Submission No 70

MANAGEMENT OF SHARKS IN NEW SOUTH WALES WATERS

Organisation: Australian Aerial Patrol

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Submission to the Parliamentary Inquiry into Management of sharks in New South Wales waters

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1.0 Recommendations

- The Australian Aerial Patrol recommends to government that it establish a permanent coordinating body to ensure that beach safety providers work together in an integrated fashion to enhance bather safety with respect to sharks. Furthermore, the coordinating body should ensure that a proper plan is prepared and funding is made available for more than just in-water mitigation options. For the first 3 to 5 years this body should be administered by the Department of Premier and Cabinet and once it is functioning smoothly it could be transferred to another agency (possibly Emergency Services).
- The Australian Aerial patrol urges the government to work with it to increase the ability of observers to sight sharks by investing in research work currently being undertaken on multi and hyperspectral scanners and related image recognition software.
- The NSW government should investigate the creation of aerial patrols in other parts of NSW. With assistance the AAP would be willing to pass on its skills and experience to any community group that wished to go down this path. The AAP believes that government funding could catalyse private sector investment and, if the coordinating body mentioned above is created, then a new era of collaboration in the collection and supply of data could expand knowledge about sharks across the State.

2.0 Key findings

- We present evidence that aerial patrols are no less effective at protecting beach goers than other established methods. For the Aerial Patrol flight path and the beach meshing program there has been only one fatality in each of the areas covered by these two approaches.
- The Aerial Patrol has been in the air for almost 60 years. It has enormous local support and strong recognition. It brings comfort to people due to its reputation and is fully independent of State government funding. Whilst dismissed by the DPI as being potentially misleading there is real value in providing people with a sense of security – after all the chance of shark bite is vanishingly small but fear of shark attack may stop some people from going to the beach.
- The NSW DPI Fisheries has spent the better part of a decade building a case against aerial patrols and doing little to investigate alternatives to beach meshing. It continues to charter aircraft for ‘surveys’ and then public state that they are of no value. The recent interest in alternatives is solely due to the intervention of the State’s Premier.
- After almost 80 years the reason why the mesh nets are claimed to work still has no answer. On the one hand the DPI claims that sharks are encouraged to swim somewhere else but on the other, the pattern of decline in shark catches in the NSW meshing program parallels a culling program in South Africa and past overfishing of sharks in southern Australia. The lack of any clear answer after 80 years does not bode well for upcoming research programs and cannot be a source of confidence for the public going forward. The DPI needs to provide a robust scientific explanation for the program it is managing with funding from NSW Treasury.
- The coordination of shark related beach safety by a research organisation has clearly failed to keep pace with public concerns and interests, and a new approach is needed. The DPI has variable levels of proof of efficacy for different approaches – with the method it manages having the lowest level of proof whilst demanding the highest level for aerial patrols. We note the desperate need for coordination of parties currently involved in shark related beach safety. We

note the views by colleagues in beach safety providers that much could be done without allocating funds to fisheries research.

- The Aerial Patrol supports research but it needs to be outcome focused and meet the needs of policy makers and beach safety providers. It is not an end in itself. At the moment any research on sharks is promoted as relevant to beach safety but there is a yawning gap between what is undertaken and its application to real world issues. There have been a number of tagging programs operating in the State over at least a decade and, whilst the results are interesting, there is no evidence of them being applied.

3.0 Structure of this submission

The AAP welcomes the opportunity to make a submission to this inquiry and to set out in detail how it currently plays an important role in improving the safety of beachgoers. We demonstrate that the Australian Aerial Patrol has beach safety outcomes that are no worse than existing alternatives and has advantages in some situations. We make the case that different methods need to work together such that the advantages of one complement the disadvantages of another.

This submission:

1. Sets out the background to the Australian Aerial Patrol including operational procedures relevant to shark spotting;
2. Compares the performance of the Australian Aerial Patrol to other aerial patrols around the country;
3. Compares the Aerial Patrol with other mitigation methods currently in use, especially beach meshing
4. Makes suggestions and recommendations about how the government could improve the coordination of existing beach safety providers and enhance sighting rates for aerial work.

Our recommendations are put forward so that government can have access to a full range of approaches that are of value and can be assured that government and non-government organisations work together in a climate of mutual respect.

4.0 History of the Australian Aerial Patrol

The Aerial Patrol was formed in 1957 following a meeting convened by the City of Greater Wollongong Council. The Patrol's charter, to maintain the safety and the welfare of the community through aerial observation and support, was paramount throughout the organisation and forms to this day the basis for which all operations and activities are conducted and provided.

The Australian Aerial Patrol is probably most widely known for its regular shark spotting and beach safety patrols along the coastline between Stanwell Park (south of Sydney) and Mollymook. These patrols are undertaken on Saturdays, Sundays and public holidays throughout the course of summer October to April and constitute an observation platform for recreational safety, be it swimming, surfing, boating, fishing, bushwalking and the like as well as maintaining a watchful eye on potential bushfire hazards. As well, the Aerial Patrol is available to respond to an emergency 24 hours a day, 365 days a year. At peak season, weekday patrols are undertaken resulting in up to 6 passes over beaches each day.

The years 1992 to 2004 saw the beach patrols conducted over Sydney's metropolitan beaches at the request of the NSW Surf Lifesaving Association. The Sydney services were withdrawn the summer of 2003 as a result of funding issues despite vigorous dialogue with the six Sydney Coastal Councils and the NSW Government to offset the shortfall.

In recent years, the Aerial Patrol has expanded its level of service to the communities of the south east region of New South Wales and through its affiliation with the NSW Volunteer Rescue Association, to the regional inland centres throughout NSW. An accreditation under the State Rescue Policy, administered by the NSW Rescue and Emergency Services Board, provides the necessary authority to the Aerial Patrol to assist and support all land and marine based emergency services when appropriate.

In 1993, the Australian Aerial Patrol was recognised by the then Civil Aviation Authority as strategically well positioned, geographically, for Search and Rescue (SAR) and appointed the organisation as an Accredited SAR Unit. This was expanded in 2001 to a Tier 1 SAR capability – the highest level of civilian SAR in the Commonwealth and only one of three such organisations at that time and in the nation. Parallel to that, a Working Agreement was formalised in 1993 between the Aerial Patrol and the Australian Volunteer Coast Guard by the then Minister for Emergency Services constituting the only such Agreement between a marine agency and an aerial support agency in Australia.

The Australian Aerial Patrol, as a Registered Charity, has relied entirely on a wide range of community fundraising mechanisms to offset its operational costs. The promotion of annual art unions is without a doubt the Aerial Patrol's most successful fundraiser. Four Local Government bodies within Illawarra and Shoalhaven provide funding towards the operations and a regional Corporate sponsorship and support from various Registered Clubs and local companies also inject funding towards operations. Further, a number of fundraising functions are conducted throughout the year. Together, these campaigns raise the $500,000+ needed each year to ensure the continued operation of the Patrol's current community activities.

Aerial Patrol personnel undertake their duties in an honorary and voluntary capacity and are rostered for duty 365 days a year for daylight operations. Air crew consist of 6 fully qualified commercial pilots, 36 qualified airborne observers, 12 accredited dropmasters / dispatchers and ten radio communications officers.

The Aerial Patrol is based at the Illawarra Regional Airport at Albion Park. The charter remains as it was in 1957 and will continue as such, although the area of operations has increased somewhat since those early years.

5.0 The AAP and sharks

The AAP was established to spot sharks and warn bathers and beach safety providers. Whilst it has a number of other roles it is best known for its role in shark risk management, being known locally as the 'shark patrol'. The primary purpose of the AAP is beach/waterway safety but we collect shark sighting data which, over time, is proving to be a valuable resource.

We currently operate two flight path lengths. There is generally a long flight that stretches from Stanwell Park to Ulladulla and a shorter flight path which in the past has operated from Stanwell Park to Gerroa. This year we are also doing an early, short flight from Stanwell Park to Windang Island.

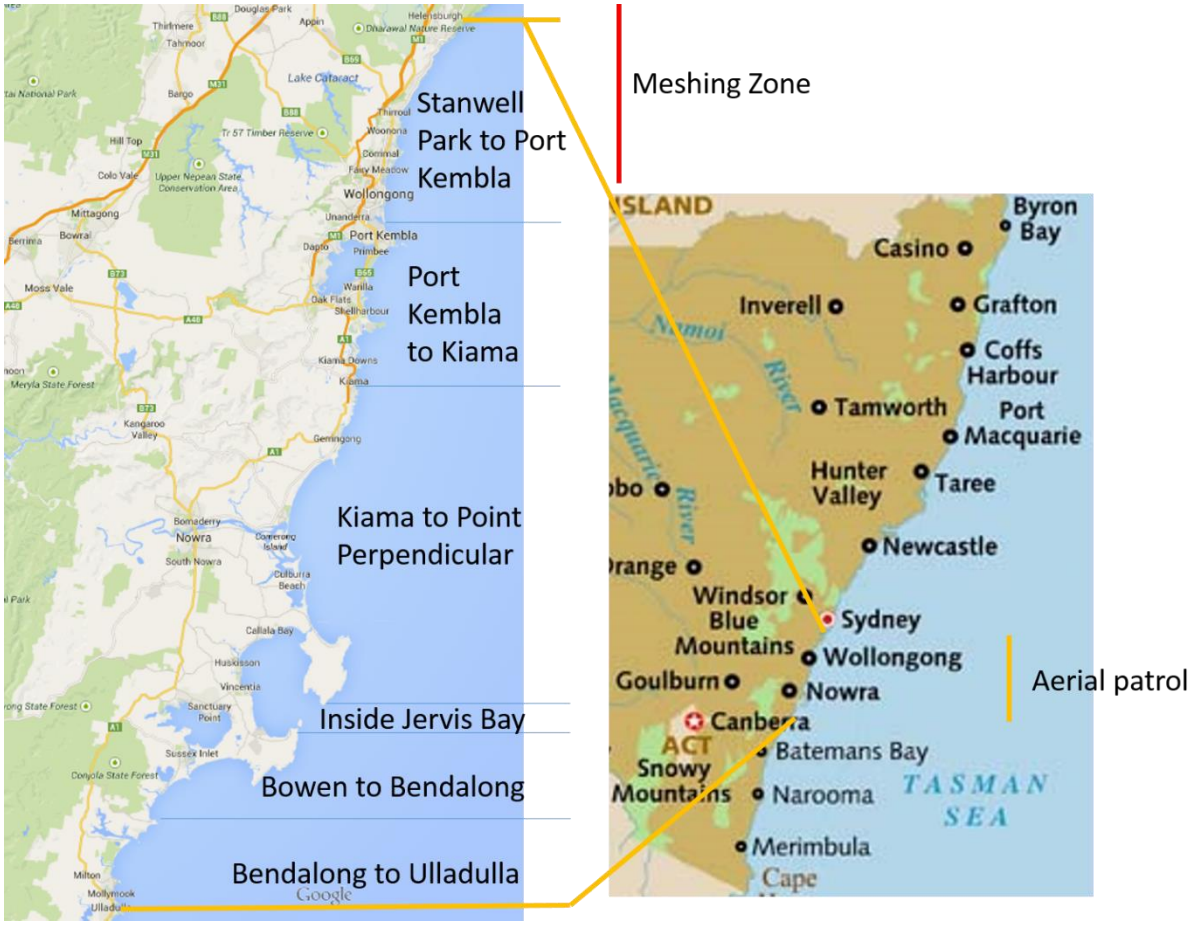

Figure 1 – current AAP patrol area and sub regions for data analysis

5.1 Data logging and reporting

The AAP keeps records of the numbers of sharks seen each flight. Although the AAP has been operating for almost 60 years the available data on shark sightings only dates back to the summer of 1997/1998. However, this is one of the few long term datasets pertaining to sharks in New South Wales. This dataset is currently being cleaned up and analysed. Some preliminary information is as follows:

a. The AAP has very good data on observation effort, i.e. we know how long each flight takes and the distance covered. This enables numbers to be calculated on a per kilometre or per hour flown basis which will resolve any concerns about different numbers of flights being flown each year. Each flight is also time and date logged which could enable researchers to investigate the influence of water temperature, tidal state and other environmental influences.
b. We have divided our core flight path into 6 subregions, defined as follows:
    i. Stanwell Park to Port Kembla – this covers the netted beaches of Coledale, Thirroul, Austinmer, North Wollongong and City Beach. This subregion is characterised by a series of small pocket beaches. Water clarity can be poor after rain due to the geology but these pools of dirty water are very localised and clear away quickly. Most of the beaches have lifeguard patrols.

ii. Port Kembla to Kiama – this covers the entrance to Lake Illawarra and a mix of long and short beaches such as Windang/PortKembla and Kendalls respectively. The longer beaches have relatively small patrolled (by lifeguards) areas and there is a growing number (as a proportion of the total number of beaches) that are not guarded.
iii. Kiama to the entrance to Jervis Bay – this area include the long beach of Seven Mile and the entrances to the Shoalhaven River and Lake Wollumboola (when open). Large areas are unguarded.
iv. Inner Jervis Bay – the Bay contains a number of beaches protected from ocean swells and it is popular with families. Sharks are easy to see against the white sand.
v. Entrance of Jervis Bay to Bendalong– this compartment has long, generally unpatrolled beaches and Sussex Inlet, which is a source of fish heading to the adjacent beaches to spawn.
vi. Bendalong to Ulladulla – a compartment with unpatrolled beaches and the entrance to Narawallee Lagoon.

The rationale for the divisions is as follows:

i. It enables a more detailed analysis of the areas where sharks are most common which may help researchers to look for explanations.
ii. It facilitates discussions with Councils in terms of planning
iii. Observations over many years suggest that sharks are more abundant on beaches adjacent to major estuaries and in the southern part of the patrol path.

c. Each shark sighting is logged by the flight controller onboard the aircraft and the nearest beach logged. In terms of interpreting old flight logs the following interpretation of notes has been adopted in consultation with long standing observers:

i. 'Sharks'- is interpreted to be 2
ii. 'More than X' – is interpreted as X+1
iii. 'Small group' – is interpreted as 5
iv. 'Large group' – is interpreted as 10
v. 'Several groups' – is interpreted as less than 5
vi. 'Many groups' – is interpreted as more than 5

This is a very conservative approach and likely results in an underestimate of numbers. The observer protocol has been changed to require a more accurate count. Changes in data collection protocols over time is not unusual in the collection of fisheries statistics.

d. Our data are reported on the basis of swimming season and not calendar year. In broad terms:
i. Like many other animals shark numbers are very variable in time and space. Sharks may be seen as individual animals or in schools of 100 or so.
ii. Sharks are most abundant in the mid to late summer and early autumn when water temperatures are at their highest. The AAP generally doesn't begin regular flight until December which, based on experience, is when appreciable numbers of sharks first appear. The lack of sightings between April and November does not mean that sharks are not present.

iii. There does not seem to be any overall detectable increase or decrease in numbers over the past 17 years (Fig 2). There is a peak during the years 2007 to 2008 but numbers have declined since then. The species most responsible for the increase in numbers are hammerheads.

iv. The number of sharks seen in the northern part of the patrol path is generally small. Larger numbers of sharks are seen in the southern subregions (Fig 2).

v. It is difficult to identify sharks to species with any degree of regularity. This is especially the case for whalers which are challenging enough when viewed up close. Hammerheads are very distinctive and, given the distribution of the three species occurring in NSW (great, smooth and scalloped), the species seen by the Aerial patrol is likely to be the smooth hammerhead (*Sphyrna zygaena*) as it occurs both north and south of Sydney, whilst the other two species are found to the north. There is some uncertainty about whether bull sharks are found south of Sydney as these have been recorded by observers but the DPI disputes these observations. The Atlas of Living Australia (www.ala.org.au) has records of bull sharks south of Sydney but a recent discussion with a shark expert from the Australian Museum (McGrouther, M. pers. comm.) has revealed that these records are wrongly located.

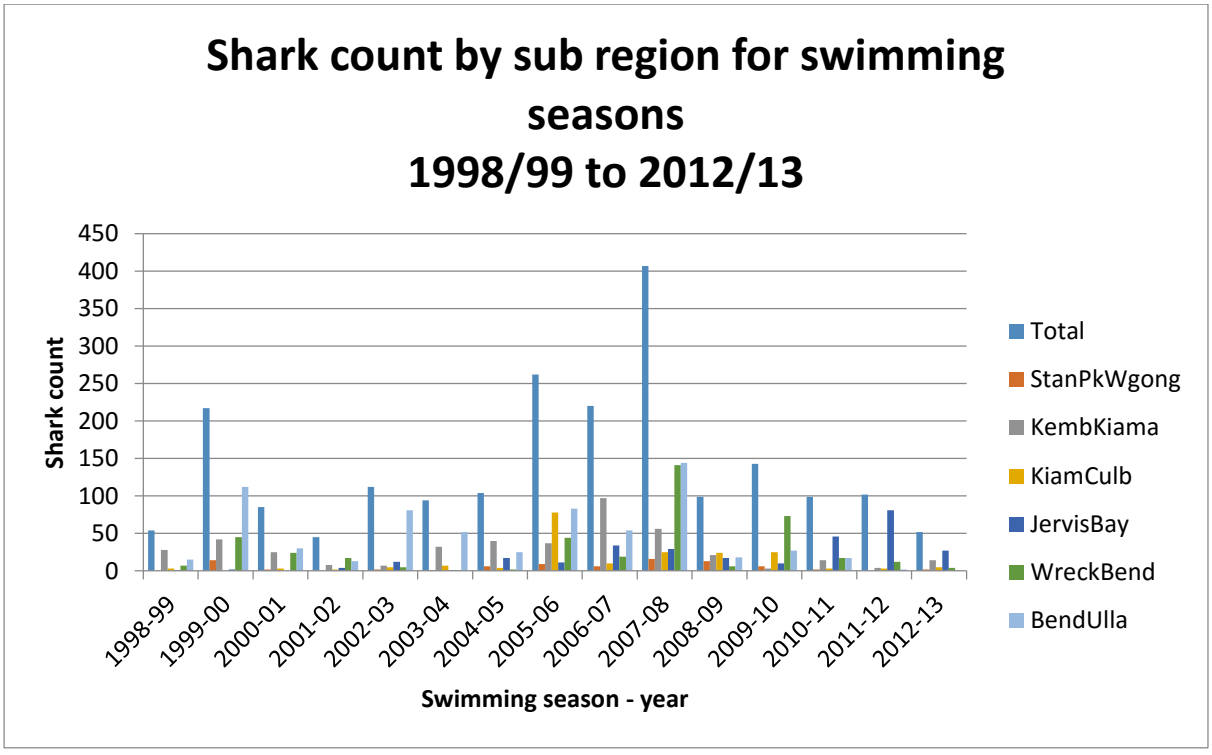

Figure 2 – partial analysis of AAP sightings data – raw data, not corrected for effort (flying hours).

The observation records are comparable to other aerial patrol and work undertaken in Western Australia and NSW respectively, that the counts are dominated by sharks that are not considered to be a significant hazard to humans (although there is no formal agreement on this) and that sharks can be very variable in time and space (McAuley 2006, NSW Beach Meshing Program – annual reports). Some flights record no sharks, others record large numbers. Schooling and aggregating behaviour can generate large numbers in small distances and, in some cases, known aggregation sites contribute to counts each year. It

should be noted that the beach meshing catches are also dominated by non hazardous species (Beach Meshing Program annual reports) and that known aggregation areas (such as the great white nursery ground off Stockton Beach) are considered to be valuable to science.

5.2 Operational reporting and liaison

Upon departure from the air field the flight controller is required to notify SurfComm (central radio command for Surf Life Saving NSW), police, professional lifeguards and Marine Rescue. As the longer flight path transits 3 Marine Rescue regions the flight controller signs on and off each region as the aircraft moves from one jurisdiction to another. This helps ground and water based crews to know approximately where the aircraft is located should they wish to call in a shark sighting or other issue for which they require aerial assistance.

If a shark is sighted there are four options available to the flight controller:

i. For beaches with professional lifeguards in attendance there can be direct radio contact. Ground crews can either advise swimmers to leave the water or they can launch a surf boat to investigate further or drive the shark out to sea with the help of the 'eye in the sky.
ii. For beaches with volunteer life savers the flight controller can radio SurfComm and be put in contact with the relevant beach patrol who can either evacuate swimmers or launch a surf boat to investigate further or drive the shark out to sea as in i above .
iii. For unguarded/patrolled beaches the aircraft has a siren and loudspeaker that can be activated to attract the attention of swimmers/surfers and warn them that a shark is present. This normally involves the aircraft conducting as many low passes over the beach as required to ensure that bathers are aware. If they choose not to leave the water then at least the warning has been provided.
iv. In a very small number of cases the flight controller has called the police when swimmers have chosen not to leave the water when a large shark has been present.

It is up to the flight controller as to what circumstances require action when a shark is seen. No action is taken if no bathers/surfers are present. A large shark close to bathers/surfers generates radio calls or the activation of the siren. The presence of small hammerheads will generate a radio advisory but no other action as these are deemed to not pose a risk. The same may also be true if a larger, potentially hazardous shark is some distance away. The flight controllers err on the side of caution and take action in a precautionary fashion as what is obvious from the air (small or low hazard shark) may not be obvious from the beach when only a fin can be seen. In this regard the action of the AAP parallels that of beach safety providers.

Where there is uncertainty regarding a sighting the observer or flight controller can request the pilot to conduct orbits until a sighting is either confirmed or disproved.

For non hammerheads the flight controller focuses on size and proximity to bathers and is not concerned about making a species identification. The assumption is that any large shark is a potential hazard, noting that the species most likely to be present close to the coast that reach a size that may pose a hazard are generally species on the DPI target list (tiger, white and whaler). Whilst its true that there are some other species that may venture close to beaches (e.g. grey nurse) the assumption is that beach goers may be concerned about a fin and not ask whether the shark is a hazard or not.

The aircraft can also be contacted by beach safety providers to investigate potential sightings at their beaches. From the beach there are a number of non hazardous species that may, when viewed quickly, be mistaken for a shark such as dolphins, seals and sunfish, and even skeins of seaweed and debris. Each year the AAP receives a number of requests from beach crews to investigate a sighting.

5.3 Advantages of aerial patrolling for sharks – costs, distances, unpatrolled areas

Aerial patrols have been utilised as a tool for protecting bathers for many years throughout Australia and have been in and out of favour. In the 1970s a fixed wing aerial patrol operated in the Hunter region and was funded by sponsorship from the local radio station. In the years 2001/02 to 2004/05 a fixed wing aerial patrol operated out of Perth and covered Fremantle to Mullalloo Point (McAuley 2006, McAuley and Nardi 2007). This service was operated by Edith Cowan University Flying School and in its final year of operation cost $150, 000 per year to run. It was terminated for a variety of reasons including poor sighting rates (average 19 per year) and poor record keeping. Its not known how much training the fisheries department did for the flying school and many flights did not have an observer on board.

It should be noted that there are a number of different interpretations of what constitutes an aerial patrol as some organisations will keep an eye out for sharks whilst conducting other duties such as research. We do not consider these to be aerial patrols as the primary purpose is not bather protection. Having said this, the dedicated aerial patrols described below all conduct duties other than shark spotting.

At present there are four aerial patrols that are dedicated to bather protection in Australia:

i. The Australian Aerial Patrol, based in the Illawarra, which operates a fixed wing service and flies beaches from Stanwell Park to Ulladulla (about 200klm). As mentioned above this service is run by a non-profit organisation and is community funded.
ii. South Australian Aerial Patrol which operates a fixed wing service over the beaches south of Adelaide. The service is managed by the SA Department of Emergency Services and was delivered by the University of South Australia flying school but is in the process of being moved. For the 2015/16 financial year it has a budget of $400 000 (SAFECOM website). No data are available on sightings, procedures or flying hours.
iii. In Western Australia there is a rotary wing service funded by the West Australian government. This service is delivered by Surf Life Saving WA and focuses on the Perth Metro beaches with once a day flights down to the south west.
iv. Lifesaving Victoria operates two fixed wing aircraft and a helicopter funded by a mix of contributions from the corporate, community and government sectors. This service called on the expertise of the Illawarra based Australian Aerial patrol to train volunteer observers. Lifesaving Victoria's Standard Operating Procedure with respect to sharks can be found at - http://www.lifesavingvictoria.com.au/resources/documents/LSV_05.12_SOP_05_-_Shark_Sighting_Procedure.pdf

Surf Lifesaving and other safety providers with aircraft are commonly tasked with sighting and reporting on sharks as part of their general patrol duties. Surf Lifesaving South Australia reports shark sightings from several of it platforms, both aerial and water based.

In contrast, research agencies contract aircraft (primarily helicopters, especially in NSW) to survey sharks from the air (see for example, Bruce and Bradford 2008, Bruce et al 2013, NSW Beach

Meshing Program – Annual Reports) and if they see a shark close to bathers they have the capacity to contact ground crews. However, these flights are not referred to as patrols but are termed 'surveys' and the primary purpose is data collection. As such their operational parameters differ from true aerial patrols.

The advantages of aerial patrols are as follows:

- An ability to cover relatively large distances at low cost (for fixed wing).
- An ability to cover areas that are not covered by ground based crews.
- Proactive in nature – surveillance can provide an overview of what is happening and identify emerging situations, rather than responding to an incident after it has occurred.
- For helicopters there is the option of becoming active rescue providers should the need arise.
- Aircraft are visible and people like the idea of someone looking out for them

In the specific case of the Australian Aerial Patrol there are also the following advantages:

- Solid community support – long established in the region with a visible and recognisable brand
- Good liaison with local government and local emergency services
- Volunteer Rescue Association membership and operate according to VRA protocols (including training)
- Innovative
- Can attract private sponsorship and funding
- Cost effective – due to low operating costs and volunteer crews/pilots

5.4 Other airborne platforms - drones

Unmanned Aerial Vehicles (UAVs or drones) have been promoted as a tool for shark spotting and amateur pilots have certainly been able to secure some spectacular photos of sharks from drones. Drones share a few challenges with aircraft such as:

1. Sightability of sharks – water conditions such as clarity, glare etc are an issue for drones http://diydrones.com/profiles/blogs/uav-s-and-shark-spotting-a-case-study but investment in technological solutions could reduce these issues for both UAVs and aircraft. The Western Australia government is investing a significant amount of money into scanner technology and shape recognition software which could apply to both drones and other aerial platforms.
2. Limited time spent over individual beaches – unless a drone is 'parked' over a beach (in which case a tethered balloon would be a better option) then, depending on how long its flight path is required to be and its battery life it could have relatively short time periods over any given beach.

Drones as currently developed have some significant operational limitations such as time of flight (an hour for high end drones), range (experimental drones can travel about 40klm but off the shelf solutions have far smaller ranges) and vulnerability to wind (a major issue on the coast in summer), amongst other issues.

Drone pilots require aircraft licencing (http://www.gizmodo.com.au/2014/10/what-are-the-rules-about-operating-a-drone) if the use is deemed commercial. If purely recreational in nature the rules are as follows:

• Stay at least 30 metres away from people.
• Keep drone under 400 feet (121.92m).
• You may not operate your drone above a large gathering of people (e.g.: at sporting events, over crowds at the beach or groups of protestors).
• You must keep your drone within sight while you're operating it.
• You may not operate your drone within 5km of an airport and a place where planes take off or land from.
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Quite obviously there will need to be some changes if drones are to be used for beach protection work.

From a cost perspective the cost of the drone is not the only cost involved. Images sent to the operator have to be monitored and, whilst this could be undertaken by volunteers there would be fatigue issues associated with watching a screen for the duration of the swimming day. Whilst entry level drones are low in cost, the costs of those that can cover significant distances and carry a camera of suitable quality are far higher. Hourly, commercial operational rates are of the order $100 to $600 (http://www.smh.com.au/small-business/growing/meet-the-aussie-drone-entrepreneurs-20150216-13fz8c.html). The technology is changing rapidly with growing interest in longer ranges http://www.techrepublic.com/blog/european-technology/the-long-range-drone-that-can-keep-up-with-a-car-and-fly-for-an-hour/. The drone technology is only half the equation though as there is a need to ensure that pictures are transmitted to an operator. Placing onboard video downlinks adds additional weight which creates further demands on power supplies and longevity.

Having said that, drones have potential value for smaller beaches or as a back-up in patrolled areas. If the government adopted an integrated approach (as we suggest below) then an investment in technology that aids shark sightability would benefit both platforms.

5.4 Known issues and aerial patrols

Aerial patrols have been reviewed by scientists but not by beach safety providers. According to McAuley (2006) and Robbins et al (2012) the performance issues associated with aerial patrols are as follows:

i. Low amount of time spent over any beach – this can be on the order of minutes if nothing is seen.
ii. Inadequate number of times each beach is visited
iii. Sightability issues associated with environmental conditions such as sun glare, water depth, wind waves and poor water quality.
iv. 'Over representation' of species not deemed to be a hazard
v. Low sighting rates – possibly an outcome of i and ii. (but maybe simply a function of the low abundance of sharks)

The Australian Aerial Patrol took part in trials conducted by NSW DPI in 2011. This research had three main components:

i. Evaluating the depth at which observers could reliably see a plywood cutout shark placed at various depths in Jervis Bay. The waters in which the cutouts were placed were relatively deep (10m or more). It was found that observers could see the cutouts at depths down to 2.5m.

From the AAP's perspective the use of deeper water in Jervis Bay was not representative of actual beach conditions as demonstrated by these two Google Earth images of Jervis Bay and environs taken on the same date. In Figure 2 the top photograph is from inside the Bay and shows the study area to the west of Green Point. The lower photograph is an ocean facing beach (Warrain Beach). The differences in visibility are stark

Survey area where plywood cutouts were located at depth. Typical visibility inside the bay over deeper water – 13m

Open ocean beach on the same day as above photograph. Note the white sand in the area which is the normal observation area for AAP flights

Figure 3 – comparison of water quality in DPI study area versus a patrolled beach

ii. Evaluating the number of plywood cutouts that were set at a depth of just less than 2.5m along a transect in Jervis Bay. According to Robbins et al (2012) observers on board a fixed wing aircraft can see 12.5% of sharks and observers on rotary wing aircraft can see 17% of sharks.

It should be noted that Great White sharks spend about 45% of their time in waters less than 5m deep (Bruce and Bradford 2008). Almost 20% of the time was spent at 60-10m depth, i.e. well offshore. According to Bruce and Bradford (2008) "*Despite the low number sighted, sharks were readily spotted over the sand bottom and this would appear to be a highly successful method for counting sharks in shallow surf zone areas".* This comment is qualified by a reference to the need for clear water and white sands, conditions which are common along the NSW coast in summer when sharks are most abundant.

Figure 4 This photograph extracted from Bruce and Bradford (2008) shows a Great White shark near a large shoal of fish

Interestingly, in their judgement that aerial patrols could have value for conducting counts Bruce and Bradford (2008) were not arguing for long term funding to government employees. They state:

> *Options may exist for local authorities to undertake such surveys and, particularly in the case of aerial based work, local tourist flight operators who regularly fly the Stockton Beach dune and surf zone areas. The latter would require a logbook system similar to vessel based survey forms above.*

We will return to the need for a more collaborative approach by scientists below.

Whilst we would argue that sharks are far more visible than the trials indicate we are very much aware that the Aerial Patrol cannot see every shark. Sharks may well come into the beach from deeper water or a shark may swim from a headland onto a beach after the Aerial Patrol has left the beach. Poor sighting conditions may cause sharks to be missed and we are keen to explore the application of new technologies (mainly being developed outside NSW) that may remove hindrances such as glare.

iii. Counts of sharks and other marine life on a number of flights from Wollongong to Newcastle. It was concluded that sighting rates were very low – of the order 1 shark per 100 klm.

This criticism generates several questions, namely;

a. what number of sharks are there outside of the meshing zone? Surveys conducted by NSW DPI (and reported publicly) are generally in the meshed area;

There are no state-wide fishery independent monitoring programs operating in New South Wales and thus the question of shark distribution and abundance along the coast and over time is impossible to answer. The beach meshing program (itself a fishery) has a good long term data set which is compromised by the lack of data dating back to pre meshing days and for the early years of the program – 1937 to 1949, and the fact that in its early days the

effort (number of meshing days) was highly variable (Krogh 1994). The department has catch records from the commercial fisheries which themselves are compromised by poor reporting and lack of identification – sharks were not reported as a catch until 1948 and, then, only as a group. There is also the Gamefish tagging program which, whilst long term in nature has its own idiosyncrasies (Pepperell 1992).

The AAP's own data (currently being analysed) suggest that sharks are more abundant south of Wollongong and, especially from Jervis bay south to Ulladulla. A preliminary analysis suggests that the abundance of sharks (based on sighting rates over the past 10 years) is six times higher south of Wollongong than the north. There may be explanations other than the decades of netting in the northern area but the coincidence is worth noting.

b. how do the sighting rates of the Aerial Patrol and the NSW DPI helicopter surveys compare to others techniques?

   Obtaining and comparing data from other aerial patrols and other shark bite protection schemes is challenging.

   In South Australia the Surf Lifesaving Association collects data on its shark sighting and reports this publicly (http://www.surflifesavingsa.com.au/docs/academy/annual%20reports/SLS-Annual%20Report-Web-2.pdf):

   Table 1

Platform	Effort (hours/patrols etc)	Shark sightings
WESTPAC Lifesaver rescue Helicopter	1070 hours (123 patrols over 54 days)	60
Lifesaver Jetrescue Boats	n/a	21
Lifesaver Jet Rescue Skis	n/a	14

   In Western Australia shark sightings and observation effort (hours flown) are also reported publicly:
   http://surflifesavingwa.com.au/documents/surf0508-annual-report-2014-pages.pdf

   Table 2

Area	Year	Hours	Shark count
Westpac helicopter	2013/14	425	126
	2012/13	488	123
Southwest helicopter	2013/14	278	117
	2012/13	263	162

   In New South Wales the DPI reports the results of its surveys (not patrols) of the meshing area whilst it is checking on the nets and taking photographs. These results can be found in the Annual Reports of the Beach Meshing Program. The AAP does not (yet) report its data but will do so once the historical data has been analysed and peer reviewed.

If we seek a common unit of assessment (sharks seen per 100klm flown per year) then:

Table 3

Area	Effort (klm flown) *	Sharks/100klm flown
WA Westpac (2013)	58560	0.21
WA Southwest (2013)	31560	0.51
SA Westpac (2014)#	128400	0.04
NSW DPI surveys (2013)	14400	0.14
AAP (2013)	10600	0.6

* For the helicopter patrols it is assumed that the patrols are flown at 60knots (120klm/hr)
# shark observations and flying hours not reported in 2013 annual report

Much higher sighting rates have been document. Bruce and Bradford (2008) recorded 25 sightings of juvenile white sharks equating to an average of 0.83 sharks per kilometre of beachfront searched by vessel but this is in a known aggregation area. The Aerial Patrol could deliver high sighting rates if it simply went back to a known aggregation site for dusky whalers.

Comparing aerial patrols with passive approaches is particularly difficult. The number of sharks seen by beach patrols is sensitive to observer effort (number of beaches and days surveyed), the meshing program is sensitive to the amount of meshing effort and the aerial patrols are affected by days/distance flown. In this table we compare shark 'interactions' (sharks sighted per 100klm of coast per year). We only count sharks that may be seen on or close to the surface.

Table 4

	Shark interactions – average of 4 years 2009/10 to 2012/13	Shark interactions/ 100klm of coast/year
Beach patrols	About 140 shark alarms in 2000 klm &	7
Aerial Patrol	Average 100 sharks/200klm/year	50
Beach meshing	About 60 sharks/200klm/yr *	30
DPI surveys #	65 sharks/200klm/yr	33

& The NSW coastline is about 2000klm long (http://www.ga.gov.au/scientific-topics/national-location-information/dimensions/border-lengths)

* surface sharks only (not including Port Jackson, Angel and seven gill sharks

only two years data reported

c. How many sharks should there be?

In regards to the number of sharks seen per 100klm an obvious question is how many sharks should there be? Most of the DPI aerial surveys (and its 2011 research project – Robbins et al 2012) are conducted in the meshed area between Wollongong and Newcastle where it is known that sharks are less common (see below). Given that it is the aim of the meshing program to reduce the number of sharks it would be surprising if the number of sharks in this region was large. The department claims its beach meshing

program is successful because sharks are reduced in number (as they are sent elsewhere by the presence of the nets) but then claims that aerial patrols in the same area are ineffective due low level of shark sightings.

There is some evidence that sharks are more common outside of the meshed area. Krogh (1994) found that shark catches at the northern and southern end of the meshed area are higher than the middle. There has been a considerable amount of research on the great white shark nursery ground of Stockton Bight which shows a relatively high abundance of sharks and the Aerial Patrol's own observations show that sharks are more abundant in the area from Gerroa south to Ulladulla than they are in the area from Wollongong to Stanwell Park (See Table 5 below).

The question of how many sharks there should be is not an easy one to answer. We know that the NSW coast has low fisheries production due to the narrow continental shelf, lack of large rivers delivering nutrients and the lack of major upwellings. Pepperell (2008) makes the point that the NSW coast was never a rich fishing ground. Having said that, sharks were probably more abundant before European fishing began. Records of shark catches do not appear in the fishery landing statistics until 1948 and records from the shark meshing program prior to 1950 don't seem to be available (see Reid et al 201) and thus it is not feasible to gain an understanding of the abundance of sharks prior to the start of the beach meshing program.

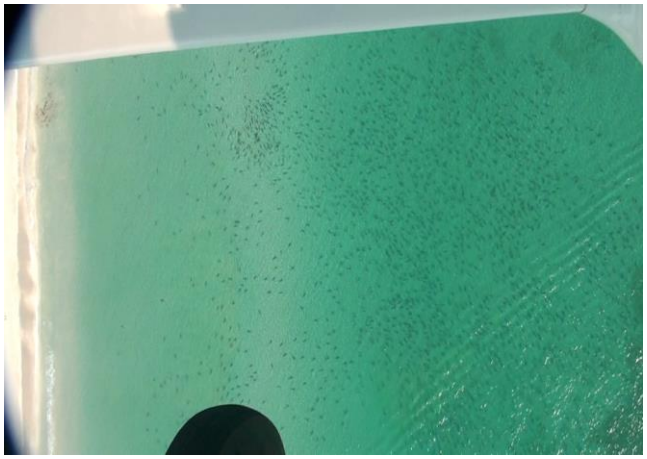

Figure 5a – blacktip shark aggregation in Florida

Photo courtesy: Dr Stephen Kajiura

Florida Atlantic University

Figure 5b – typical shark sighting in AAP flight path

There is no basis for the claim that sighting rates are low as there is no information on what sighting rates could/should be. There is also no information on how many sharks there are in coastal areas. We doubt whether there have ever been the sorts of shark numbers seen using aerial surveys in the eastern US coast from Florida north into the Carolinas ((Figure 5a).

6.0 Comparing aerial patrols with other techniques

Whilst the issues associated with the Aerial Patrol have been researched in depth by the DPI there have been no similar analyses of other techniques currently in use such as the beach meshing program, tagging or beach based observations.

6.1 Beach meshing program

The AAP does not have a formal position on the meshing program but has taken an interest for the following reasons:

i. The meshing program is deemed a success by the DPI whereas the Aerial Patrol is not, even though both approaches have similar outcomes in terms of protecting bathers (See Table 7);
ii. The DPI has regularly claimed that aerial sighting rates are low but most of its data come from the area covered by the beach meshing program (See above)
iii. The DPI uses examples of shark bites in areas covered by an aerial survey as evidence of failure but these same shark bites, which have occurred in the meshed area, are not interpreted as evidence of failure of the meshing program (See later in this section)
iv. The only investment the department has made in alternatives to the shark meshing program has been in evaluating the Aerial Patrol resulting (see Section 6.3)

The AAP has largely been forced into analysing the meshing program in more detail as the DPI's annual claims that aerial work is ineffective have an impact on our work. The DPI maintains this view even though it spends an undisclosed amount on helicopter surveys each year (see response to questions on notice for Budget Estimates 2015). For example the DPI conducted 37 helicopter surveys in the meshing zone alone in 2013/2014 which could cost in the vicinity of $75 000 (37 flights x 400klm – Albion Park to Stockton return - x $1000/hr). According to the beach meshing annual reports these surveys are aimed at checking the nets (which should be the job of the boat based observers who put in over 3000hours per year as paid contractors) and taking photos of sharks (too few to be an issue according to the department).

The meshing program has primarily been analysed in terms of its impact on endangered and threatened species (Green et al 2009). However, despite this program having been operated for some 80 years there has been no detailed evaluation of why it is claimed to be successful. The DPI claims the program is not a cull but culling is one of the objectives documented in Green et al (2009) which is a key guiding document in the joint management arrangements that regulate the program. The DPI claims that the nets are used to prevent the formation of territories by the sharks but there is no evidence of territory formation by the species of concern. The DPI admits that '**There is no scientific evidence that sharks aggressively defend small, localised territories…..'** (Answer to question 253 – Budget Estimates General Purpose Standing Committee No. 5) but then claims that "**The word 'territory' means different things to different people, and this is the case for sharks as well as many other animals "** and argues that a territory includes any sort of aggregation of animals be it for feeding or nursery purposes. However, this broad approach is at variance to the commonly accepted definitions in animal ecology (see references at https://en.wikipedia.org/wiki/Territory_(animal)) where the concept of an area being defended is a key factor separating sites where animals may congregate for some reason as opposed to an area which, in the minds of most members of the community, an animal would defend from interference by others.

These sort of issues become an issue for the Aerial Patrol in several ways. The DPI clams that the meshing program breaks up territories and disrupts migration patterns (Answer to Question 252 - Budget Estimates General Purpose Standing Committee No. 5). In the context of the DPI's claim that mesh net program is not a cull, one implication of the DPI's theory is that sharks are forced out of the Newcastle/Sydney/Wollongong region to other regions. Certainly the Aerial Patrol data show far greater numbers of sharks south of Wollongong than to the north. An analysis of ten years (2004/05 to 2013/14) of Aerial Patrol data for those sections of its flight path inside and outside the meshing zone show the following:

Table 5

Sharks/100klm coast/year for the area Wollongong north to Stanwell Park (meshed)	0.15
Sharks/100klm coast/year for the area Wollongong south to Ulladulla (unmeshed)	0.93

The DPI figure for the whole meshed area (Wollongong to Newcastle) is 0.14 sharks/100klm (Table 3) coast/year but note that this figure is for one year only. Either sharks are seriously depleted in the meshing zone or sharks are being forced into adjacent areas.

A rational explanation for the observations is that the meshing program is simply overfishing the sharks. The Catch Per Unit Effort (a partial indicator of abundance based on catch per netting day) documents a long term decline in the numbers of sharks caught in the area subject to the meshing program (Reid et al 2011). The meshing program is termed "a pulse fishing strategy " in a review of the Queensland program which has gear in the water all year (Anon 2006) in. It is not described as a migration disrupter by fisheries scientists. According to Paxton and West (2006) 'The aim of shark meshing is simply to reduce the populations of dangerous sharks by killing them'. In South Africa it is openly acknowledged that the shark meshing program is designed to achieve localised depletion (Cliff and Dudley 1992), as quoted below:

> ***How Do the Nets Work?***
> *Although incidents have continued to occur at unprotected beaches and at certain netted beaches, the number of incidents in Natal has been substantially reduced by the widespread installation of nets (Wallett 1983; Cliff 1991). The nets have reduced the number of sharks along the entire Natal coast (Davies 1963; Wallett 1983), thereby lowering the probability of a shark encountering a bather at netted or unprotected beaches. This reduction in shark numbers is shown by the rapid decline in the catch rate immediately after the installation of nets in Durban in 1952 (Davies 1964; Holden 1977) and the remainder of the Natal coast from 1966 (Wallett 1983; Cliff* ***et al.*** *1988b) (Fig. 3). Since 1970, catch rates have remained relatively constant, and catches are now thought to be sustained by the influx of sharks from adjacent waters.*

Cliff and Dudley (2011) show how catches increased as more nets were added to the coast and this caused a depletion as catches exceeded the ability of the shark population to replenish itself either via local breeding or inward migration from other areas (See Figure 6).

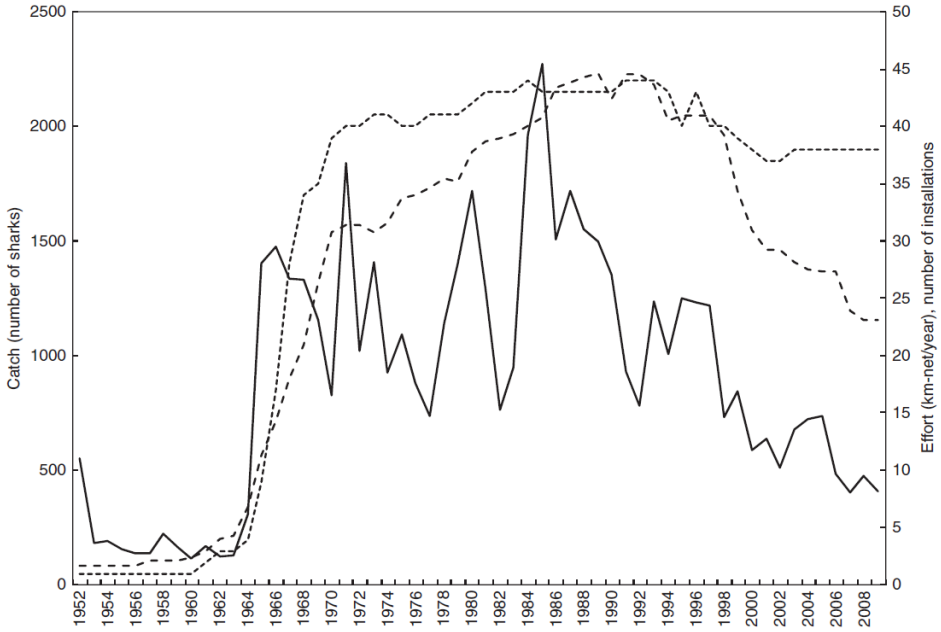

Figure 6 - Reproduced from Figure 2 (Cliff and Dudley 2011) showing total annual catch (solid line) and effort (number of installations, dotted line, kilometres of net per year) in the KwaZulu-Natal shark control program

This graph bears a remarkable similarity to the decline in the NSW shark meshing area (Figure 7.

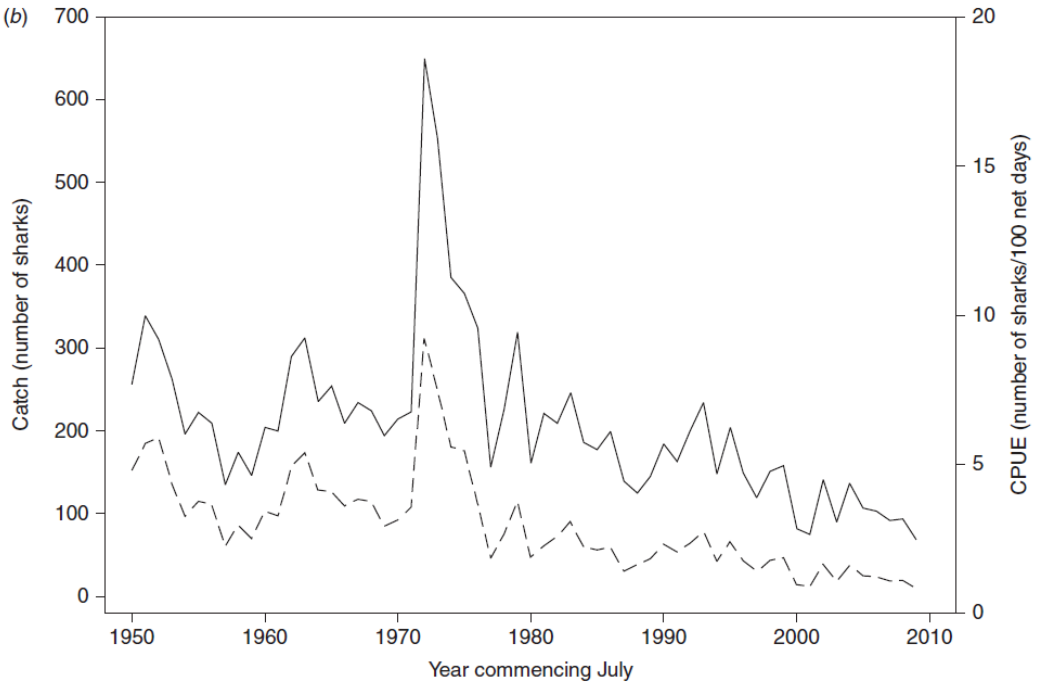

Figure 7 - reproduced from Reid et al (2011) – (a) total effort (number of net days) separated by region for a period from 1950-1951 to 2009-2010. (b) Total catches (number of sharks) by year (solid lines) and catch per effort (number of sharks per 100 net days) 1950-1951 to 2009-2010 (dashed lines).

This depletion effect is similar to many unregulated and unsustainable fisheries. A classic and relevant example from a shark fishery in Australia relates to the fisheries for school and gummy sharks where catches plummeted after an unregulated expansion of fishing, including the use of gillnets (Walker 1998).

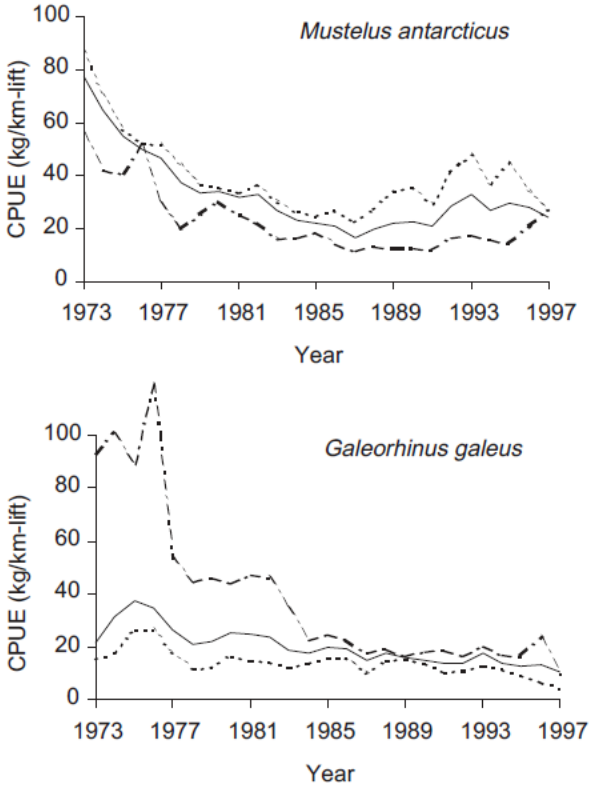

Figure 8 - reproduced from Walker (1998) – *Mustelus antarcticus* and *Galeorrhinus galeus* CPUE trend during 1971-1997 for gill-nets of 6 inch mesh in Bass Strait (-----), of 7 inch mesh off South Australia (-.-.-.-.) and of all mesh sizes and Bass Strait and South Australia combined (unbroken line)

The pattern displayed by the meshing program in New South Wales is much more consistent with a depletion model than a migration disruption model. The DPI needs to clarify its current narrative that the meshing program is not a cull aimed at depleting sharks to some undefined lower level.

This depletion effect appears designed to operate on a regional scale, thus the un-netted beaches are protected by the regional scale decline in shark numbers which is driven by netting at 51 beaches. As mentioned by Cliff and Dudley (1992) the low catch rates are maintained by migration of sharks into the meshing zone. Without this catch rates would be close to zero. Krogh's (1994) observations that catch rates are higher at the northern and southern end of the NSW meshing zone would be better explained by sharks migrating into the meshing area than sharks being dissuaded by the nets in some way and migrating out from the centre.

If depletion is indeed occurring the DPI needs to explain what is the lower limit of the shark population that is being pursued. If the sharks were the subject of a managed commercial fishery most fishery managers would be seriously concerned at the marked drop in catch rates, especially when the catch involves animals which are well known for their susceptibility to fishing pressure. A well-managed commercial fishery would have a limit reference point, below which the fish stock was

not permitted to drop. For a modern shark fishery this would be set at about 50% of the original biomass so as to maintain a viable yield and protect the stock. The CPUE in the meshing program has dropped by far more than 50% and this would indicate that the population has declined precipitously. If this is a deliberate strategy by the DPI then the objectives of the program should be openly stated.

Whilst its true that there has been only one fatality in the Newcastle to Wollongong region since meshing began there have been 46 shark bites in the same area over the period 1953 to 2013 (31 of these in the 20 years from 1993 to 2013) (Australian Shark Attack File). It is clear that the nets do not fully protect bathers as not all sharks are removed. Furthermore, 40% of sharks caught in the nets are caught as they are swimming from the beach out to sea (Anon undated).

The beach meshing program clearly does not take all sharks and clearly does not prevent shark bites. In the same way, the aerial patrol does not see all sharks and occasional shark bites occur in the patrol path. However, the DPI's different approaches to evaluating its own meshing program versus aerial patrols is clearly demonstrated in how it uses shark bites to support its case against aerial patrols:

2011/12 Annual Report

> *Two shark bites occurred within the region covered by the northbound inter-observer aerial surveys:*
>
> - *The first shark bite was at North Avoca on 03 January 2012. Although there was no survey on this date, no sharks were seen by either observer on the preceding (02 January) or following day (04 January), even though additional orbits were conducted in the Avoca region on request from the SLSC.*
> - *The second shark bite occurred on 18 January 2012 at Redhead Beach at 16:45.*
>
> *The aerial survey aircraft flew over this beach at 11:31 northbound and 12:56 southbound.*
>
> *These data again imply the ineffective nature of aerial surveys in providing an additional bather safety network against potential shark attack. The results of the various studies undertaken over several years to date raise serious concerns about the utility of aerial beach patrols as an early warning system for sharks.* (emphasis added)

2012/13 Annual report

> *One shark bite occurred within the region covered by the aerial surveys. The incident occurred at Dee Why on 30 December 2012 at 11:45 am. The victim was surfing along a wave when he felt a bump on his surfboard. The surfer did not see anything, but on reaching the beach after riding a few more waves noticed a crescent-shaped 'bite' in the lower deck of his surfboard. The aerial survey aircraft flew over this beach at 12:15 pm southbound within 30 minutes of the interaction. No animal sightings were recorded within a 33 km radius of Dee Why.*
>
> *These data again imply the ineffective nature of aerial surveys in providing an additional bather safety network against potential shark attack. The results of the various studies undertaken over several years to date raise serious concerns about the utility of aerial beach patrols as an early warning system for sharks* (emphasis added)

The fact that these shark bites occurred in the meshing zone is not interpreted by the DPI as a failure of the meshing program. Indeed the dozens of shark bites that have occurred does not seem to be cause for any real analysis of whether the mesh nets have caused the decline in fatalities or whether other, plausible reasons such as the development of faster emergency services and more effective lifeguard patrols could play a role.

The shark meshing program costs an estimated $1.4million per year, involves about 5000 net lifts and takes a very small number of potentially dangerous sharks (about 30 or so). It is thus, incredibly inefficient.

The mode of operation of the shark meshing program is not unknown. Similarly, it can't be explained why a (claimed) sighting rate of 12.5% can result in no fatalities in the Aerial Patrol flight path since 1966. As to why the meshing programs is a success and the Aerial Patrol not, is a mystery.

6.2 Beach based surveillance

We put forward these observations to demonstrate how beach safety providers can work together such that the weaknesses of one approach can be complemented by the strengths of another. It also demonstrates how the DPI has different levels of proof of value for different approaches to shark hazard mitigation.

Beach based lifeguards and lifesavers have long been tasked with spotting sharks and warning bathers. There are 71 patrolled beaches along the NSW coast (Surf Lifesaving NSW Annual Report 2013/14) with the vast majority being in the Newcastle to Wollongong region. Other beach safety providers cover a number of other beaches.

Patrolled areas are generally small and, outside of the Newcastle to Wollongong region there are not only large areas of unpatrolled beach but large numbers of totally unpatrolled beaches. Figure 9 shows a patrolled section of a beach in the northern suburbs of Wollongong which is also part of the meshing program (a net is just to the North at Thirroul) and part of the Aerial patrol flightpath. Figure 10 shows Seven Mile beach, which stretches from Gerroa south to the entrance to the Crookhaven River. Patrolled areas are marked but there are multiple beach access points along the coast and swimmers and surfers swim virtually anywhere they can access the beach.

Figure 9 - Bellambi Beach patrolled area – northern suburbs of Wollongong

A more significant challenge is that surfboard riders are not permitted to surf between the flags and board riders have dominated the number of shark bite victims in recent years.

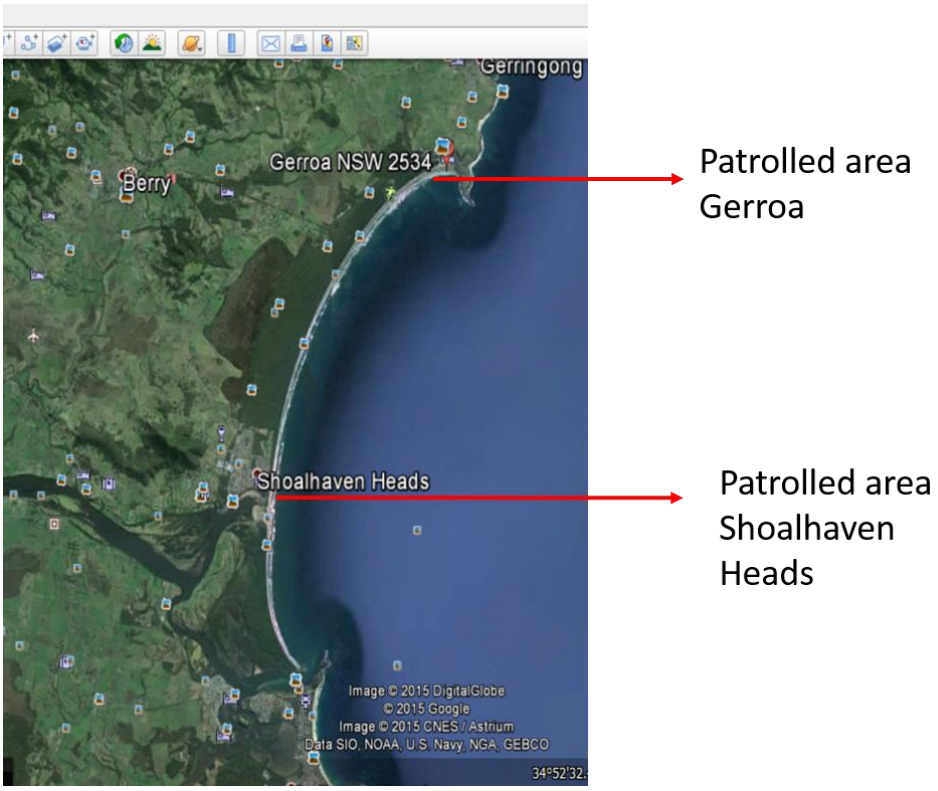

Figure 10 Google earth image of Seven Mile Beach south of Kiama showing the location of the two patrolled areas and the large areas of unpatrolled beach with multiple access points.

Each year the Surf Life Saving Association documents the number of beach evacuation alarms which are used to advise bathers to leave the water. As per Table 4 the average is 140 alarms for each of the past 4 years which equates to about 7 sharks per 100klm of coastline per year. There is no research on what distances the sharks are sighted nor the species involved. This is not a criticism of the SLSA as its primary role is to protect swimmers, not conduct shark research.

The only research reviewed by DPI is from Hawaii (Parrish and Goto 1997) which analysed observations of sharks from lifeguard towers in Oahu (Hawaii). It was noted that "**Sharks were reported as close as the water's edge and as far as 300 m offshore"** but the numbers at each distance were not reported and there was no information on identification to species – an outcome that DPI has criticised aerial surveillance for. The only published study of land-based observations of marine life that could be found involved camera based observations of dolphins in Fremantle (Paiva et al 2015). Cameras could sight dolphins are distances up to 400m. It should be noted that the dolphins were on the surface. This compares to the DPI study of shark sighting from aircraft where the artificial sharks were at 2.5m depth. DPI claims that beach based sighing is better than the Aerial Patrol is based on comparing results of studies of animals on the surface versus animals at depth. Whereas the DPI worries about aerial patrols not seeing sharks before they get close to the surface it has no concerns about sharks getting close to swimmers outside the patrolled areas or whilst not visible to beach based lifeguards.

The DPI has claimed that beach based observing is the best alternative to aerial patrols (Robbins et al 2012) but has provided no Australia sourced research and on this basis the DPI allocates a very

small amount of funds each year for the purchase of beach towers (noting that a tower may, depending on its design and size may cost up to $30K.

The Aerial Patrol maintains a close liaison with beach based safety providers as previously mentioned. The Patrol logs into the SurfComm radio network upon departure from the airport and can contact ground crews if required (and vice versa). The beach patrols are best suited to the patrolled areas and nearby (via their watercraft) and the Aerial Patrol to the unpatrolled sections of the beaches. By working together we match the advantages and disadvantages of each service.

6.3 Other techniques

Under the approval conditions of the Shark Meshing Program, each year the DPI is required to report publicly on its investigations into alternatives to shark meshing. Extracts from the Beach Meshing Program annual reports reveal the following:

Table 6

09/10 Monitor technological advances in shark control measures	Status: Completed. As developed and sourced from relevant agencies. *Passive sonar technology* Passive sonar technology primarily relies on echo characteristics of 'targets' in the water. As air is the most reflective property to sound underwater, swim bladders of fish provide excellent targets for active sonar devices such as fish-finders. There was a review of this technology by the Shark Scientist for the potential application to shark control. The Shark Scientist noted that as sharks do not possess swim bladders they provide a very limited potential acoustic signature for effective tracking. The potential for a passive acoustic array to locate and track sharks was thought therefore likely to be highly restricted. Acoustic signatures for most marine species are not well defined and even acoustic stock assessments of commercially important fish species require a high level of expertise to enable specialist scientists to calculate the biomass of fish in the region. Currently, an automated recognition system only exists in defining acoustic signatures of certain categories of vessel - after many years of dedicated research into vessel signatures. The lack of knowledge of marine animal acoustic signatures would currently require any system to be manned by specialists able to detect potential shark signals as every fish, marine reptile and marine mammal that passes through the acoustic 'curtain' would trigger the alarm. Even if such an array was currently available, it would be unfeasible to use as a shark defence system due to the sheer logistics of such a program. No other shark control measures have emerged recently that can be reasonably considered as a practical alternative to meshing.
2010/11. Monitor technological advances in shark control measures.	Status: Ongoing. Aerial surveillance trials have been undertaken (refer to section 2.3 Helicopter and Aerial Surveillance Trial). No new shark control measures have emerged recently that can be reasonably considered as a practical alternative to meshing.
2011/12 *Continue to evaluate alternatives to lethal methods of shark control.*	A review of the potential for electric barrier technology to be used as a shark control measure off NSW was completed in 2007 (Peddemors, 2007). DPI's Shark Scientist has over 20 years experience in electro-repelling of sharks and is regularly reviewing any new technologies that may assist in developing non-lethal shark control measures. Trials using the

DPI Shark Scientist will continue to monitor alternatives to the SMP for more details refer to section 2.5 Review effectiveness of fishing operations used in shark control programs.	SharkShield™ with small whaler sharks (*Carcharhinus galapagensis*) indicated that the technology was not able to deter these sharks if recognisable bait was presented. The data suggest that the electric shark repelling technology presently available may have limited effect in NSW coastal waters. The use of drum lines is not permitted under the operation of the SMP through the Management Plan as contractors are prohibited from using baits or lures.
2.5.3: *Use outcomes to trial gear-related modifications of the SMP.*	No alternative to physical shark control measures are considered viable to trial.
2012/13 7. Monitor technological advances in shark control measures	Status: Ongoing. Aerial surveillance trials have been undertaken (refer to section 2.2 Aerial Surveillance Trial). No new shark control measures have emerged recently that can reasonably be considered as a practical alternative to meshing.
2013/14 2.5.3: *Use the outcomes of those reviews to trial gear-related modifications of the SMP.*	No feasible alternatives to the measures in the SMP are currently considered viable to trial, however DPI will continue to liaise with relevant proponents with a view to conducting sea trials when and if appropriate
7. Monitor technological advances in shark control measures.	Status: Ongoing. Aerial surveillance trials have been undertaken (refer to section 2.2 Aerial Surveillance Trial). No new shark control measures have emerged that can reasonably be considered as a practical alternative to meshing.

Several aspects are apparent from this analysis:

1. By and large the DPI has done very little beyond reviewing the research of others to investigate any alternatives to the mesh nets as required in the management plan.
2. The DPI has spent a considerable amount of time and money documenting the weak points of aerial patrol work. As to how this meets the requirement to 'Monitor technological advances in shark control measures' is an open question, especially when alternatives which would be better described as 'technological advances' have been subject to far less scrutiny and expenditure of public funds. According to Anon (2015) **- Aerial survey methods were not considered in this review, as they have been previously investigated by the NSW DPI (in the case of fixed-wing and helicopter platforms; Robbins et al. 2012**). Its beggars belief that the DPI thinks that that this is the end of the story when it comes to improving shark sightings using technology. A few minutes on Google has generated some productive conversations for the AAP and we are having to follow up and seek our own funding for research and development aimed at improving sightability of sharks.
3. The DPI has initiated no research on alternatives to beach meshing as far as we can ascertain.
4. If the DPI had conducted the reviews it was required to do (and has demonstrably done at least in the early years of the management plan) then the rationale for allocating $30 000 for the recent consulting report (Anon 2015) on alternatives needs to be spelled out.

Without the intervention of the Premier its unknown how long this situation would have persisted. Furthermore, given the annual criticism by the Fisheries Scientific Committee of the DPI's performance on its implementation of the management plan, there is a clear need to ensure that the focus of DPI shark research, as it relates to swimmers, should be focused on enhancing protection.

The lack of accountability for its actions is a significant issue as the State moves forward into, hopefully, a new era of protecting bathers and reducing the sorts of fears that may have wider community impacts. Before we turn to the recent consulting report on alternatives to beach meshing we want to draw the attention of the Inquiry to the arbitrary nature of the evaluation criteria employed by the DPI in its judgement about mechanisms for protecting bathers.

Table 7

Program	**Documented outcome performance**	**Determination and source**
Beach meshing	One fatality since commencement	Successful according to DPI promotional material and Green et al (2006)
Aerial Patrol	One fatality since commencement	Ineffective according to DPI research (robbins et al 2012) and 'discredited' according to commentary by one scientist (https://theconversation.com/mike-baird-is-right-culling-sharks-doesnt-work-heres-what-we-can-do-instead-46195)
Beach based observations including towers – Australia	Anecdotally there have been no fatalities in a patrolled area of a beach.	Deemed effective by DPI commentary (Robbins et al 2012)
Shark spotters program South Africa	One fatality since commencement	Deemed effective according to Robbins et al (2012) and in Anon (2015)

It is clear from Table 7 that different approaches are evaluated in an inconsistent manner. Furthermore, as documented above, the DPI has not allocated research funds to any other approach claiming that there is no proof that they work yet proof points for some mechanisms are very low indeed.

For other approaches such as sonar (Clever Buoy), electrical barriers and SharkSafe (kelp mimicking barrier) the criteria for evaluating performance are unknown. Waiting for shark bites to occur in areas that have trials versus no trials could take decades and have a questionable ethical basis. If the research is based on evaluations of how many sharks cross the barriers then this presents significant challenges as the DPI has no data on how many sharks there are and it is impossible to tag all sharks that may potentially cross the barrier, noting that tagging data shows that species of concern may travel hundreds if not thousands of kilometres and the possible population of great white sharks alone may be of the order 800-1200.

In the recent consulting report "The Cardno Review" (Anon 2015) the consultants made their recommendations based on:

1. *Practically able to implement at a whole-of-beach scale?*
2. *No potential to affect human health (e.g. pacemakers)?*
3. *Ability to withstand conditions similar to NSW beaches?*
4. *Currently commercially available?*
5. *Effectiveness tested on white, tiger or bull shark, or is technology a physical barrier?*
6. *Has independent testing been undertaken and/or have results of testing been published in the peer reviewed literature that verified effectiveness against white, tiger or bull sharks, or technology is a physical barrier?*
7. *No potential for adverse impacts on wildlife?*
8. *No potential to affect other water users (e.g. commercial fishers)?*
9. *Cost*

Oddly, there is no outcome focused on ensuring people are safe, other than ensuring that they are not impacted by the equipment being tested. What is required is some clear outcome criteria against which the techniques can be tested to ensure that the same performance criteria applied to the meshing program and approved techniques are being applied to the trials. If this is not undertaken then there is the risk that perfectly useable approaches may be deemed unacceptable for illogical reasons.

7.0 Costs

Aerial patrols are deemed expensive by the DPI but there is no independent analyses of costs and no real benchmarks. Some of the complicating factors include:

1. Some aerial patrols are dedicated as such but most will conduct other duties as the need arises. For the AAP, other duties are a significant part of the role due to its membership of the Volunteer Rescue Association (VRA) and these duties include waterway safety beyond sharks, fire spotting, assisting rescues and the like. Other aerial patrols are primarily focused on a suite of activities of which shark spotting is one, such as many of the patrols undertaken by Surf Lifesaving. Similarly, the DPI operates surveys, aimed more at photographing sharks than bather protections. The patrol purpose dictates how frequently the beaches get overflown and this is one of the main areas of criticism for aerial patrols. However, the same concern exists with patrols oriented towards ascertaining swimmer risks – a helicopter could fly over a beach and someone enter the water two minutes later and drown. However, there is no criticism of these types of beach patrols from the DPI even though drowning is a far more common issue than shark bite.
2. Type of aircraft – there is a range of hourly costs associated with different types of aircraft. Small single engine fixed wing aircraft cost about $350 an hour to charter whereas a large helicopter may cost ten times this much.
3. Organisational structure – organisations that are based on paid employees have higher costs than volunteer based organisations. The AAP has an advantage as almost all of its services are, including pilots, ground staff, observers and flight controllers are volunteers.
4. Area covered and frequency of coverage – the size of the patrol area is obviously a factor. In Western Australia there are some long distances down to the South West to be covered and this, couple with the use of helicopters makes the work expensive. Number of overflights is a cost issue and this can vary according to time of year and day of the week.

Table 8

Type of aerial work	Distance covered - frequency	Annual cost
AAP	200klm, beaches covered between two and six times per day in peak swimming times	$0.5m
WA metropolitan and SW *		$2.5m ($12.237m over 5 yrs)
WA extended SW *		$0.7 ($2.619 over 3 years)
South Australia SLSA	Not apparent from annual report	?
South Australia aerial patrol #	40klm	$0.4m
NSW DPI surveys @	200klm	Charter cost only – estimated $75000. Staff costs not included. Other survey flights not included.

* Department of Premier and Cabinet

http://www.safecom.sa.gov.au/site/about_us/how_sector_is_funded.jsp)

@ Estimate based on reported number of flights (Annual Report) and charter costs (estimated to be about $1000/hr)

Costing other measures used to protect bathers is also challenging. The WA government has costed a number of activities which are either directly or indirectly related to sharks (Appendix 1). A great deal of funds have been directed at research (not just fisheries research), advisory material and the like which are directly related. Items such as jet skis would be multi-purpose. In New South Wales there has been an investment in research (mainly focused on shark tracking) and advisory material. The DPI also has a small grants program to fund observation towers on beaches (http://www.dpi.nsw.gov.au/fisheries/info/sharks/tower). The number funded to date is not listed on the website and the definition of 'tower' is very broad. The main program run by DPI is the beach meshing program, the costs of which are not documented in each annual report but are in the order of $1.4m per year. As mentioned previously the outcomes of the beach meshing program and the Aerial Patrol (fatalities) are the same. The AAP is about one third the cost of the beach meshing program (due to it being sponsored and relying on volunteers).

8.0 Public interest and public response to the AAP

The public has an enormous interest in sharks and a fear that is out of all proportion to the risk of being bitten. Friedrich et al (2014 and Crossley et al (2014) are but two groups of a large number of authors who have explored the relationship between humans and sharks and its not proposed to conduct a detailed review here. Suffice to say that the fear that people have of sharks is out of all proportion to the risk of shark bite and the media has played a major role in fanning the fear. If there are real impacts on tourism then its an open question as to whether the sharks are a problem or some sections of the media.

Managing perceptions needs to be a key plank of any government response. There is a limit to what science can do when what the public want to have is a sense of security and beach safety providers have a clear understanding of this. Whilst organisations such as SLSA engage in scientific research this research is but one plank of an integrated strategy that focuses on improving bather safety and having a recognisable brand associated with this. The NSW DPI doesn't seem to understand this.

Chartering helicopters from commercial companies may provide photographs but they are invisible as far as the public are concerned. If a member of the public sees the AAP or a SLSA helicopter it has a far more powerful message.

Aerial patrols have been accused of providing a false sense of security for the beach going public (Robbins et al 2012). Research in South Australia suggests that the public overestimate the ability of aerial patrols to see sharks (Crossley et al 2014). Curiously, the same allegations are not made about the role of aerial patrols in possibly encouraging people to swim, and drown. The implication is that a person may be encouraged to enter the water when the risk of shark bite is more than they perceive. It should be noted that neither the South Australian Aerial Patrol nor the Australian Aerial Patrol make any claims that beaches are 100% safe as a result of their activities.

Robbins et al (2012) did not investigate why the public thought highly of the Aerial Patrol and no research has been undertaken on anything other than the technical aspects. For the people in the Illawarra and Shoalhaven the Aerial Patrol has been a part of beach going life for a couple of generations and it has enormous brand recognition. Anecdotally, the high visibility of the Aerial Patrol makes people feel comfortable that someone is looking out for them. Whilst this may not be a scientific approach the fact is that the whole issue is ruled by emotion which defies rational analysis. (Neff 2012). The media shapes the public discourse around sharks on beaches and politicians need to respond. A purely rational response would be that the low number of shark bites does not warrant netting or any other technique is not the advice politicians welcome when the pressure is on.

The aerial patrols may not be perfect and have a performance record no worse than the meshing program. Given that beach meshing does not make beaches 100% free of shark bites, and the government encourages the perception amongst the public that meshing the beaches makes swimming safer there is an argument that if aerial patrols are misleading then so too is the meshing program.

The need to implement a program that integrates the science and the management of public perceptions is increasingly important. Whilst the response to the Western Australia government's program of shark measures was shaped by the debate over drumlines the fact remains that there was a wide variety of initiatives. In discussing this with people in WA it is clear that the key involvement of a coordinating agency like the Department of Premiers and Cabinet has helped bring parties together. In NSW the DPI does not act in this way. An integrated policy response that provides some assurance to the people that their safety is of concern will not be delivered by an agency that is purely focused on research and this needs to change.

9.0 Existing solutions to known issues

Fisheries agencies (McAuley 2006 and Robbins et al 2012) have put forward a comprehensive list of the problems of aerial patrols, not just the AAP. Our response to these is as follows:

Table 9

Issue raised by fisheries agencies	**Current AAP action**	**Future opportunities if funding available**
Weather may prevent flying	Safety is paramount	Non proposed
Low amount of time spent over beaches *	Increase number of passes per day.	Funding dependent. Also requires sufficient volunteers.

	We have experimented with GPS tracking of the plane as it could allow members of the public to know when the plane is coming. The technology works but some investment is needed to make it easy to use.	One option is to provide an emailable link to GPS tracking run from the plane. There is free software but some IT involvement would be needed to enhance public access.
Sightability of sharks under some environmental conditions (e.g. glare, poor water quality, water depth)	Observers use polaroid sunglasses (as do life savers). This is a known issue and options being researched	New scanner technology being developed outside of NSW could be brought in for trials and development. AAP has a proposal from a WA provider and is currently looking at fund raising options.
Poor reporting	AAP flight reports are filed at the completion of the flight. Council and the AAP steering committee generally has observer reports by the end of the flying day AAP is currently getting its data holdings analysed so as to review gaps and areas for improvement	Currently considered best practice Funding application (2nd) made to an overseas foundation to enable a workshop to be run to help us review our data collection and reporting procedures.
Poor training and interest	This may have been an issue in WA in the past but is not an issue for the AAP	Currently considered best practice. Depending on interest in the DPI there may be opportunities for enhanced data collection but this requires some interest in the AAP's activities
Poor sighting rates	As demonstrated in this submission the alternatives have significant questions over what proportion of sharks are caught or seen (beach based observers). #	This needs the attention of an independent group of scientists to review the DPI claims.
'Ineffective'	Outcomes in terms of fatalities no different to meshing program	If the meshing program is effective then the AAP is effective.
Lack of accurate species identification	AAP can reliably separate hammerheads from other species. In discussing this with other aerial patrols the rationale for highly accurate species ID is unclear. Beach goers worry about seeing a fin, and whether it is attached to a	With some training the identification work could be improved. WA has some good aerial photography and the AAP could approach universities to provide some training.

	dusky whaler or a bronze whaler is irrelevant.	

* as mentioned elsewhere in this submission this only seems to be put forward as an issue for shark patrols. Fisheries agencies are unconcerned about the same situation applying to a bather entering the water and drowning whilst an aircraft is not present.

in the 2014/15 meshing season the DPI helicopter survey counted 29 great white sharks in the Hunter region. The mesh nets caught 3. These poor results may be indicative of the inefficient nature of the shark nets.

In the view of the AAP there could be efforts to improve the sightability of sharks under less than optimal conditions. The WA government has allocated considerable funding to this and the AAP has being investigating how to source funds to enable the technologies to be developed in NSW. For this work to be funded in NSW would require the involvement of an agency other than DPI as it is not a fisheries issue.

Electronic remote sensing has been trialled in a number of areas for spotting marine wildlife. For example, LIDAR (laser based scanning) has been used for counting whales in Canada and has the potential see sharks as it is used for underwater mapping from the air and has the capacity to 'see' sharks at depths that exceed the unaided eye.

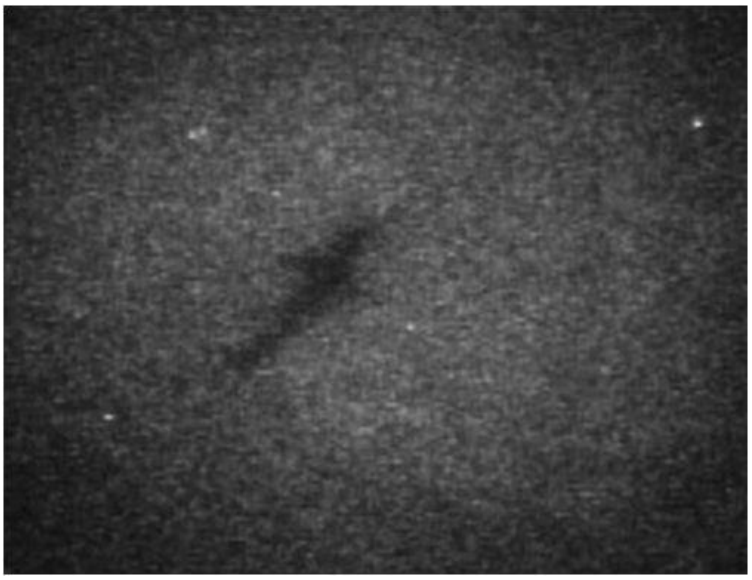

Figure 11 – LIDAR image of shark – courtesy Dr James Churnside – NOAA, USA

However, not only is LIDAR equipment very expensive there would be considerable development costs associated with developing the algorithms required and doing so in real time.

The area where the AAP would like to explore further is the use of hyperspectral scanning equipment which has the potential increase the sightability of sharks. This type of equipment (along with multispectral scanners) is well developed for land based applications (such as agriculture and forestry) and there has been work undertaken to date both on land and in marine settings. The equipment is small, easily mountable under the wing of a plane and relatively affordable (tens of thousands of dollars). However, further development work is required to ensure that the scanners 'see' and correctly identify sharks (in comparison to dolphins for example) and the information

captured can be processed live on board. The AAP has advice that it is all technically achievable and simply requires funding to be made available.

The two main mechanisms promoted by fisheries agencies as their preferred approaches also have some problems

Table 10

Approach promoted by fisheries agencies	Issues
Beach meshing	• Inefficient – in NSW it costs $1.4m to catch about 30-50 target sharks per year • Toll on non-target species • Removal of sharks from about 200klm of coast with ecosystem consequences. These may simply be overfished or, if shark are sent elsewhere, the sharks may be directed to other regions • Its unknown what proportion of sharks the nets catch/deter. They could catch less than 1 in 8 sharks present. • About 40% of sharks are caught on the beach side of the net • Potential false sense of security for bathers • Do not prevent shark bites • Gillnets do not sample the full range of species or sizes present – as an issue this is no different to the sampling biases of the Aerial Patrol.
Tagging programs	• Costly – satellite tags cost in the vicinity of $4000 to $5000 plus the costs of catching the shark, data downloads and staff time. The tags have to be replaced after 12 to 18months. The population of great white sharks alone on the East coast is about 1000. If the aerial sighting rates of 12/17% are unacceptable then this implies that tagging rates should be far higher. The cost of tagging all great whites would be $5m every 18 months. Long term (10year) acoustic tags require sharks to be operated in as they are installed internally – costs need to be documented for decision makers to have a clear understanding. • At this stage all the tags have shown is that sharks swim long distances but direct application to beach safety is not yet occurring. In WA there is a program whereby a shark with an acoustic or satellite tag can send a message to a website but the proportion of sharks tagged is unknown. We accessed the website on 18/10/15 (1345 EST) and the site had logged 5 sharks via the detection system and 8 via direct sighting. • Satellite tags only work when the shark is on the surface (even shallower than the depth at which the aerial patrols can see them). This a shark could be at a beach totally undetected.
Educational material	Providing educational material via apps, website or signage is an important component of generating awareness amongst beach goers. We could find no evaluations of the effectiveness of apps or websites. Matthews et al (2014) reported that less than half of survey respondents even remember seeing a sign when they went to the beach let alone remembering its content.
Aerial ‘surveys’	As mentioned above the DPI charters its own aircraft to conduct aerial surveys of the nets and photograph sharks in the beach meshing area. The

	department reports its finding in the beach meshing annual report. Evaluations of their own work are listed as follows: • 2014/2015 Annual report - These data corroborate previous survey results suggesting aerial surveys are a relatively inefficient and ineffective method to enhance bather protection from potential shark attack.* • 2013/2014 Annual report 'These data corroborate previous survey results suggesting aerial surveys are a relatively inefficient and ineffective method to enhance bather protection from potential shark attack.' • 2012/13 Annual report 'These data again imply the ineffective nature of aerial surveys in providing an additional bather safety network against potential shark attack.' • 2011/12 – trials of AAP and independent helicopter
Beach towers and spotter programs	As reviewed above there has been no formal evaluation of the efficacy of beach based observations. Sighting distance, visibility and determining the proportion of sharks seen as a function of how many are there are issues shared with aerial patrols.

* this is the first year that the DPI survey found a large number of great white sharks in the Hunter region (29). In the same year the shark meshing program caught 3 sharks in the Hunter region out of 15 in the whole SMP region. This result generated the annual criticism of aerial patrols but no comment on the efficiency of shark meshing.

What is clear from the above table is that no technique is free of problems. If required, one could focus on the weaknesses of any given approach and claim that it is 'ineffective'.

The beach meshing program generates material of interest to scientists (DNA and autopsies), as do tagging programs. These programs are well supported by the research staff in fisheries agencies. Indeed, in 20XX the department cut back on the number of days that observers were placed on the vessels of shark meshing contractors in order to make funds available to a project on the great white shark nursery ground in Stockton Bight.

As to why the DPI continues to invest public funds in aerial surveys after 5 years of proving their lack of worth is unknown. There is an emphasis on securing high resolution photographs. The AAP does not encourage photography as it distracts observers from their work.

The Inquiry needs to investigate the potential costs and utility of tagging in much more detail. There have been a number of tagging programs run over the past 10 years (See Appendix 2 for a partial list) and there is an unknown number of acoustic listening stations along the coast (was 70 as mentioned by Storrie and Otway 2008). DPI is not the only agency who puts out listening stations for tagged marine life (not just sharks) and some are inactive due to the finalisation of a project or a lack of funds.

Location of listening stations along the NSW coast in 2006. Each dot may present more than one array.

The Inquiry should ask:

- where previously tagged great white sharks were detected
- why non of the listening stations are satellite linked (it may take months for the data to be downloaded and analysed
- why the significant up turn in shark attacks on the NSW coast over the past two decades did not generate any move to implement more timely warning technology (Table 11)

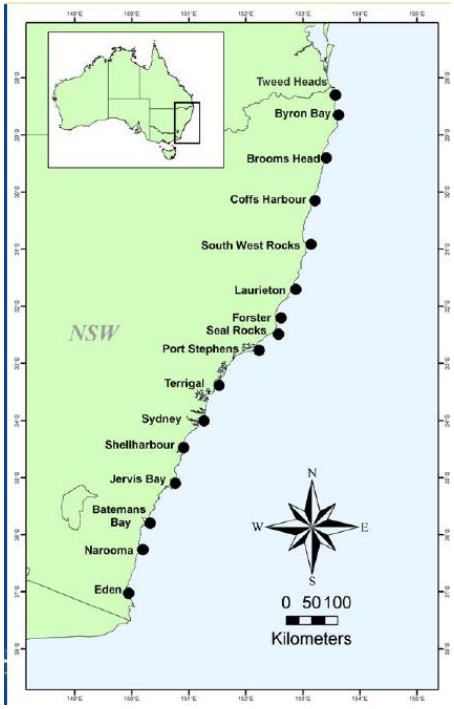

Figure 12 – location of listening stations in 2006

Getting a clear picture of just how many active listening stations are in place is challenging. Appendix 3 has a list extracted from the Australian Animal Tracking and Monitoring System (AATAMS) database. The full database can be found at https://aatams.emii.org.au/aatams/installationStation/list. Note

Table 11 – Shark bites for the coast north of Stockton Beach (source: Australian Shark Attack file)

5 years block	Shark bites
1983-1987	1
1988-1992	3
1993-1997	1
1998-2002	6
2003-2007	10
2008-2013	26

The Inquiry needs to look closely at the costs associated with tagging. Tagging may be useful for answering some questions about shark presence and migration but its use in protecting bathers is unproven. For tagging to be useful it needs to be almost real time. Some of the significant limitations include:

i. Satellite tags are only in communication when the shark is on the surface. They have a short battery life and catching sharks and tagging them is very time consuming – note how many the DPI has caught recently.
ii. Acoustic tags have a longer battery life (10years) but require underwater listening stations to be installed and maintained. Unless the listening station has a surface satellite link then the data are only available when a diver retrieves the files. Satellite links are not cheap. A shark has to be within 300 to 500m of a listening station for it to be detectable.

iii. Costs can be very significant. The purchase of the equipment is only part of the cost. The sharks have to be caught and tagged and if satellite tags are used the tags need to be replaced almost annually. The Inquiry needs to find out just how many sharks need to be tagged to provide a sufficient level of protection for bathers, how long it may take to tag this many and if the DPI is uncertain and requires more research then how long this will take.

It should be noted that funding for tagging programs has been severely cut in recent years which has probably reduced the number of operational listening stations (noting that none of these provide real-time data).

10.0 Sharks and tourism

This submission does not analyse the effects of shark presence on tourism. We note that some sharks may be an issue but others may be an attraction (e.g. grey nurses and divers). The potential impacts on beach related tourism are largely down to perceptions, driven by the media. As we mention above, it is the management of perceptions that is important. People want to see tangible action and this is where aircraft with recognisable branding are a valuable contribution to the armoury.

In terms of a potential role for the AAP in assisting the tourism industry we have considerable experience in the Illawarra that could be transferred elsewhere. In this submission we have addressed the negative views of aerial patrols by the State's fisheries research providers and demonstrated not only are the currently favoured alternatives bedevilled by their own flaws but there is no, one size fits all solution. With the tourism industry being heavily influenced by images and perception we feel that a service that provides beach goers with a sense of being looked after is no less valuable than hard science programs.

The AAP has previously offered to assist local people on the NSW North Coast to establish their own aerial patrol and this offer remains open. For this to be effective would require a much more positive and constructive attitude from the DPI and a willingness to work with volunteers.

10.1 Adequacy of current shark/bather interaction management

There is no State-wide coordination of bather protection in regards to sharks. The current patchwork has evolved for a variety of reasons, such as:

i. The Sydney Newcastle Wollongong area has been a priority for government due to the tourism value of beaches.
ii. The Aerial Patrol was an initiative of Wollongong City Council and it is locally funded by Wollongong, Kiama, Shellharbour and Shoalhaven Councils. It was once present off the Sydney coast when government funding was available
iii. The meshing program is run by the research arm of DPI and does not seem to be a part of any integrated effort.
iv. Tagged sharks and underwater listening stations have been in place since 2006 (http://www.dpi.nsw.gov.au/research/updates/issues/november-2006/sharks-wired-for-sound-and-survival) but there has been no development of any links to coastal communities, as there is in WA. At present there does not appear to be any coordination of research activity involving listening stations nor any mechanism for making use of those placed by independent researchers.

As such, large parts of the coast have no bather protection service. The beach safety providers (SLSA and APOLA) cover the patrolled areas of a large part of the coast and overlap with the meshing

program and the Aerial Patrol path. In the area from Wollongong north to Stanwell Park there is meshing, Aerial Patrol and beach based patrols.

As discussed the DPI approaches the meshing program from a research perspective and this is not broad enough to facilitate the sort of coordination that is required if the best strengths and weaknesses of existing approach are to be matched. Moreover, whilst research is important it may operate over many years before being useful in real world conditions (noting that after 80 years the mechanism that underpins the beach meshing program is unknown).

In short there is a lack of a lead agency which has translated to a lack of strategy and a lack of coordination. The fisheries research agenda has become dominant and this has resulted in a focus on generating research funds and a lack of interest in pursuing solutions that don't involve research being conducted or coordinated by the DPI.

There is no coordination on data collection. Indeed, in making the judgement that the Aerial Patrol is flawed the DPI has done itself a disfavour in writing off a potentially valuable source of data as there is little monitoring of sharks along the NSW coast that does not involve capture (e.g. commercial fishing or beach meshing). The DPI makes use of data collected by non-scientists in other areas of its business (e.g. commercial fishing logbooks, gamefish tagging program and angler catch reporting as but 3 examples) and there are many examples of the collaboration between scientists and citizen scientists in other areas of natural resource management. In 2006 the DPI chose not to invite the AAP to the so called 'Scientific Shark Summit' as it was for scientists but not scientists from beach safety providers were present. Again, this year, the AAP was not invited to the Shark Summit as it was deemed a 'service provider' and the Summit was not for service providers. Service provider in the form of beach safety providers were present. This unproductive and exclusionary behaviour by the department is not something that would be tolerated in other areas of volunteerism and public safety.

The focus of a bather protection program should not be on fisheries research. The government needs to explore opportunities for managing public perceptions in a variety of ways, not just by conducting shark research.

The AAP has demonstrated that it is possible to operate a beach protection service without large amounts of state government funding. State funding may provide the backbone of any new initiatives or enhancements but there should be a clear requirement for a proportion of funds to be sourced from sponsorship. As to why the DPI runs a shark surveillance system in an era of outsourcing is unknown but it clearly only serves the interests of the department and does not have the primary purpose of protecting bathers. The department makes use of students on its flights and it is clear that there are minimal requirements of training and experience.

11.0 Recommendations for improvements

It is clear from the material provided the State government is not being served well by having shark issue managed by the research arm of DPI Fisheries. This agency is not using the existing assets and good will in way that is focused on protecting bathers. It has not been proactive on initiating research on alternatives to beach meshing nor taken an interest in working with others and it has no publicly available plans for coordinating even the existing players. This is not surprising in that its charter is not beach safety. Our discussions with people in Western Australia have revealed a similar pattern when the issue was managed by WA Fisheries. In some respects this is more a failing of governments past and present, having left the issue to fisheries researchers in the absence of having a well thought through strategy.

However, it is now time for a change.

11.1 Administrative reform

Whilst sharks are the issue under consideration the outcome of interest is beach safety. In the case of drownings, whilst research is important, the management of swimmer risks is not left in the hands of beach dynamics researchers. The AAP notes that there are a number of agencies involved in beach safety such as the Australian Professional Lifeguards Association, Surf Lifesaving, police and ambulance, amongst others. For boating there has long been a major role for the volunteer sector through Marine Rescue. Again there are mechanisms for coordination and taking a strategic approach.

In our talks with people in Western Australia the need for some central government coordination was exposed dramatically when public angst hit an all-time high several years ago. Public concern was not going to be assuaged by a single action such as tagging sharks and drumlines proved to be very controversial. What proved effective was a suite of measures including, if not dominated, by high profile aerial patrol work. Central government was able to take on board the need to have visible action, even if this was not perfect in the eyes of fisheries researchers. Whilst WA opted for helicopters it was clear that they opted for a known and trusted brand. In New South Wales the AAP is a known and trusted brand.

In moving forward the AAP sees the need for some reform in government that makes managing public perceptions a key component of keeping people safe. The key elements we see include an approach that is:

1. Proactive and visible
2. Strategy based
3. Collaborative
4. Fed by verifiable information that may come from research

To drive this we believe that there is a need for the establishment of a coordinating body answerable to an agency that has a track record in coordination. It needs to have state-wide jurisdiction and the ability to ensure that players work together in a constructive fashion. It should have representatives from:

1. NSW Police
2. NSW DPI
3. APOLA
4. SLSA
5. AAP
6. Local government – outside Sydney
7. Sydney Coastal Councils
8. A research provider
9. An NGO

We propose that this committee be answerable to the Department of Premier and Cabinet for a period of time (3 to 5 years) whilst it creates a strategic plan and the collaboration is settled in. After this period it could be transferred to another jurisdiction such as the Department of Emergency Services.

11.2 Investing in new technology

There is much that could be done to invest in technology. The AAP is about to install a live video to ground system to enable beach safety providers to have a live view of beach users on unpatrolled beaches. This system will probably not be suitable for sharks.

We have been researching the potential for specialised scanner and note the work being funded in Western Australia. This requires ground trothing on our coast and we have had discussions with research and development providers in WA. Funding form the NSW government would help accelerate development and we would be keen to work closely with the software developers.

There are also some simple software engineering jobs that could be put in place to enhance information access from the plane and make the job of supplying this information easy for our observers. We mention the example of flight tracking.

11.3 Expand the aerial patrol network

Visible action is what beachgoers want. The reaction we had in Ballina in June 2015 at the Gromfest surf competition was overwhelmingly positive. The AAP was invited by Ballina Council to fly cover for this surf competition following two shark attacks and our volunteers put in 27 hours flying over the festival. We can help others to set up their own aerial patrols. We would suggest that government provide seed funding with a requirement for a gradual transition to sponsorship over a prescribed time period.

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Appendix 1 – Funding made available to bather protection in Western Australia – source Department of Premier and Cabinet

According to the WA Department of Premier and Cabinet the WA government has allocated the following funds:

- $12.237m over five years to 2017 for beach and aerial safety surveillance and patrol programs along the metropolitan and south west coasts, contracted through Surf Life Saving WA (SLSWA).
- $2.619m over three years to 2018 for extended aerial patrols in the south west (before the 2014/15 season patrols in the south west operated during the peak November to February period only. The additional funding allows for patrols either side of the season from September to April).
- $1.2m to SLSWA for the purchase, maintenance, replacement and training of 12 jet skis for the metro and greater southern regions.
- $175,000 to the Cottesloe Surf Life Saving Club for the construction of two watchtowers.
- $1.7m to the WA Department of Fisheries (Fisheries) for research including community engagement.
- $2.05m to Fisheries for the operation of a Shark Response Unit.
- $2m to Fisheries to manage the serious threat policy, which allows for the taking of a shark posing a serious threat to public safety.
- $150,000 to Fisheries for the development of a smartphone app.' BeachSafe'.
- $2m to Fisheries for a two year tagging and tracking program, which completed in June 2015.
- $400,000 to the City of Busselton for two beach enclosures.
- $400,000 allocated to two further beach enclosures, proposed for the City of Joondalup (metro) and the City Albany (Great Southern).
- $1.9m over four years to Applied Research Programs into non-lethal shark detection and deterrent technologies, managed through the WA Office of Science.
- $1.282m allocated to a 13-week drum line trial program between January and April 2014.

Appendix 2

Tagging projects in NSW relevant to sharks (http://imos.org.au/nswimospubs.html)

Note, this only includes those rpojects uploaded into the IMOS data base. Discussions with university researchers reveals that there are an unknown number of projects as there is no real coordination.

- Grey Nurse Shark south-east Australian Coastal Acoustic Monitoring System (SEACAMS), Industry and Investment New South Wales, Nick Otway, 2006-2008
- Great white shark tagging project, Industry and Investment New South Wales, Nick Otway, 2006-2007 Movements and biology of coastal sharks in NSW, Industry and Investment New South Wales, Amy Smoothey, Vic Peddemors, 2007-2012
- Near-shore habitat use by juvenile white sharks in coastal waters off Port Stephens, Commonwealth Scientific Industrial Research Organisation, Barry Bruce, Russell Bradford, 2010-2011, Partner Institution(s): Hunter-Central rivers CMA, Port White shark population and abundance trends, Bary Bruce, 2011-2015, Funding: National Environmental Research Program (NERP)

Appendix 3 NSW DPI listening stations – AATAMS data base

NSW DPI (Artificial	Estuarine (Lake	ARRAY
NSW DPI (Artificial	Lake Macquarie	ARRAY
NSW DPI (Artificial	OAR (Sydney)	ARRAY
NSW DPI (Artificial	Offshore	SINGLE
NSW DPI Coastal	Clyde River	ARRAY
NSW DPI Coastal	Clyde River VPS	ARRAY
NSW DPI Coastal	Estuarine gates	CURTAIN
NSW DPI Coastal	Georges River	ARRAY
NSW DPI Coastal	Long Reef - the	SINGLE
NSW DPI Coastal	Nearshore	SINGLE
NSW DPI Coastal	NSW DPI North	ARRAY
NSW DPI Coastal	NSW DPI	ARRAY
NSW DPI Coastal	NSW DPI	ARRAY
NSW DPI Coastal	Shoalhaven	ARRAY
NSW DPI Coastal	Shoalhaven	ARRAY
NSW DPI Edward	Edward Wakool	ARRAY
NSW DPI Jervis Bay	NSW DPI Jervis	ARRAY
NSW DPI	Clarence River	ARRAY
NSW DPI	Gated Estuaries	CURTAIN
NSW DPI	Port Hacking	ARRAY
NSW DPI	Sydney	ARRAY
NSW DPI	Sydney	ARRAY
NSW DPI -	SEACAMS	ARRAY
Port Stephens	AATAMS Port	ARRAY
Port Stephens	Port Stephens	ARRAY
Port Stephens	Port Stephens	ARRAY