	No	0.98	F
Sydney South	Coogee	2/01/2020	<i>Carcharodon carcharias</i>	White Shark	Dead	Whole	No	1.99	M
	Maroubra	2/01/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.45	F
	Maroubra	2/01/2020	<i>Carcharodon carcharias</i>	White Shark	Alive & Released	No	Yes	1.78	F
	Elouera	14/01/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Dead	No	No	0.67	M
	Elouera	14/01/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Dead	No	No	1.05	M
Illawarra	Wattamolla	23/12/2019	<i>Galeocerdo cuvier</i>	Tiger shark	Dead	Whole	No	3.05	M
	Wattamolla	23/12/2019	<i>Isurus oxyrinchus</i>	Shortfin Mako	Dead	No	No	-	Unk.
	South Wollongong	27/12/2019	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.05	F
	North Wollongong	30/12/2019	<i>Dasyatis thetidis</i>	Black Stingray	Alive & Released	No	No	1.2	F
	Garie	2/01/2020	<i>Carcharodon carcharias</i>	White Shark	Dead	Yes	No	2.15	F
	Wattamolla	3/01/2020	<i>Carcharhinus limbatus</i>	Common Blacktip	Dead	Yes	No	1.68	F
	Wattamolla	7/01/2020	<i>Carcharhinus limbatus</i>	Common Blacktip	Dead	Yes	No	1.45	M
	Thirroul	7/01/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	0.9	F
	Garie	13/01/2020	<i>Carcharias taurus</i>	Grey nurse Shark	Alive & Released	No	Yes	2.5	M
	Austinmer	17/01/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.4	F
	Austinmer	17/01/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	0.9	F
	Austinmer	17/01/2020	<i>Carcharias taurus</i>	Grey nurse Shark	Alive & Released	No	Yes	2.4	F

Appendix 1 Table 6: Detailed Catch Report - 19 January 2020 to 15 February 2020

Region	Beach	Date	Scientific Name	Common Name	Status	Samples taken (yes/no/whole)	Tagged	Size (m) FL	Sex
Hunter	Stockton	20/01/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.65	F
	Stockton	20/01/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.28	M

Region	Beach	Date	Scientific Name	Common Name	Status	Samples taken (yes/no/whole)	Tagged	Size (m) FL	Sex
	Stockton	20/01/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.32	M
	Stockton	22/01/2020	<i>Carcharhinus brevipinna</i>	Spinner Shark	Dead	Yes	No	1.32	M
	Stockton	24/01/2020	<i>Sphyrna lewini</i>	Scalloped Hammerhead	Dead	Whole	No	1.6	M
	Stockton	26/01/2020	<i>Caretta caretta</i>	Loggerhead Turtle	Alive & Released	No	No	0.7	Unk.
	Dixon Park	5/02/2020	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Alive & Released	No	No	2.1	M
	Redhead	5/02/2020	<i>Carcharhinus leucas</i>	Bull Shark	Dead	Yes	No	2.45	M
	Merewether	12/02/2020	<i>Carcharhinus brevipinna</i>	Spinner Shark	Dead	Yes	No	1.5	M
Central Coast North	Blacksmiths	20/01/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.03	M
	Lakes	20/01/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.23	F
	Blacksmiths	20/01/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.81	F
	Blacksmiths	20/01/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.36	F
	Blacksmiths	21/01/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.23	F
	The Entrance	25/01/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.22	F
	Blacksmiths	28/01/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.14	F
	Blacksmiths	28/01/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead and decomposed	No	No	1.1	Unk.
	Catherine Hill Bay	2/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.02	M
	Catherine Hill Bay	2/02/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	0.4	F
	Blacksmiths	2/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.98	F
	Blacksmiths	2/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.98	F
	Caves Beach	6/02/2020	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Yes	No	1.85	M
	Caves Beach	6/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.05	M
	Blacksmiths	6/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.83	F
	Blacksmiths	6/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.81	F
	Blacksmiths	13/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.85	M
	Caves Beach	13/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.82	M
	Caves Beach	13/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.85	M
	Caves Beach	13/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.87	M
	Blacksmiths	13/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.94	M
	Caves Beach	13/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Dead	Whole	No	0.89	M
	The Entrance	13/02/2020	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Yes	No	1.93	M
	The Entrance	13/02/2020	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Yes	No	1.89	M
	Caves Beach	13/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.87	M
	Caves Beach	13/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.85	M
	Blacksmiths	13/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.87	M
	Blacksmiths	13/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.98	M
	Blacksmiths	13/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.88	M
	Blacksmiths	13/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.84	M
	Blacksmiths	13/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.83	M
	Blacksmiths	13/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.79	M
	Blacksmiths	13/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.87	M
	Blacksmiths	13/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.88	M



Region	Beach	Date	Scientific Name	Common Name	Status	Samples taken (yes/no/whole)	Tagged	Size (m) FL	Sex
	Blacksmiths	13/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.84	M
	Blacksmiths	13/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.99	M
	Blacksmiths	13/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.91	M
	Blacksmiths	14/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.9	Unk.
	Blacksmiths	14/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.89	Unk.
	Blacksmiths	14/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.87	Unk.
	Blacksmiths	14/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.86	Unk.
	Blacksmiths	14/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.83	Unk.
	Blacksmiths	14/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.84	Unk.
	Blacksmiths	14/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.83	Unk.
	Blacksmiths	14/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.82	Unk.
	Blacksmiths	14/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.88	Unk.
	Blacksmiths	14/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.84	Unk.
	Blacksmiths	14/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.88	Unk.
	Blacksmiths	14/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.9	Unk.
	Blacksmiths	14/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.9	Unk.
	Blacksmiths	14/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.8	Unk.
	Blacksmiths	14/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.87	Unk.
	Blacksmiths	14/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.86	Unk.
	Blacksmiths	14/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.8	Unk.
	Blacksmiths	14/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.85	Unk.
	Blacksmiths	14/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.85	Unk.
	Blacksmiths	14/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.8	Unk.
	Blacksmiths	14/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.8	Unk.
Central Coast South	Kilcare	19/01/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Whole	No	1	F
	Kilcare	22/01/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.94	M
	Avoca	24/01/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.13	M
	Copacabana	24/01/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	0.6	F
	Kilcare	28/01/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.14	F
	McMasters	28/01/2020	<i>Aetobatus ocellatus</i>	White Spotted Eagle Ray	Alive & Released	No	No	1	Unk.
	North Avoca	7/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.36	M
	Umina	14/02/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	0.9	F
Sydney North	Warriewood	6/02/2020	<i>Sphyrna lewini</i>	Scalloped Hammerhead	Dead	Whole	No	1.45	F
	Palm	11/02/2020	<i>Sphyrna mokarran</i>	Great Hammerhead	Alive & Released	No	No	2.4	M
Sydney Central	Narrabeen	19/01/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.05	M
	Dee Why	14/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1	F
	Narrabeen	14/02/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.2	F
Sydney South	Bondi	22/01/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.1	F
	Bondi	28/01/2020	<i>Carcharias taurus</i>	Greynurse Shark	Alive & Released	No	Yes	2.1	F
Illawarra	Wattamolla	20/01/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.34	M
	Coledale	5/02/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	0.9	F

Region	Beach	Date	Scientific Name	Common Name	Status	Samples taken (yes/no/whole)	Tagged	Size (m) FL	Sex
	North Wollongong	7/02/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	0.4	F
	Thirroul	11/02/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Dead	No	No	1.1	F
	South Wollongong	11/02/2020	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Yes	No	1.85	M
	South Wollongong	11/02/2020	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Yes	No	1.95	M
	Thirroul	11/02/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Dead	No	No	1.15	F
	Thirroul	11/02/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	0.9	F
	Thirroul	11/02/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	0.8	F
	South Wollongong	11/02/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	0.7	F
	South Wollongong	11/02/2020	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Yes	No	2	M
	Coledale	11/02/2020	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Yes	No	1.85	M
	Coledale	14/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.25	F

Appendix 1 Table 7: Detailed Catch Report – 16 February 2020 to 14 March 2020

Region	Beach	Date	Scientific Name	Common Name	Status	Samples taken (yes/no/whole)	Tagged	Size (m) FL	Sex
Hunter	Nobbys	19/02/2020	<i>Carcharhinus brevipinna</i>	Spinner Shark	Dead and decomposed	No	No	2.75	F
	Stockton	21/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.65	F
	Stockton	21/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.75	M
	Stockton	24/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.7	M
	Stockton	24/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.75	F
	Stockton	26/02/2020	<i>Carcharias taurus</i>	Grey nurse Shark	Dead	Whole	No	1.98	M
	Stockton	2/03/2020	<i>Carcharias taurus</i>	Grey nurse Shark	Alive & Released	No	Yes	2.2	F
	Stockton	6/03/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	0.9	F
	Nobbys	11/03/2020	<i>Delphinus delphis</i>	Common Dolphin	Dead	Whole	No	2.1	F
Central Coast North	Caves Beach	17/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Dead	No	No	0.8	M
	Lakes	17/02/2020	<i>Carcharhinus leucas</i>	Bull Shark	Dead	Whole	No	2.39	M
	Soldiers	17/02/2020	<i>Carcharhinus limbatus</i>	Common Blacktip	Dead	Yes	No	1.77	M
	The Entrance	17/02/2020	<i>Carcharhinus brachyurus</i>	Bronze Whaler	Dead	Yes	No	1.86	M
	The Entrance	17/02/2020	<i>Carcharhinus limbatus</i>	Common Blacktip	Dead	Yes	No	1.78	M
	The Entrance	17/02/2020	<i>Carcharhinus limbatus</i>	Common Blacktip	Dead	Yes	No	1.63	F
	Lakes	19/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	1.03	F
	Lakes	19/02/2020	<i>Sarda australis</i>	Australian bonito	Dead	No	No	0.62	Unk.
	Lakes	19/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.05	M
	Soldiers	19/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.92	F
	Blacksmiths	19/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.96	F
	Blacksmiths	19/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.84	M
	Blacksmiths	19/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.12	M
	Blacksmiths	19/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.04	M

Region	Beach	Date	Scientific Name	Common Name	Status	Samples taken (yes/no/whole)	Tagged	Size (m) FL	Sex
	Blacksmiths	19/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.85	M
	Blacksmiths	19/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.01	M
	Blacksmiths	19/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.08	M
	Blacksmiths	19/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.92	M
	Blacksmiths	19/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.03	F
	Blacksmiths	19/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.83	F
	Blacksmiths	19/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.09	F
	Blacksmiths	19/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.16	F
	Lakes	24/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.96	F
	Lakes	24/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.95	F
	Lakes	24/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.95	F
	Lakes	24/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.93	F
	Lakes	24/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.92	F
	Lakes	24/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.98	F
	Lakes	24/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Dead	No	No	0.94	Unk.
	Soldiers	24/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.97	F
	Soldiers	24/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.99	F
	Soldiers	24/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.92	F
	Blacksmiths	24/02/2020	<i>Manta birostris</i>	Manta Ray	Alive & Released	No	No	2.2	M
	The Entrance	24/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.93	F
	The Entrance	24/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.97	F
	The Entrance	24/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Dead	No	No	1.01	F
	The Entrance	24/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Dead	No	No	0.93	F
	The Entrance	24/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Dead	No	No	0.97	F
	The Entrance	24/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Dead	No	No	0.95	F
	The Entrance	24/02/2020	<i>Carcharhinus falciformis</i>	Silky Shark	Dead	Yes	No	1.57	F
	Lakes	28/02/2020	<i>Carcharhinus leucas</i>	Bull Shark	Dead	Whole	No	2.21	F
	Blacksmiths	28/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	0.97	M
	Blacksmiths	28/02/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Dead	No	No	0.94	M
	Blacksmiths	28/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead and decomposed	No	No	1.16	M
	Lakes	2/03/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	No	No	1.1	F
	Shelly	6/03/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.28	M
	Lakes	10/03/2020	<i>Carcharhinus sp.</i>	Whaler shark (unknown sp.)	Dead	No	No	2	Unk.
	Shelly	13/03/2020	<i>Sphyrna lewini</i>	Scalloped Hammerhead	Dead	No	No	1.1	Unk.
Central Coast South	Terrigal	23/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.14	F
	Avoca	25/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.14	F
	Kilcare	28/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.05	F
	Umina	28/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.49	M
	Avoca	2/03/2020	<i>Carcharhinus obscurus</i>	Dusky Whaler	Dead	Yes	No	0.77	F
	Umina	12/03/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead and decomposed	No	No	0.4	Unk.
Sydney North	Palm	18/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.95	F

Region	Beach	Date	Scientific Name	Common Name	Status	Samples taken (yes/no/whole)	Tagged	Size (m) FL	Sex
	Warriewood	18/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.8	M
	Palm	21/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.72	M
	Warriewood	21/02/2020	<i>Sphyrna lewini</i>	Scalloped Hammerhead	Dead	Whole	No	1.42	F
	Whale	21/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.95	F
	Warriewood	24/02/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	0.7	Unk.
Sydney Central	Curl Curl	19/02/2020	<i>Carcharhinus limbatus</i>	Common Blacktip	Dead	Yes	No	1.9	M
	Manly	2/03/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Dead	Whole	No	0.57	F
Sydney South	Bondi	28/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.3	F
	Bronte	5/03/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.6	F
Illawarra	Coledale	17/02/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1	F
	Coledale	17/02/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.2	F
	Coledale	17/02/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Dead	No	No	1.3	F
	Wattamolla	17/02/2020	<i>Carcharhinus limbatus</i>	Common Blacktip	Dead	Yes	No	1.8	M
	Wattamolla	17/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.15	F
	North Wollongong	21/02/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.05	F
	North Wollongong	21/02/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Dead	No	No	1.25	F
	North Wollongong	21/02/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Dead	No	No	0.8	F
	Wattamolla	21/02/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.05	M
	North Wollongong	26/02/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Dead	No	No	1.2	Unk.
	Austinmer	11/03/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.05	F
	Garie	13/03/2020	<i>Carcharhinus limbatus</i>	Common Blacktip	Dead	Yes	No	1.95	M
	Thirroul	13/03/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.2	F
	Thirroul	13/03/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.1	F

Appendix 1 Table 8: Detailed Catch Report – 15 March 2020 to 11 April 2020

Region	Beach	Date	Scientific Name	Common Name	Status	Samples taken (yes/no/whole)	Tagged	Size (m) FL	Sex
Central Coast North	Blacksmiths	19/03/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.86	M
	Catherine Hill Bay	28/03/2020	<i>Aetobatus ocellatus</i>	White Spotted Eagle Ray	Dead	Yes	No	0.62	M
	Caves Beach	31/03/2020	<i>Carcharhinus obscurus</i>	Dusky Whaler	Dead	Yes	No	0.78	M
	Soldiers	3/04/2020	<i>Carcharhinus falciformis</i>	Silky Shark	Dead	Yes	No	1.63	F
	Soldiers	3/04/2020	<i>Carcharhinus falciformis</i>	Silky Shark	Dead	Yes	No	1.26	M
	Soldiers	3/04/2020	<i>Galeocerdo cuvier</i>	Tiger shark	Dead	Whole	No	3.24	F
	Blacksmiths	6/04/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.13	F
Central Coast South	McMasters	17/03/2020	<i>Carcharias taurus</i>	Grey Nurse Shark	Alive & Released	No	No	2	M
	Kilcare	24/03/2020	<i>Carcharhinus obscurus</i>	Dusky Whaler	Dead	Yes	No	2.77	F
	Copacabana	25/03/2020	<i>Rhinoptera neglecta</i>	Australian Cownose Ray	Alive & Released	No	No	1	M
	Terrigal	27/03/2020	<i>Carcharhinus obscurus</i>	Dusky Whaler	Dead	Yes	No	2.8	F

Region	Beach	Date	Scientific Name	Common Name	Status	Samples taken (yes/no/whole)	Tagged	Size (m) FL	Sex
	Umina	5/04/2020	<i>Chelonia mydas</i>	Green Turtle	Alive	No	No	1	Unk.
Sydney North	Warriewood	19/03/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.1	F
	Palm	25/03/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.12	M
Sydney Central	Narrabeen	1/04/2020	<i>Chelonia mydas</i>	Green Turtle	Dead	Whole	No	0.46	Unk.
Illawarra	North Wollongong	16/03/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Dead and decomposed	No	No	-	Unk.
	Wattamolla	18/03/2020	<i>Carcharhinus limbatus</i>	Common Blacktip	Dead	Yes	No	1.9	M
	Austinmer	25/03/2020	<i>Carcharhinus limbatus</i>	Common Blacktip	Dead	Yes	No	1.8	M
	Austinmer	25/03/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	0.9	F
	Austinmer	25/03/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.2	F
	Austinmer	25/03/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1.4	F
	Austinmer	30/03/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Alive & Released	No	No	1	F
	Austinmer	2/04/2020	<i>Carcharhinus obscurus</i>	Dusky Whaler	Dead	Yes	No	1	F
	Austinmer	2/04/2020	<i>Carcharhinus obscurus</i>	Dusky Whaler	Dead	Yes	No	0.7	M
	Thirroul	3/04/2020	<i>Carcharhinus obscurus</i>	Dusky Whaler	Dead	Yes	No	0.7	M

Appendix 1 Table 9: Detailed Catch Report – 12 April 2020 to 01 May 2020

Region	Beach	Date	Scientific Name	Common Name	Status	Samples taken (yes/no/whole)	Tagged	Size (m) FL	Sex
Hunter	Newcastle	21/04/2020	<i>Carcharias taurus</i>	Greynurse Shark	Dead	Yes	No	2.91	F
Central Coast North	Blacksmiths	20/04/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.85	M
	Blacksmiths	20/04/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	0.93	M
	Blacksmiths	23/04/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.31	M
	Blacksmiths	23/04/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.14	F
	Blacksmiths	23/04/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.07	F
	Blacksmiths	23/04/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.09	F
	Caves Beach	23/04/2020	<i>Galeocerdo cuvier</i>	Tiger shark	Dead	Yes	No	2.7	F
	Blacksmiths	30/04/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.16	F
	The Entrance	1/05/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.18	M
	The Entrance	1/05/2020	<i>Auxis thazard</i>	Frigate Mackerel	Dead	No	No	0.36	Unk.
Central Coast South	Umina	12/04/2020	<i>Carcharias taurus</i>	Greynurse Shark	Alive & Released	No	Yes	2.3	F
	Avoca	17/04/2020	<i>Myliobatis australis</i>	Southern Eagle Ray	Dead	Whole	No	1.24	F
	Copacabana	17/04/2020	<i>Carcharhinus limbatus</i>	Common Blacktip	Dead	Yes	No	2.01	M
	Avoca	21/04/2020	<i>Carcharias taurus</i>	Greynurse Shark	Alive & Released	No	No	1.8	M
	Kilcare	28/04/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.12	F
Sydney North	Avalon	20/04/2020	<i>Delphinus delphis</i>	Common Dolphin	Dead	Whole	No	2	F
	Bilgola	24/04/2020	<i>Galeocerdo cuvier</i>	Tiger shark	Dead	Yes	No	2.64	M
	Bilgola	24/04/2020	<i>Carcharias taurus</i>	Greynurse Shark	Dead	Whole	No	2	F
Sydney Central	Dee Why	21/04/2020	<i>Isurus oxyrinchus</i>	Shortfin Mako	Alive & Released	No	Yes	1.2	F

Region	Beach	Date	Scientific Name	Common Name	Status	Samples taken (yes/no/whole)	Tagged	Size (m) FL	Sex
Sydney South	Maroubra	22/04/2020	<i>Chelonia mydas</i>	Green Turtle	Alive & Released	No	No	0.9	Unk.
	Cronulla	24/04/2020	<i>Carcharias taurus</i>	Greynurse Shark	Dead	Yes	No	2	M
	Elouera	28/04/2020	<i>Galeocerdo cuvier</i>	Tiger shark	Alive & Released	No	Yes	3.1	M
Illawarra	Wattamolla	15/04/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.15	F
	Wattamolla	15/04/2020	<i>Sphyrna zygaena</i>	Smooth Hammerhead	Dead	Yes	No	1.22	M
	Wattamolla	15/04/2020	<i>Carcharhinus limbatus</i>	Common Blacktip	Dead	Yes	No	1.45	M
	North Wollongong	27/04/2020	<i>Squatina australis</i>	Australian Angel Shark	Dead	Yes	No	0.7	F
	South Wollongong	27/04/2020	<i>Mobula japanica</i>	Spinetail Devil Ray	Dead	Yes	No	1.5	M