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Shark Meshing (Bather Protection) Program 2014-15 Annual Performance Report

Prepared in accordance with the Joint Management Agreements and associated Management Plan

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Coordinating editors:

Trevor Daly
Senior Conservation Manager
Fisheries NSW

Vic Peddemors
Shark Scientist
Fisheries NSW

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Executive Summary

Since the 2009-10 meshing season, the Shark Meshing (Bather Protection) Program (SMP) has operated in accordance with Joint Management Agreements (JMAs) and an associated Management Plan authorised by the *Fisheries Management Act 1994* and the *Threatened Species Conservation Act 1995*.

The JMAs and the Management Plan require an annual performance report to be prepared and submitted to the parties to the JMAs and relevant scientific committees convened under the State's threatened species legislation by 31 July each year.

There were a total of 189 marine life interactions with the SMP during the 2014-15 meshing season, comprised of 44 (23%) interactions with target sharks, and 145 (77%) interactions with non-target marine life. Of those 189 interactions, animals were released alive on 73 occasions.

The 44 interactions with target sharks were comprised of: 10 White Sharks; 8 Shortfin Makos; 6 Dusky Whalers; 5 Common Blacktip Sharks; 5 Bronze Whalers (1 released alive); 5 Broadnose Sevengill Sharks (1 released alive); 2 Bull Sharks (1 released alive); 2 Tiger Sharks; and 1 unidentified shark (decomposition prevented identification).

There were 50 interactions with non-target sharks comprised of 42 Smooth Hammerheads (1 released alive); 4 Greynurse Sharks; 1 Australian Angelshark; 1 Thresher Shark; 1 Silky Shark; and 1 unidentified Hammerhead Shark.

There were 86 interactions with rays, comprised of: 47 Southern Eagle Rays (33 released alive); 27 Australian Cownose Rays (25 released alive); 4 Blue Spotted Eagle Ray (all released alive); 3 Smooth Stingray (1 released alive); 2 Manta Ray (both released alive); and 3 unidentified rays (2 released alive).

There were 9 interactions with marine mammals and reptiles, comprised of: 4 Green Turtles; 3 Common Dolphins; 1 Hawksbill Turtle; and 1 unidentified Turtle (released alive).

Twenty three (23) of the 189 interactions were with threatened species (10 White Sharks; 4 Green Turtles; 4 Greynurse Sharks; 1 Hawksbill Turtle and 1 unidentified Turtle) or protected species (3 Common Dolphins).

The trigger point for the objective of 'minimising the impact on non-target species and threatened species' **was tripped in 2014-15** following the entanglement of **4 Green Turtles** (3 dead, 1 released alive) after 10 were also caught in 2013-14.

The trigger point for the objective of 'minimising the impact on non-target species and threatened species' **was also tripped in 2014-15** following the entanglement of **3 Common Dolphins** (all dead) after 4 were also caught in 2013-14.

The observer program was implemented with observers present on 29% of all net checks (hauls) undertaken by 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 66 of the 116 animals found dead in the nets in 2014-15, with 73 animals released alive.

The compliance plan was implemented in 2014-15. Non-compliance issues related to two contractors was detected which resulted in the issuing of formal letters and withholding of some payments. All non-compliance issues in 2014-15 were resolved to the satisfaction of the shark meshing supervisor.

In the 2014-15 fiscal year there were 18 reported shark incidents in NSW, two of which were fatal. The fatalities occurred at unpatrolled beaches at Byron Bay and Ballina and involved a swimmer and a surfer, respectively. Three shark interactions occurred at meshed beaches of

the SMP at Avoca, Dee Why and Merewether beaches. Forensic investigation by NSW DPI Fisheries shark scientists indicated that those three interactions were with Wobbegong Sharks, which is not a target species of the SMP, and as such these incidents did not trip the trigger point related to 'reducing the risk to humans from shark attacks at beaches of the SMP'.

Therefore the Management Plan trigger point related to the objective of 'reducing the risk to humans from shark attacks at beaches of the SMP' was not tripped in 2014-15.

The Management Plan trigger points related to the other objectives of 'minimise OHS risks associated with implementing the SMP'; and 'transparent monitoring and reporting' were also not tripped in 2014-15.

DPI is currently finalising the 5-year review of the JMA. As part of the 5-year review report, the review reports for the four outstanding trigger points will be submitted to the Parties to the JMA, the FSC and SC. These comprise outstanding review reports for not meeting the objectives of 'reducing the risk to humans from shark attacks at beaches of the SMP' triggered in 2011-12 following a shark bite of a surfer at Redhead Beach; for the 'OHS incidents' triggered in 2012-13 following slip and fall incidents of two contractors; for the 'entanglement of threatened species' triggered following the entanglement of two Humpback Whales in 2012-13, and another whale in 2013-14; and for 'transparent monitoring and reporting' triggered in 2013-14 as the annual performance report was not submitted to the relevant parties by 31 July 2014.

The 5-year review and trigger point review reports will investigate and identify the cause of the problems and identify what, if any, remedial action is recommended to return the performance indicators to an acceptable range. The 5-year review and trigger point review reports will be made publicly available and implemented following endorsement of any recommendations contained therein by the Parties to the JMAs.

In 2014-15, DPI met all requirements of the JMAs and associated Management Plan.

This Annual Performance Report has not identified a need for any amendments to the Management Plan or JMA.

Introduction

The Shark Meshing (Bather Protection) Program (SMP) is a public safety measure introduced in 1937 to reduce the risk of shark attack at the State's most popular public bathing beaches. Surf Life Saving NSW figures indicate that an average of almost 3.9 million people annually swam at those beaches over the last six years. Under the current program, 51 beaches between Wollongong and Newcastle (Table 1, Map 1) are netted by contractors using specially designed meshing nets. The aim of the SMP is to reduce the threat of shark attack within the area of the SMP whilst minimising impacts on non-target species. No fatalities have occurred on a meshed beach in over 60 years, and only one fatality has occurred on a meshed beach since the program commenced.

Since the 2009-10 meshing season, the SMP has operated in accordance with Joint Management Agreements (JMAs) and an associated Management Plan authorised under the *Fisheries Management Act 1994* and the *Threatened Species Conservation Act 1995*.

The SMP is listed as a key threatening process by the Fisheries Scientific Committee (convened under the *Fisheries Management Act 1994*) and the Scientific Committee (convened under the *Threatened Species Conservation Act 1995*) as it adversely affects threatened species, populations or ecological communities and could cause species, populations or ecological communities that are not threatened to become threatened.

The Chief Executive of the Office of Environment and Heritage (OEH) (formerly the Department of Environment, Climate Change and Water) may enter into a JMA under s.121 of the *Threatened Species Conservation Act 1995* with another public authority. Similarly, the Minister for Primary Industries may enter into a JMA with a public authority under s.221V of the *Fisheries Management Act 1994*. 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.

Consequently, there are two JMAs for the SMP. One is between the Minister for Primary Industries and the Director-General of the Department of Primary Industries (DPI). The second is between the Chief Executive of OEH and the Director-General of DPI. The JMAs and Management Plan are freely available on the shark meshing page of the DPI website.

The JMAs and Management Plan were developed after broad consultation with stakeholder groups and the wider community during March to May 2009. The consultation document '*Report into the NSW Shark Meshing (Bather Protection) Program - 2009*' (the SMP Review) provided an environmental assessment of the impacts of the SMP and made key recommendations about ways to achieve the objectives of the program while reducing the potential impact on threatened and other non-target species, and to maximise the potential scientific benefits of the SMP.

The objectives of the JMAs 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 JMAs, the DPI will:

- only carry out shark meshing in accordance with the JMAs 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 JMAs as required.

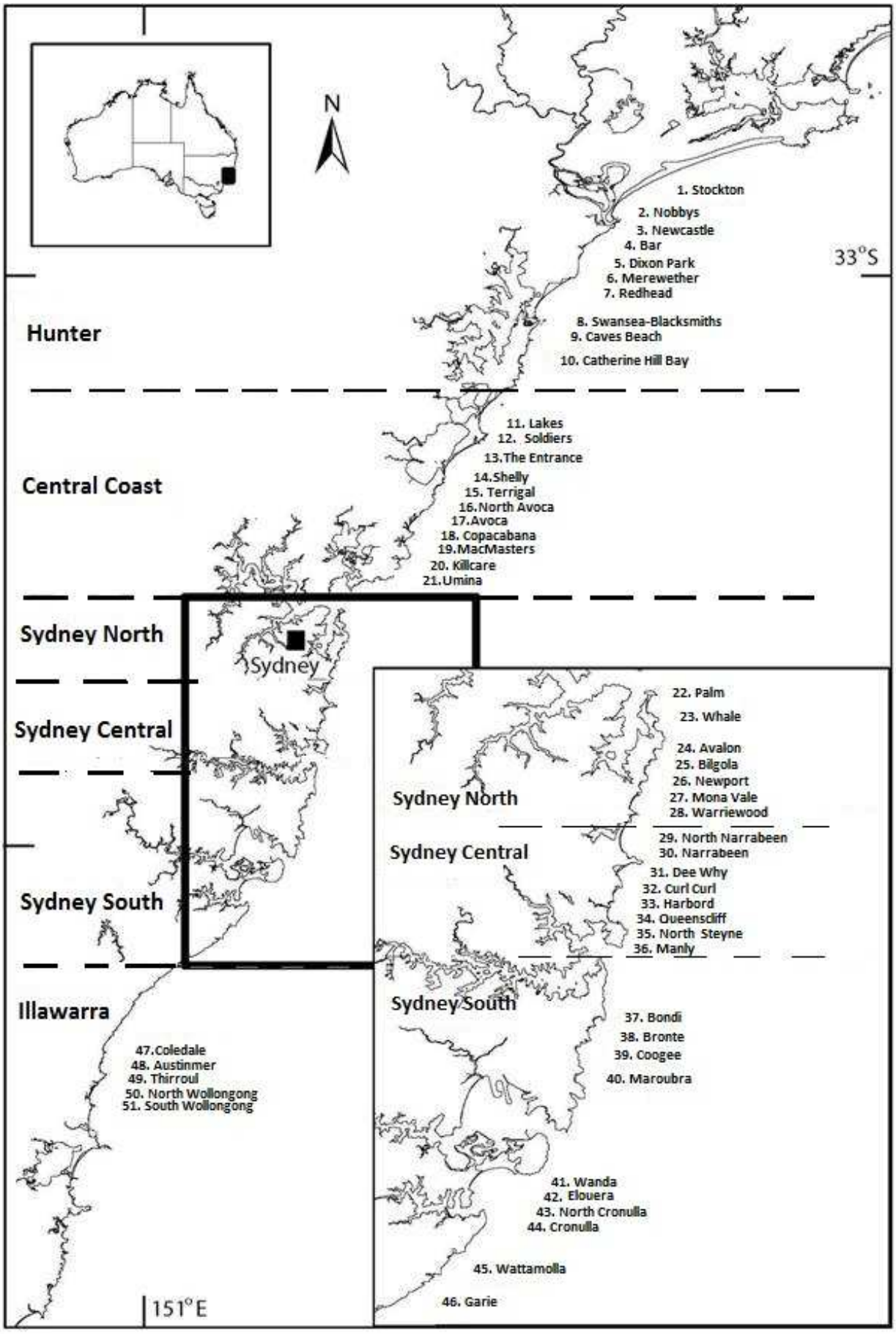
The objectives of the Management Plan are to:

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 6 regions and 51 beaches of the SMP meshed in the 2014-15 season.

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

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



1 SMP Management Plan Performance Assessment

In accordance with the requirements of the JMAs 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 JMAs. The FSC and SC will advise the Minister for Primary Industries and the Chief Executive Officer of OEH, respectively, of any deficiencies in implementation of the JMAs 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.

- During the 2014-15 season the shark meshing supervisor required that when a Departmental observer was on board any of the contractor's vessels that a navigation application be utilised to record the track of the contractor's vessel whilst conducting shark meshing activities. The contract allowed the shark meshing supervisor to instigate the recording of the tracks. The recorded tracks confirmed the contractor's inspections of the nets in accordance with their monthly logsheets.
- 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 following lost or damaged nets were reported during the 2014-15 season. Note that these reports include those where there was apparent interference with nets:

- Sydney Central contractor reported on 30 September that a net at North Steyne was damaged due to what appears to have been an anchor dropped through the middle of the net that cut the net in half.
- Central Coast contractor reported on 24 April the Killcare, MacMasters, Terrigal and Soldiers nets were missing, this was due to the severe storm activity that week.
- Sydney North contractor reported on 24 April the Avalon net was missing, this was due to the severe storm activity that week.

1.2 Observer Program

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

Temporary employment of Observers

To satisfy the Observer Program requirements, three people were engaged by way of temporary employment for the eight months of the SMP (2014-15). Two of the positions were casual positions for the 2014-15 meshing season, with the third position being retained as a temporary full time position for 12 months. One observer worked on the contractor boats in the Hunter and Central Coast regions; and the other two observers worked between the Sydney North, Sydney Central, Sydney South and Wollongong contractor boats. The temporary full time observer also assisted the Shark Scientist with collation of data, dissections and cataloguing 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.

To ensure the observers were competent and resourced to safely undertake the duties prescribed in the Observer Program for the 2014-15 meshing season, DPI conducted a training day on 13 August 2014 at the Sydney North Fisheries Office, Wollstonecraft, for both the observers and contractors. The day broadly covered management changes; contract management; administration; threatened species; and research requirements.

Contractors also attended the training day and were reminded of the tagging procedures and correct collection of samples for the research and monitoring program.

In 2014-15 contractors and observers were reminded to pay particular attention to any hammerhead sharks caught in the nets to ensure correct identification following the 2012 listing of the Great Hammerhead as a Vulnerable species, and the Scalloped Hammerhead as an Endangered species in NSW. Contractors were advised to retain all deceased hammerheads, and to take samples from those in advanced stages of decomposition.

Observers continued to focus on ensuring collection of biological samples, with samples (or whole animals) taken from 66 of the 189 animals caught in 2014-15 (refer to section 5, Table 5). Of the other 123 animals, 73 were released alive.

Allocated hours for Observers

Observers are predominantly used on hauling days, rather than setting days. This enables the observers to document any catch and to assist the contractors with obtaining samples for scientific research. During the hauling process the contractors check the net for any catch, clean the net and check it for any damage. After the net is hauled it may be reset. On average observers were present on 29% of the total hauling days. Details of observer coverage for each region are also provided in Table 2.

Table 2 Observer hours and hauling days observed for 2014-15.

Meshing Region	Total No. of hauling days	No. of hauling days observed	% of hauling days observed	Allocated Hours	Actual Hours
Hunter	116	36	31%	595	363
Central Coast	85	27	32%	595	345.5
Sydney North	108	19	18%	435	246.5
Sydney Central*	108	34	31%	435	199.5
Sydney South*	147	38	26%	466	251.5
Illawarra*	102	35	34%	466	186.5
Total	**666**	**189**	**29%**	**2992**	**1592.5**

*Denotes the 4 meshing regions overseen by the full-time observer position in the SMP - time is allocated for this position up to 38 hrs per week for the entire meshing season and includes work on other SMP-related duties. What are displayed in the table are purely observer hours.

Variations to allocated hours

Variations to the allocated hours can be expected due to inclement / unfavourable weather and unforeseen events.

Overall percentage of haul days observed in the 2014-15 meshing season was 29%, compared with 30% and 19% in the 2013-14 and 2012-13 meshing seasons respectively.

Outcomes of Observer Program

Outcomes of the Observer Program for the 2014-15 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 Fisheries Compliance Unit, Ourimbah).
2. The observers provided accurate setting locations of all nets within the area of operation using hand-held global positioning units (GPS).
3. Details for all marine mammals and reptiles captured in nets were relayed to DPI and OEH.
4. Collection of 41 biological samples and 25 whole animals.

Funding from the Observer Program in the 2014-15 meshing season was made available to fund other commitments such as aerial surveys and for the Observation Tower Funding Program. $30,000 was allocated to the latter, which was shared between Wyong Shire Council, Lake Macquarie City Council, Coffs Harbour City Council and Surf Life Saving NSW. The money for Wyong Shire Council and Lake Macquarie City Council, went towards part funding the ongoing construction of observation towers near The Entrance and Redhead, while Coffs Harbour City Council and Surf Life Saving NSW purchased equipment such as binoculars to assist with bather protection.

1.3 Compliance Plan

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

Audit and Compliance Checks in 2014-15

Compliance inspections were undertaken prior to and during the 2014-15 meshing season.

- Preseason checks of the contractors nets were conducted by the shark meshing supervisor.
- Fisheries officers physically inspected 48 of the 51 SMP mesh nets from offshore patrol vessels or on board the contractor's vessel.
- Three covert operations were coordinated by the shark meshing supervisor as deemed necessary, two of these operations resulted in sanctions placed on one of the contractors.
- On the 22 & 23 of January 2015 an overt operation was coordinated by the shark meshing supervisor which involved fisheries officers being on board contractor's vessels whilst they conducted their operations. Forty three of the 51 nets were inspected by fisheries officers during this operation.
- Throughout the 2014-15 SMP season fisheries officers conducted numerous overt and covert inspections of the contractors and their nets (Table 3).

Table 3 Details of compliance measures undertaken during 2014-15.

Region	Date	Inspection Type
Hunter	27/8/14	Pre-season inspection of 12 nets on land
	30/9/14	At sea inspections of 7 nets (Red Head to Stockton)
	23/1/15	At sea inspections of 7 nets on board contractors vessel (Stockton – Red Head)
	12/2/15	Observations of Contractor operating 10 nets (Bar – Catherine Hill)
Central Coast	27/8/14	Pre-season inspection of 11 nets on land
	17/9/14	Observations of 2 nets (N and S Avoca)
	18/9/14	Observations of Contractor (didn't work)

	19/9/14	Observations of Contractor operating 5 nets (Umina – Terrigal, Killcare not observed)
	20/9/14	At sea inspection of one net by SMP Supervisor on contractors vessel (S Avoca)
	23/9/14	At sea inspection of 11 nets by FOs on board contractor vessel (Umina – Lakes)
	17/10/14	Observation of 1 net set (S Avoca)
	5/12/14	At sea inspection of 1 net set (Macmasters)
	16/1/15	At sea inspections of 9 nets (Lakes – Umina, not N & S Avoca)
	22/1/15	At sea inspections of 7 nets on board Contractor's vessel (Umina – Terrigal)
	23/1/15	At sea inspections of 5 nets on board Contractor's vessel (N Avoca, Shelly - Lakes)
	13/4/15	Observations of Contractor (didn't work)
	14/4/15	Observations of Contractor (didn't work)
	15/4/15	Observations of Contractor operating 11 nets (Lakes - Umina)
Sydney North	21/8/14	Pre-season inspection of 11 nets on land
	24/9/14	Observations of 7 nets (Palm to Warriewood)
	26/9/14	Observations of contractor (didn't work)
	9/10/14	Observations of 5 nets (Avalon – Warriewood)
	22/1/15	At sea inspections on board Contractor's vessel 7 nets (Palm to Warriewood)
	5/3/15	At sea inspections of 7 nets (Palm – Warriewood)
Sydney Central	21/8/14	Pre-season inspection of 16 nets on land
	19/9/14	At sea inspection of 3 nets (Manly – Queenscliff)
	23/1/15	At sea inspections on board Contractor's vessel 8 nets (Manly to N Narrabeen)
	23/4/15	On land inspection and recovery of 1 net (Dee Why)
	5/3/15	At sea inspections of 8 nets (N Narrabeen – Manly)
Sydney South	21/8/14	Pre-season inspection of 12 nets on land
	3/10/14	At sea inspection of 4 nets (Maroubra, Wanda, Wattamolla and Garie)
	5/12/14	At sea inspection of one net (Bondi)
	22/1/15	At sea inspection of 2 nets on Contractors vessel (Wattamolla and Garie)
Illawarra	14/8/14	Pre-season inspection of 12 nets on land
	3/10/14	At sea inspection of 5 nets (Coledale – S Wollongong)
	22/1/15	At sea inspection of 5 nets on board contractors vessel (Coledale – S Wollongong)

Note: 'Inspection' means physically inspected by the shark meshing supervisor or a Fisheries Officer. 'Observation' means that the nets were observed to be set by the shark meshing supervisor or a Fisheries Officer.

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:

- Size, length, marking of nets 100% compliance.
- Pinger and whale alarms on 100% of nets inspected.
- Operational compliance by contractors was 92% 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 every one in ten inspections the compliance rate will be recorded at 90%).
- Beach meshing contractors are required to comply with a range of specifications under the contract. These are monitored by the shark meshing supervisor via covert and overt inspections and observers. Investigations detected instances of non-compliance and in two cases, contractors were interviewed and payments adjusted.

All non-compliance issues in 2014-15 were resolved to the satisfaction of the 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 2014-15.

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.	Status: **Complete** Reported in the 2010/11 Report.

Level 2: Data collection and review of existing data	
Level and Topic	**Status and Comment**
2.1 Review and refine data collection methods	Status: Ongoing. 2.1.1: *Review data collection methods used in the SMP*. Data collection methods are regularly reviewed and are adapted as technology and applicable uses are identified. The shark scientist informally reviewed sampling techniques and conducted a workshop on 13 August 2014 to ensure observers and contractors were trained to collect samples for DNA analysis and other uses. A complete wet lab training session was undertaken and a dissection kit was dispensed for each shark meshing boat. 2.1.2: *Develop refined catch data forms and identification resources*. Catch data forms and instructions for use were dispensed at the pre-season training days for observers and contractors. New skate & ray identification aides were supplied to contractors to assist in correct identification for the catch records. Weekly catch reporting to the Fisheries NSW compliance management officer continued in the 2014-15 meshing season. 2.1.3: *Identify associated training programs for observers and contractors*. The most prominent training required for the 2014-15 meshing season for observers and contractors was reiterating tagging procedures for nominated shark species and disentanglement procedures for non-target species from OEH.
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.* General research has continued into molecular forensics for whaler sharks. No species identification from genetic samples was undertaken in 2014-15. Genetic samples are used for longer term projects and are made available on request to researchers from around the world. Further review of genetic samples and ongoing use for species identification has been limited due to a lack of available funding. 2.2.2: *Identify associated training programs/resources for observers and contractors.* Training of contractors and observers in 2014-15 has been designed to improve accuracy of shark identification, specifically for

Level 2: Data collection and review of existing data

	the whaler shark family which are inherently difficult to differentiate. The use of the DPI publication '*Identifying Sharks and Rays, A Guide for Commercial Fishers*' was revisited during the training day for observers and contractors in August 2014. Each contractor was provided with a copy of the identification book for retention on their meshing boat.
2.3 Review data on temporal and spatial factors affecting the operation of the SMP.	Status: Ongoing. 2.3.1: *Review research being conducted by CSIRO Marine Research on White Shark movements*. 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. The CSIRO provides regular updates of satellite-tagged White Shark movements to the DPI shark scientist. 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. 2.3.2: *Review existing data on other species (e.g. Tiger Shark, Bull Shark).* There have been no substantial increases in knowledge or research on Tiger Sharks occurring in NSW in 2014-15 that would affect the operations of the SMP. 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 submitted in 2014-15 to the international journal, PLOS ONE. DPI scientists are collaborating with Queensland shark scientists tagging and tracking Bull Sharks as the 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. 2.3.3: *Review existing data on spatial and temporal movements of non-target species.* The scientific literature on spatial and temporal movements of non-target species is reviewed where possible given available resources. No new information was obtained in 2014-15 that would 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 shark scientist 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.

Region	Shark sightings		
	2012-13	2013-14	2014-15
Hunter	21	33	60

Level 2: Data collection and review of existing data

Central Coast	12	38	29
Sydney	46	46	46
Illawarra	3	7	4
Total	**82**	**124**	**139**

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

From 2006 to 2036 the population of NSW is projected to grow by over 2.3 million as natural increase and net overseas migration drive growth, while Sydney's population is projected to grow by 1.7 million people during this period (DECCW, 2009). An ongoing increase in beach usage in the area of the SMP can be 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 six years for the beaches listed. The beach visitation is recorded at around 1 pm for the period from 25 September to 25 April of the next consecutive year. The average summer beach visitation within the area of the SMP over the last six years has increased to almost 3.9 million people per annum.

Region	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	Average 09-10 to 14-15
Hunter	122,910	152,788	286,798	360,549	741,444	690,343	392,472
Central Coast	237,751	295,034	412,764	1,095,724	1,260,034	1,241,243	757,092
Sydney	1,543,121	2,051,599	1,783,692	2,483,113	3,488,837	3,897,491	2,541,309
Illawarra	123,940	82,543	105,273	132,628	304,703	392,447	190,256
Total	**2,027,722**	**2,581,964**	**2,588,527**	**4,072,014**	**5,795,018**	**6,221,524**	**3,881,128**

Beaches included in NSW SLS beach visitation data

Hunter	Central Coast	Sydney		Illawarra
Catherine Hill Bay	Avoca Beach	Avalon Beach	Palm Beach	Austinmer
Caves Beach	Copacabana	Bilgola Beach	Queenscliff	Coledale
Cooks Hill	Killcare	Dee Why	South Curl Curl	North Wollongong
Dixon Park	MacMasters	Freshwater	Warriewood	Thirroul

Level 2: Data collection and review of existing data

Merewether	North Avoca	Manly	Whale Beach	Wollongong City
Newcastle	Shelly Beach	Mona Vale	Garie	
Nobbys	Soldiers Beach	Narrabeen	Maroubra	
Redhead	Terrigal	Newport	North Cronulla	
Stockton	The Entrance	North Curl Curl	South Maroubra	
Swansea Belmont	The Lakes	North Narrabeen	Wanda	
	Umina	North Steyne		

Data obtained to date on shark interactions/sightings and beach usage has not indicated that any changes are required to the operation of the SMP.

2.4.3: *Develop better links between agencies and develop systems to optimise collection and use data.*

Productive links have been established between DPI, SLS NSW (volunteers and paid lifeguards), Council Lifeguard Services and the Australian Shark Attack File. Data and information is shared freely between the groups and coordination of information is improving for shark attack responses and the provision of 'real-time' information to surf lifesaving groups during the aerial surveys. During 2014-15, the DPI Shark Scientist collaborated with the Lake Macquarie Council to develop a shark sighting response plan which will enable lifeguards & life savers to minimise risk to bathers following a shark sighting.

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

Status: Ongoing.

2.5.1: *Review NSW shark meshing net configurations.*

The Sydney Central contractor continued a trial of setting his nets approximately 1m off the bottom during the 2014-15 season. This resulted in a substantial reduction in net damage and entanglement with free-floating macroalgae, but batoid catches are too low to enable assessment of the efficacy in reducing their catch. This trial is ongoing and likely to require several more years to determine the results with any statistical certainty. Further research on SMP net configurations will be undertaken pending future research funding and contractor cooperation i.e. amendments to net configurations would be outside the scope of existing contracts.

2.5.2: *Review the application of other shark control measures for use in NSW (e.g. drum lines).*

DPI shark scientist has over 20 years 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 suggest that the electric shark repelling technology presently available may be of limited effectiveness in NSW coastal waters.

The use of drum lines 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 NSW DPI Shark Scientist has however remained in regular contact during 2014-15 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'^{TM} drum line system being developed by the Reunion Island Regional Committee for Sea Fisheries and Aquaculture (CRPMEM) .

2.5.3: *Use the outcomes of those reviews to trial gear-related modifications of the SMP.*

DPI representatives participated in a stakeholder meeting during 2014-15 to discuss new alternative technologies to the

Level 2: Data collection and review of existing data	
	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, it is envisaged that an independent review of currently available technologies will be conducted. This independent review will be followed by a stakeholder workshop to identify potential candidate technologies that may be trialled off NSW beaches in future pending further funding allocation.
2.6 Develop methodologies for standardising fishing effort and analysing comparative CPUE data.	Status: Ongoing 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. 2.6.2: *Develop alternative approaches to standardised soak-times.* No alternative approaches were developed in 2014-15.

Level 3 Establish/support collaborative research (e.g. CSIRO, other government agencies and universities)	
Level and Topic	**Status and Comment**
3.1 Research needs identified (e.g. environmental impacts of shark meshing).	Status: Ongoing 3.1.1: *Distribution, abundance, biology and ecology of target species affected by the SMP*. 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 (*Carcharodon carcharias*) in southern Australia'. This research is currently being prepared for publication in a scientific journal. Additionally, genetic samples of White Sharks caught in the SMP contributed to the first estimation of effective population sizes for Australian White Sharks, and their population structure (Blower *et al.*, 2012). In collaboration with aerial surveys conducted by CSIRO and UTS, the 2012-13 and 2013-14 DPI aerial surveys included surveys of the region between Seal Rocks and Stockton which represent the nursery grounds for White Sharks on the Australian east coast. Samples from White Sharks caught in the NSW SMP have also contributed to a Southern Cross University study in 2014-15 investigating levels of metal and metalloid pollution in sharks off NSW (Gilbert *et al*. 2015) and will contribute to a second publication investigating polychlorinated biphenyls (PCBs). Catch data from the NSW SMP were incorporated into a collaborative study investigating beach areas used by juvenile white sharks in eastern Australia (Werry *et al.* 2012). Authors were from four different institutes, including NSW DPI, CSIRO, Australian Rivers Institute and Queensland DPI.

Level 3 Establish/support collaborative research (e.g. CSIRO, other government agencies and universities)	
	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. The DPI research project investigating the ecology and movements of Bull Sharks in NSW has forged strong links with researchers from Griffith University and James Cook University and QDPI, leading to one published manuscript (Heupel *et al.* 2015) and several international conference presentations. Several research projects investigating whaler (Dusky, Spinner and Blacktip) sharks in NSW and Queensland waters have been initiated with collaborations via Macquarie University, James Cook University and QDPI (Geraghty et al 2013; Geraghty et al 2014). A study investigating age, growth and movements of Shortfin Mako sharks has been completed in 2014-15 through collaboration with UTS, CSIRO and SARDI. 3.1.2: *Distribution, abundance, biology and ecology of non-target species affected by the SMP.* 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 have been published in 2014-15 (Lee *et al*. 2014; Lee *et al*. 2015). A new research project has been 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, and are being prepared for publication. Dusky Shark tissue samples from the NSW SMP have 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. 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. 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; Pirotta *et al.* (in press)). As an international expert on acoustic dolphin deterrents (ADDs) popularly known as 'pingers' and member of the international World Wildlife Fund (WWF) Cetacean Bycatch Task Force, the DPI shark scientist is 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' pinger 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.
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*. An analysis of historical DNA samples taken from sharks caught in the SMP has been completed in collaboration with Macquarie University. DNA samples from sharks caught in the SMP are being incorporated in studies investigating east coast stock structure of various whaler sharks in collaboration with the University of Queensland and James Cook University. Smooth Hammerhead Shark stock

Level 3 Establish/support collaborative research (e.g. CSIRO, other government agencies and universities)	
	structure is being investigated in collaboration with UQ and UNIFESP (Brazil). Collaboration has been initiated with UTAS and JCU to conduct genetic analysis of Seven-gill Sharks. 3.2.2: *Develop SMP DNA library.* A shark DNA library incorporating material from the SMP has been developed by DPI and currently contains over 660 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 (Boomer et al, 2010) was identified in the SMP catch. 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), and Shortfin Mako Sharks. In collaboration with University of Queensland scientists, SMP-sourced genetic samples from Dusky, Sandbar, Common Blacktip (*C. limbatus*) and Spinner sharks are now being used to develop new genetic tools to determine the effective population sizes for these species.
3.3 Conduct scientifically-based shark attack risk assessment.	Status: Ongoing 3.3.1: *Compile data from research relating to identified high-risk elements*. Data is 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. Further research in this area requires access to additional funding. 3.3.2: *Apply standard risk assessment model (i.e. AS/NZ: 4360).* During 2014-15 a risk assessment process was 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 understand the efficacy of the shark nets in reducing interactions with potentially dangerous sharks. Also, 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. 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 2014-15.

<table>
<tr><th colspan="2">SMP Monitoring Program – Outcomes for 2014-15</th></tr>
<tr><td>1. Shark Meshing Contractor Catch Report.</td><td>All contractors provided weekly reports of catches by telephone or were called each Friday to obtain the report.</td></tr>
<tr><td>2. Shark Meshing DPI Catch Summary Report.</td><td>Monthly catch summary reports were submitted to the Fisheries Scientific Committee, the NSW Scientific Committee and OEH (Appendix 1)</td></tr>
<tr><td>3. Tagging program.</td><td>The tagging program continued in 2014-15 however there was only one shark released alive in 2014-15 (Bull Shark) and it was not tagged. No marine turtles were tagged in 2014-15. For further details refer to Appendix 1.</td></tr>
<tr><td>4. Routine DNA sampling and verification.</td><td>Routine DNA sampling of all dead animals was undertaken in 2014-15. This included genetic samples for 41 target sharks, 68 non-target sharks and rays, 3 Common Dolphins, 3 Green Turtles and 1 Hawksbill Turtle (for further details refer to monitoring parameter 5 below and Table 7).
Sampling DNA from live sharks was not undertaken in 2014-15.
No species identification from genetic samples was undertaken in 2014-15 due to a lack of available funding.</td></tr>
<tr><td>5. Shark vertebral and other tissue samples.</td><td>Biological samples were taken from 66 (all dead) of the 189 animals caught in the 2014-15 season, and are listed below:
<table>
<tr><th>Common Name</th><th>Sample Type and Number</th><th>Total Number Caught</th></tr>
<tr><td>Broadnose Sevengill Shark</td><td>4 biological samples</td><td>4</td></tr>
<tr><td>Bronze Whaler</td><td>2 biological samples</td><td>4</td></tr>
<tr><td>Common Blacktip Shark</td><td>3 biological samples</td><td>5</td></tr>
<tr><td>Common Dolphin</td><td>3 whole dolphins</td><td>3</td></tr>
<tr><td>Dusky Whaler</td><td>2 biological samples, 1 whole shark</td><td>6</td></tr>
<tr><td>Green Turtle</td><td>3 whole turtles</td><td>4</td></tr>
<tr><td>Greynurse Shark</td><td>3 whole sharks, 1 biological sample</td><td>4</td></tr>
<tr><td>Hawksbill Turtle</td><td>1 whole turtle</td><td>1</td></tr>
<tr><td>Shortfin Mako</td><td>5 biological samples</td><td>8</td></tr>
<tr><td>Smooth Hammerhead</td><td>5 whole sharks, 24 biological samples</td><td>42</td></tr>
<tr><td>White Shark</td><td>9 whole sharks</td><td>10</td></tr>
</table></td></tr>
<tr><td>6. Monitoring of all shark attacks.</td><td>A total of 18 shark attacks were investigated in NSW waters during the 2014-15 financial year. Three of these were recorded within the SMP region, all of which resulted in minor injuries inflicted by wobbegong sharks. As wobbegong sharks are not a target of the SMP, these shark interactions do not activate any trigger points under the Management Plan. The two fatalities due to shark attack in NSW occurred outside of the SMP region in the Northern Rivers region of NSW.
When an attack occurs in NSW the DPI shark scientist or delegate interviews the victims where they are willing and seeks as much information and evidence of shark identification as can be attained. This includes scale-bar photography of wounds requested from 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.
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.</td></tr>
</table>

SMP Monitoring Program – Outcomes for 2014-15	
7. Monitor technological advances in shark control measures.	Although several new shark control measures have emerged during the past few years, none have been tested in environments simulating the dynamic coastal zone off NSW. Additionally, no scientifically robust evidence has been forthcoming so support claims regarding new innovative technologies developed to detect and/or deter sharks. The NSW Government has announced that $100,000 will be allocated to investigate technological advances in shark control measures. It is envisaged that an independent review of all technologies will be conducted. The results of this independent review will be presented at a stakeholder workshop to identify potential candidate technologies that may be trialled off NSW beaches in future pending further funding allocation.
8. Patterns of movements of non-target marine animals.	DPI has continued working with relevant agencies and reviewed available information during 2014-15 and is not aware of any new information that would necessitate any changes to the SMP.
9. Population trends and patterns of movements of dangerous sharks and attack behaviour.	DPI has sourced information from relevant agencies during 2014-15 and is continuing collaborative research into trends and patterns of movements of dangerous sharks (refer to Table 4 section 2.3). Information available to date does not necessitate any changes to the SMP.
10. Patterns of recreational water contact activities in marine waters.	DPI has reviewed the information that is available from relevant agencies for 2014-15 (refer to Table 4 section 2.4). DPI also collected some data on recreational water contact activities at SMP beaches during aerial surveys conducted during 2014-15. Information collected to date does not necessitate any changes to the SMP.
11. Threatened Species recovery plan reviews.	No new threatened species recovery plans were reviewed in 2014-15 and DPI is not aware of any new information that would necessitate any changes to the SMP.
12. Contractor compliance.	Non-compliance issues related to two contractors were detected during 2014-15 which resulted in the issuing of formal letters and withholding of some payments. All non-compliance issues in 2014-15 were resolved to the satisfaction of the shark meshing supervisor (for further details refer to section 1.3 Compliance Plan).
13. Monitor net locations by GPS.	GPS location of nets was completed during the 2014-15 meshing season and all nets were in similar positions to those reported in previous years.
14. Shark Meshing Program Annual Performance Evaluation.	This 2014-15 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 2014-15.

1.5.1 Objective 1 - reduce the risk to humans from shark attack 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.

The trigger point was not tripped during the 2014-15 season (Table 6).

Table 6 Fatal and serious shark incidents in the SMP regions 2008-09 to 2014-15

Meshing Period	Fatal	Serious	Total
2008-09 (pre-JMA)	0	3	3
2009-10	0	0	0
2010-11	0	0	0
2011-12	0	1	1
2012-13	0	0	0
2013-14	0	0	0
2014-15	0	0	0

Note: Shark attack information was cross-referenced with shark log records held by SLS NSW (Surf Life Saving Manager) and the Australian Shark Attack File (Curator: John West). These enquiries showed that no other attacks resulting in fatality or serious injury were recorded in the area of operation during the reporting period.

In 2014-15 fiscal year there were 18 reported shark incidents in NSW outside of the beaches covered by the SMP, two of which were fatal.

The first fatality occurred on the far north coast of NSW at Clarke's Beach, Byron Bay, which is an unpatrolled beach. The victim was swimming when bitten on both thighs by a White Shark calculated by DPI scientists to be approximately 3.2m in length using forensic techniques. Unfortunately the victim passed away following exsanguination.

The second fatality occurred to a surfer at Shelly Beach, Ballina on the NSW far north coast. Extensive injuries caused by a White Shark of between 3 and 4 metres in length led to the victim passing away following exsanguination. .

One interaction with a Bull Shark approximately 3m in length off Seven Mile Beach, Byron Bay, led to substantial injuries.

Fifteen reported shark interactions resulted in minor injuries, of which four attacks were considered to be provoked (two by Galapagos Whalers during fish feeding on Lord Howe Island, and two on spear-fishers – from a Tiger Shark and Greynurse Shark). Two interactions with White Sharks led to minor injuries, while six were attributed to Wobbegong Sharks. The shark species could not be positively identified for the remaining interactions. Although three of the shark interactions occurred within the region of operation for the NSW Shark Meshing Program, all were attributed to Wobbegong Sharks. The nets of the SMP are not designed to protect bathers from Wobbegong Sharks (which are not a target species of the SMP).

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

The trigger point for this objective is: *entanglements of non-target species and threatened species over two consecutive meshing seasons exceed twice the annual average catch of the preceding 10 years for those species*.

Catch records indicate that 189 animals were reported entangled in the nets during the period from 1 September 2014 to 30 April 2015 (Table 7), and that 77% (145) were of threatened, protected and/or non-target animals (Tables 7 and 8).

Twenty three (23) of those 189 interactions were with threatened or protected species, including:

- 10 White Sharks (all dead);
- 4 Green Turtles (3 dead, 1 released alive);
- 4 Greynurse Sharks (all dead);
- 3 Common Dolphins (all dead);
- 1 Hawksbill Turtle (dead);
- 1 unidentified turtle (released alive).

In addition, there were 131 interactions with other non-target species, including:

- 86 Rays (19 dead, 67 released alive)
- 42 Smooth Hammerheads (41 dead, 1 released alive);
- 1 Australian Angelshark (dead);
- 1 Thresher Shark (dead);
- 1 Silky Shark (dead).

Batoids (rays and skates) continue to comprise the highest proportion of interactions with the SMP, 45%, followed by the collective group of target sharks (Broadnose Sevengill Shark, whalers, Bull Shark, White Shark, and Tiger Sharks) at 23%, and Smooth Hammerheads accounted for 22%.

The trigger point for the objective of '*minimising the impact on non-target species and threatened species*' **was tripped twice in 2014-15** following the entanglement of four **Green Turtles** in 2014-15, after 10 were also caught in the 2013-14 meshing season; and following the entanglement of three **Common Dolphins** in 2014-15, after four were also caught in the 2013-14 meshing season (Table 8).

A review report for both incidents will be prepared 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 JMA was implemented in 2009-10 could provide some indication of the effectiveness of the reduced net checking times from 96 to 72 hours. Table 9 compares the proportion of animals released alive for the five years before and after the JMA for some major faunal groups. This suggests that reduced net checking times have been effective for many of those groups, although it is important to note that many of these animals are caught in very low numbers, and small changes can be reflected in high percentages.

Releases of live target sharks have basically doubled; while releases of live Greynurse Sharks have increased by 50%; and there was approximately a 37% increase overall. Hammerheads and dolphins continue to show 100% mortality. Turtles and ray releases remained relatively constant over that period at about 25% and 68%, respectively.

Table 7 Total SMP entanglements for the 2014-15 meshing season.

Scientific Name	Common Name	Hunter	Central Coast	Sydney North	Sydney Central	Sydney South	Illawarra	Released alive / fate unknown	Dead	Total	% of total*
Target Sharks											
Notorynchus cepedianus	Broadnose Sevengill Shark				2		3	1	4	5	3
Carcharhinus brachyurus	Bronze Whaler	1		2		1	1	1	4	5	3
Carcharhinus leucas	Bull Shark				1	1		1	1	2	1
Carcharhinus limbatus	Common Blacktip Shark	1			1	2	1		5	5	3
Carcharhinus obscurus	Dusky Whaler				1	4	1		6	6	3
Isurus oxyrinchus	Shortfin Mako		3	1		4			8	8	4
Galeocerdo cuvier	Tiger Shark					2			2	2	1
Carcharodon carcharias	White Shark	1	5		2	2			10	10	5
	unidentified sharks		1						1	1	1
Non-Target Sharks and Rays											
Squatina australis	Australian Angelshark		1						1	1	1
Rhinoptera neglecta	Australian Cownose Ray			2	13	10	2	25	2	27	14
Alopias vulpinus	Thresher Shark	1							1	1	1
Carcharias taurus	Greynurse Shark			1	2	1			4	4	2
Carcharhinus Falciformis	Silky Shark		1						1	1	1
Manta birostris	Manta Ray		1			1		2		2	1
Sphyrna zygaena	Smooth Hammerhead	9	8	11	4	8	2	1	41	42	22
Myliobatis australis	Southern Eagle Ray	15	4	7	7	14		33	14	47	25
Sphyrna sp	Hammerhead Shark		1						1	1	1
Aetobatus narinari	Blue Spotted Eagle Ray			4				4		4	2
Dasyatis brevicaudata	Smooth Stingray					3		1	2	3	2
Dasyatidae – undifferentiated	Stingray		3					2	1	3	2
Non-Target Marine Mammals and Reptiles											
Delphinus delphis	Common Dolphin				2		1		3	3	2
Chelonia mydas	Green Turtle	2			1	1		1	3	4	2
Cheloniidae sp.	Turtle		1					1		1	1
Eretmochelys imbricate	Hawksbill Turtle	1							1	1	1
	TOTAL	**31**	**29**	**28**	**36**	**54**	**11**	**73**	**116**	**189**	

* denotes that rounding of percentages results in a number in excess of 100%

Table 8 Non-target and threatened species entanglements[1] for 2004-05 to 2014-15 and trigger point analysis for 2014-15.

Scientific Name	Common Name	04 - 05	05 - 06	06 - 07	07 - 08	08 - 09	09 - 10	10 - 11	11 - 12	12 - 13	13 - 14	10 yr annual average	Trig. pt. (2 x 10 yr ann. avg.)	13 - 14	14 – 15	Trigger point trip?
													Threatened or Protected Species			
Sphyrna mokarran	Great Hammerhead	0	1	0	0	0	0	0	0	0	0	0.1	0.2	0	0	No
Carcharias taurus	Greynurse Shark	2	1	2	2	1	2	3	4	9	4	3.0	6.0	4	4	No
Sphyrna lewini	Scalloped Hammerhead [2]	0	0	0	0	1	0	0	0	1	0	0.2	0.4	0	0	No
Carcharodon carcharias	White Shark	10	8	11	7	8	5	6	15	3	6	7.9	15.8	6	10	No
Cheloniidae spp.	Turtles [3] - combined	4	5	2	3	3	2	7	2	2	12	4.2	8.4	12	6	No
	Unspecified turtles	4	5	2	3	3	2	2	1	1	0	2.3	4.6	0	1	No
Chelonia mydas	Green Turtle	0	0	0	0	0	0	5	1	0	10	1.6	**3.2**	**10**	**4**	**YES**
Dermochelys coriacea	Leatherback Turtle	0	0	0	0	0	0	0	0	0	2	0.2	0.4	2	0	No
Caretta caretta	Loggerhead Turtle	0	0	0	0	0	0	0	0	1	0	0.1	0.2	0	0	No
Eretmochelys imbricate	Hawksbill Turtle	0	0	0	0	0	0	0	0	0	0	0	0	0	1	No
Megaptera novaeangliae	Humpback Whale	0	1	0	0	0	0	0	0	2	1	0.4	0.8	1	0	No
Pseudorca crassidens	False Killer Whale	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0	0	No
Balaenoptera acutorostrata	Minke Whale	0	0	0	0	0	0	0	0	0	0	0.0	0.0	0	0	No
Delphinidae spp.	Dolphins - combined	2	1	4	4	3	2	2	2	0	7	2.7	5.4	7	3	No
	Unspecified dolphins	2	0	0	1	0	0	0	2	0	0	0.5	1.0	0	0	No
Tursiops truncatus	Bottlenose Dolphin	0	1	2	2	0	1	2	0	0	1	0.9	1.8	1	0	No
Delphinus delphis	Common Dolphin	0	0	2	1	3	1	0	0	0	4	1.1	**2.2**	**4**	**3**	**YES**
Tursiops aduncus	Indo-Pacific Bottlenose Dolphin	0	0	0	0	0	0	0	0	0	2	0.0	0.0	2	0	No
Dugong dugong	Dugong	0	1	0	0	0	1	0	0	0	0	0.2	0.4	0	0	No
	Seals	0	0	1	2	1	1	0	0	0	0	0.5	1.0	0	0	No
													Non-Target Species			
Squatina australis	Australian Angelshark	15	15	10	16	12	12	19	14	3	6	12.2	24.4	6	1	No
Heterodontus portusjacksoni	Port Jackson Shark	7	2	4	2	2	6	0	4	3	2	3.2	6.4	2	0	No
Sphyrna zygaena	Smooth Hammerhead [2]	57	39	34	18	13	16	18	36	22	22	27.5	55	22	42	No
Alopias vulpinus	Thresher Shark	3	0	2	3	3	7	3	0	0	0	2.1	4.2	0	1	No
	Rays - combined	58	60	51	46	30	44	60	42	35	90	51.6	103.2	90	86	No
	Finfish - combined	1	2	0	4	1	0	0	0	0	1	0.9	1.8	1	0	No

1: 'entanglements' Includes mortalities and animals released alive.

2: There are low levels of confidence in hammerhead species identification prior to implementation of the JMAs in the 2009-10 season.

3: Turtles have been grouped at family level for reporting purposes. There are low levels of confidence in turtle species identification prior to implementation of the JMAs in the 2009-10 season. Four Green Turtles, 1 Hawksbill Turtle and 1 Unspecified Turtle were reported by contractors in the 2014-15 season.

4: "Smooth Hammerhead" includes unidentified hammerheads.