# Tactical Research Fund: measuring dropout rates from commercial demersal gillnets in Western Australia

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## PROJECT No. 2009/097

Tactical Research Fund: measuring dropout rates from commercial demersal gillnets in Western Australia

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## NON TECHNICAL SUMMARY

**2009/097 Measuring dropout rates from commercial demersal gillnets in Western Australia**

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**OBJECTIVES:**

1. Determine the dropout rate of targeted demersal scalefish from commercial gillnets
2. Determine the retention rate (catch efficiency) of commercial gillnets
3. Identify species prone to dropouts and quantify dropouts at a regional level
4. Identify stages in the fishing process where dropouts are more likely to occur
5. Determine the level of interaction between commercial fishing gear and non-target species.

**NON TECHNICAL SUMMARY:**

## OUTCOMES ACHIEVED TO DATE

The project has contributed to the following outcomes:

1. The project can inform the perception by stakeholders in both the recreational and commercial fishing sector about Demersal gillnets.
2. Provided vision of the selectivity of demersal gillnets across species of sharks, rays and finfish thus removing the notion that gill nets capture indiscriminately.
3. Identified the potential of using underwater video camera technologies to effectively capture the moment of gear retrieval and quantify the levels of dropouts,
4. Identified the opportunity for future trials using recent advancements in camera technology as a means of providing greater certainty of results to date.
5. The data collected may inform the Marine Stewardship Council pre-assessment requirements.

The project obectives for this pilot study were not met because of limitations due to the video cameras not being able to record the full-length of demersal gillnet deployment and recovery of the nets. Rapid advancements in underwater camera technology and decreasing costs for hardware suggest that the capacity to effectively capture an entire length of demersal gillnet deployment and recovery are becoming both practical and affordable.

The Western Australian (WA) Demersal Gillnet and Demersal Longline Fishery (the Fishery) operates between the West Coast (26°30’S) and the South Coast (116°55’40”E) of WA, with the exception of a spatial closure to Perth Metropolitan waters, and is the only Demersal gillnet and longline fishery operating in WA at the time of this report.

The WA Department of Fisheries has effectively managed the Fishery since the inception of the Fisheries’ first management plan in 1988. Since then various spatial and temporal closures have been introduced. In addition, the establishment of a Voluntary Fisheries Adjustment Scheme has resulted in a 36% reduction of effort (fishing units) in the fishery.

Following a re-assessment of the Fishery under the Commonwealth Environment Protection and Biodiversity Conservation Act (1999) in 2009, the fishery was declared as an approved

Wildlife Trade Operation (WTO), allowing the export of product from the fishery. Despite these achievements, some stakeholders perceived the fishery to be both indiscriminate in the method of harvest and damaging to the substrate.

The total catch composition of the fishery is predominately made up of four species of shark, including Gummy Shark (*Mustelus antarcticus)* , Dusky Shark (*Carcharhinus obscurus*), Sandbar Shark (*Carcharhinus plumbeus*) and Whiskery Shark (*Furgaleus macki*). However, demersal scale fish do account for approximately 17% of the catch and are recognised as a legitimate component of the catch. While demersal gillnets are considered to be effective in capturing and retaining sharks, rays and finfish, strong concerns were raised by stakeholders that considerable numbers of scalefish were dropping out of commercial gillnets, particularly iconic species such as West Australian Dhufish (*Glaucosoma hebraicum*), Blue Groper (*Achoerodus gouldii*) and Snapper (*Pagrus auratus*). In response to these claims, members of the WA Demersal Gillnet and Longline Association embarked on this project to quantify and qualify the level of finfish dropouts and investigate interactions with Threatened, Endangered and Protected species (TEP’s).

To investigate claims of dropouts and determine the catchability and effectiveness of Demersal gillnets, four to eight underwater cameras were placed in the nets of vessels operating out of Albany, Augusta and Dongora during both diurnal and nocturnal sets, resulting in approximately 673 hours of recorded footage. Nets were set at various depths, durations, times of day and under varying sea conditions. We observed 1980 fish (including squid and cuttlefish) from 84 species in and around the nets. Of those 1980 fish seen only on 2.6% (52 fish) of observations events were recorded where fish interacted with the net. Of these 52 events only 5 resulted in the capture and death of fish. Four of those 5 fish were recorded in the catch at the surface while the fate of one fish (a Dusky Morwong, *Dactylophora nigricans*) remains unknown. It is possible that the fish was eaten by a Port Jackson Shark (*Heterodontus portusjacksoni*) or that the predation knocked the fish out of the net.

Technical challenges and the availaibility of vessels to undertake the research impeded researchers from achieving the project objectives.

The technical challenges included a change in our understanding of the times of day and periods over which fishermen were deploying and retrieving their nets. The initial information suggested that nets were deployed for up to 5 or 6 hours during daylight. After initial trials and discussions with fishers it became apparent that some fishers were leaving their nets in the water for up to 24 hours and that others were deliberately setting at night. This required us to increase the length of the recordings and add a lighting system for night time work. By increasing the memory capacity and adding longlife batteries it was possible to record up to 7 hours ( a limitation of the battery) and to record up to 5 hours at night (a limitation of the battery with the use of a light). However, this did not cover the full set time from deployment to the recovery of the net limiting the conclusions that can be drawn, and therefore the outcomes.

If further data are required two options exist if this type of approach is to be undertaken. The first is to limit the length of the deployments to the capability of the existing video technology so that sufficient replication can be achieved. This would require collaborating with fishers that were prepared to fish during daylight hours for periods of less than 7 hours or at night for 5 hours or less and recording enough replicate deployments from throughout the range of the fishery to be able to make generalisations. However, this is not comparable to an actual fishing event and appropriate adjustments or conditions would need to be placed on the findings.

The second option is to further develop video technology which is capable of meeting the operating conditions of the fishers. We believe that it is feasible to develop cost effective and robust systems which can record for longer periods of time and integrate a lighting system for nocturnal recording. Modifications have already occurred as part of a different project which demonstrate that cameras and lights with timers can be deployed for longer time periods.

Sufficent units would need to be constructed and deployed to ensure adequate replication to cover 5-10% of the net and again enough replicate deployments from throughout the range of the fishery would need to be recorded to be able to make generalisations.

While this project did not meet all the objectives it set out to achieve it has highlighted that demersal gillnets do not catch all fish that they encounter, and that many species are not caught at all. Similarly, that many of the target and marketable bycatch species escaped from the nets even after they became entangled.

No dropouts were recorded and a number of fish that were recorded on video becoming caught in the nets were removed on board the vessel from the section of the net where the camera recorded them. A caveat is that the sample size and the number of observations supporting this statement is small and inconclusive, however, it is possible that fish falling out of the net is much less of an issue than initially believed. In an ideal research environment the video imagery would cover both the deployment and the recovery of the net with sufficient sample size to reach a conclusive result.

The physical impact the fishing gear has on the substrate from the limited video footage appeared to be negligible, and from this it is possible that demersal gillnets do not pose a threat to the natural structure of the benthos. From the 673 hours of video imagery collected from the 18 deployments we did not observe any threatened, endangered or protected species (TEP's) interacting with demersal gillnets. Greater replication across the range of the fishery would assist the robustness of this statement.

**Success of project outcomes against objectives.**

1. Determine the dropout rate of targeted demersal scalefish from commercial gillnets.

Of the five fish that were seen to be caught by the cameras, four were retained in the sections of the gillnets where those video cameras were located. The fifth fish may have dropped out, but was observed to be the subject of a predation event when the camera stopped recording. This objective was only partially achieved as a consequence of the video cameras not recording the full-length of deployment (including setting and retrieving the net).

2. Determine the retention rate (catch efficiency) of commercial gillnets.

The video imagery recorded showed that the gillnets used in the Western Australian Demersal Gillnet and Demersal Longline Fishery have a low retention rate with many target and non-target species evading capture. This is especially true of many of the smaller reef fish which swam through the nets repeatedly. This objective was only partially achieved and a greater number of replicates is required across the spatial extent of the fishery.

3. Identify species prone to dropouts and quantify dropouts at a regional level.

This objective was not achieved due to video cameras not recording the full-length of deployment. Similarly, a greater number of replicates is required across the spatial extent of the fishery to achieve this objective in a comprehensive manner.

4. Identify stages in the fishing process where dropouts are more likely to occur.

This objective was only partially achieved due to video cameras not recording the full-length of deployment. Some dropout was reported by on-board observers, but not quantified. An on-board camera system would assist with quantification.

5. Determine the level of interaction between commercial fishing gear and non-target species.

This objective was achieved with low interaction levels (2.6%) observed and even lower retention rates of non target species recorded. No threatened, endangered or protected species were observed on the 673 hours of underwater video imagery.

Although the project failed to achieve all objectives, the results remain encouraging. The video imagery recorded clearly shows that demersal gillnets are selective, allowing small demersal finfish, and even larger species (including sharks) to avoid capture. Species were seen to interact with the gillnets without becoming entangled. Predation of finfish entangled in the gillnets was observed on one occasion.

Rapid advancements in underwater camera technology and decreasing costs for hardware suggest that the capacity to effectively capture an entire length of net for the entire fishing period are becoming both practical and affordable. The implementation of such advancements would enable the objectives of this project to be achieved.

The results from this pilot-study support the need for continued development in the use of video technology to investigate the level of interactions, examine the efficiency of fishing gear, observe interactions with non-target or threatened and endangered species.

**KEYWORDS:** Demersal gill nets, fish dropout, remote underwater video, shark fishery.

## 2. ACKNOWLEDGEMENTS

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## 3. BACKGROUND

The Western Australian Temperate Shark Fishery encompasses the Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery (JASDGDLMF) and the West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery (WCDGDLMF). These fisheries are represented by the WA Demersal Gillnet and Longline Association, which encompasses the vast majority of licence holders.

The project was developed in consultation with the WA Demersal Gillnet and Longline Association, Recfishwest, Western Australian Department of Fisheries (DoF), the Conservation Council of Western Australia (CCWA), the Western Australian Fishing Industry Council (WAFIC) and OceanWatch Australia (OWA) following discussions in December 2009 over resource sharing issues, with the perceived dropout of scalefish being one of the main issues. Collectively these organisations identified this issue as a priority requiring urgent attention.

## 4. NEED

Demersal scalefish species account for between 11 and 17% of the total catch composition of the Western Australian Temperate Gillnet Fishery (1994 to 1999). Scalefish landings in 2005/06 amounted to 236t in the JASDGDLMF and the WCDGDLMF.

While demersal scalefish are a legitimate component of the catch, strong concern has been raised by the recreational sector that considerable numbers of scalefish are dropping out of commercial gillnets, particularly iconic species such as West Australian Dhufish (*Glaucosoma hebraicum*), Blue Groper (*Achoerodus gouldii*) and Snapper (*Pagrus auratus*). As a result of this perception, conflict between recreational and the commercial sectors has escalated substantially over the last five years.

In light of recent restrictions on recreational bag limits for iconic WA finfish such as Dhufish and Snapper, the issue of scalefish ‘dropouts’ from commercial gillnets raises concern with respect to the catch efficiency and the ability of nets to retain demersal scalefish. The issue has the potential to negatively impact upon the security of future commercial access to the fishery.

Quantifying the number of scalefish that encounter nets, identifying species vulnerable to dropout and knowing where and when they are more likely to drop out of commercial gillnets (alive and dead) would complement existing catch composition data obtained by the WA DoF.

The WA Demersal Gillnet and Demersal Longline Association encourage the implementation of initiatives consistent with the principles of ecological sustainable development. Further, as the fishery is undergoing pre-assessment for Marine Stewardship Council (MSC) certification, the need for accurate data to determine if demersal scalefish are dropping out of demersal gillnets is critical for an informed risk assessment of this fishery.

## 5. OBJECTIVES

1. Determine the dropout rate of targeted demersal scalefish from commercial gillnets
2. Determine the retention rate (catch efficiency) of commercial gillnets
3. Identify species prone to dropouts and quantify dropouts at a regional level
4. Identify stages in the fishing process where dropouts are more likely to occur
5. Determine the level of interaction between commercial fishing gear and non-target species.

## 6. METHOD

Sony CX12 Full High Definition cameras fitted with Raynox C5050 0.5 x wide angle converter were used to film interactions between demersal fish and demersal gill nets. The initial scoping suggested that nets were deployed for up to 5 or 6 hours during daylight. Hence, the project scope required 5-6 hr recordings that could capture the full deployment and recovery of a net. Because some demersal gillnet fishers were operating in up to 80 metres of water, the underwater housings needed to be rated to at least this depth and be robust enough to be launched and retrieved over the feeder from a commercial fishing vessel (Figure 1).

The cameras were placed inside purpose built aluminium housings rated to 2000 meters. These camera housings were deemed simple and robust enough not to fail under operating conditions. Several configurations were trialled for deployment. One of the major constraints was the need to construct a camera system which did not effect the performance of the net by sinking it. Additionally, there was the need for a camera system which could be quickly fitted to, and taken off the net without greatly slowing normal fishing practices. The third constraint was the need for the system to fit through the feeder or rollerr (see Figure 1) when attached to the net.

Figure 1. Examples of feeders and a roller over and through which any camera system needs to be able to fit.

The weight and displacement of the camera housings containing the camera, camera lens and battery was calculated. High density foam used on Remote Operated Vehicles was cut to shape and attached to the camera housing to make it neutrally buoyant (Figure 2).

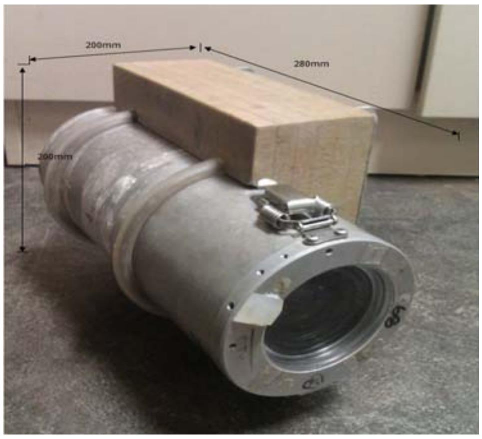

Figure 2. The underwater camera housing with neutral buoyancy attached.

After initial field trials on the 8th and 9th of November 2011 it was determined that the quickest and most secure location for a camera to be fitted to the net was on the head rope (Figure 3). Cameras were attached with two snap lock shackles next to a float. Because the head rope had some tension on it the camera remained oriented along the net.

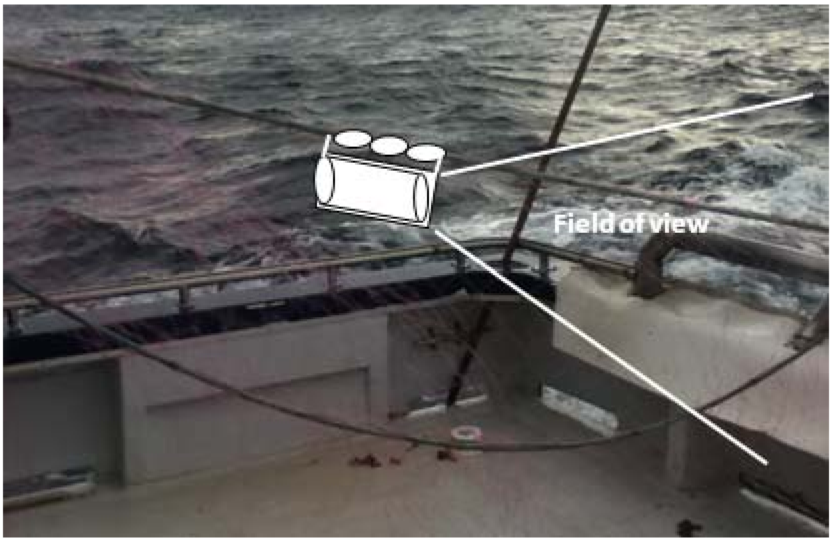

Figure 3. Schematic of a underwater camera housing attached to a head rope.

This attachment process required the skipper to stop the boat long enough to attach the camera (~30 seconds) before the camera was guided out through the feeder.

Modifications to planned methods after industry consultation

From the initial field trials and discussions with the fishers we learnt that our intial understanding of the scope (4-5 hour sets during the daytime) was incorrect, and that there was great variation in the period of time the net was left on the seafloor to fish. While some of the fishers were deploying nets for 5-6 hours, others were leaving nets in the water for up to 24 hours. In response to this knowledge the video cameras were equipped with longlife batteries and 32 Gigabyte memory cards which increased the recording time. The cameras were set to record high quality standard definition video imagery in an mpg format which maximised the amount of video that could be recorded with the available battery time. Using this configuration it was possible to record up to 7 hours of continuous video imagery. For sets in excess of 7 hours it was not possible to record the whole deployment. The implications and potential solutions are considered in the discussion.

We also learnt that some fishers were setting and retrieving nets both during the day and at night. Because some of the sets spanned both day and night periods within the one deployment it was not feasible to use a low light camera as the imagery would have been "blown out" during the day. Instead we opted to attach an artificial light source to illuminate the field of view of the camera. The light system was powered by a rechargeable 12V battery contained within a galvanised steel underwater housing. Each light contained a bank of 7 Cree XLamps XP-E LEDs each delivering a radiant flux of 350-425 mW. Royal Blue LEDs at wavelength ranging from 450 to 465 nm were used to illuminate the field of view approximately 5 metres in front of the camera (Figure 4).

The use of artificial lighting introduces a potential source of disturbance, particularly if a wave length of light is used which fish can detect and choose to avoid. The wavelengths of light that fish are most sensitive to are directly related to the structure of their eyes. A recent paper which reviews the literature (Fitzpatrick et al. 2013) found that the majority of nocturnal fishes that have been studied have eyes with a spectral sensitivity ranging from 525 to 620 nm. It is reasonable to assume that the influence of artificial illumination on nocturnal fishes can be minimised if the light source used is beyond their spectral sensitivity range. Fitzpatrick et al. (2013) trialled the effects of three different light sources (far red which is above the range, white which is in the middle of the range and royal blue which is below the range) on sampling Western Australian nocturnal fishes inside and outside a closed fishing area. They concluded that some species were more abundant in videos illuminated by far red light (particularly the Pempherids) while some of the commercially targeted species (*Pagrus auratus* and *Glaucosoma hebraicum*) were more abundant in videos illuminmated by royal blue light. Based on these results Harvey et al. (2013) chose to use royal blue light in favour of far red as it attenuates less quickly in water in comparison to far red (fish are visible at approximately 2.5 m in front of a camera for far red and 5 m for royal blue) resulting in a larger field of view.

Figure 4. The underwater camera housing and float with the light housing attached.

Image processing

Video imagery was processed using Event Measure (www seagis.com.au). Event Measure is a video based event recorder. Using Event Measure, the video was annotated with each species seen on the video imagery noted. Additionally we noted whether it interacted with the net, and if it did, whether the fish was caught or not. The software was also used to grab small clips of video imagery for demonstration purposes.

Imagery collected.

Between the 8th of November 2011 and the 18th of April 2013 approximately 673 hours of video imagery were collected from 5 trips involving 18 deployments of set nets (Table 1). With the exception of the initial trial the number of cameras deployed in each net ranged from 4-8. Recordings were made from 15 set net deployments during the day and 3 at night. For recordings made on the 22nd and 23rd of November 2011 the recordings were made during the day, but the net was left over night and retrieved the next day.

After the initial trials all cameras were positioned on the headline beside a float. Cameras were placed along the net at the discretion of the skipper and crew.

Table 1. The number of set nets in which cameras were placed. Note, that on the 22nd and 23rd of November 2011 video recordings were made during daylight, but the net was left in the water overnight and retrieved the next morning.

| Date | Location | # cameras per deployment | Hours of imagery | Time of day | Observer |
|---|---|---|---|---|---|
| 8/11/2011 | Albany | 2 | 10 | Initial trial, Day only | Matt Birt |
| 9/11/2011 | Albany | 8 | 40 | Initial trial, Day only | Matt Birt |
| 22/11/2011 | Augusta | 8 | 56 | Day, but see caption | Damon Driessen |
| 23/11/2011 | Augusta | 8 | 56 | Day, but see caption | Damon Driessen |
| 2/12/2011 | Dongara | 8 | 56 | Day | Neil McGuffie, Jay ShoeSmith |
| 3/12/2011 | Dongara | 8 | 56 | Night | Neil McGuffie, Jay ShoeSmith |
| 6/02/2013 | Albany | 7 | 49 | Day | Rowan Kleindienst |
| 6/02/2013 | Albany | 7 | 49 | Night | Rowan Kleindienst |
| 7/02/2013 | Albany | 7 | 49 | Day | Rowan Kleindienst |
| 8/02/2013 | Albany | 7 | 49 | Day | Rowan Kleindienst |
| 8/02/2013 | Albany | 7 | 49 | Night | Rowan Kleindienst |
| 9/02/2013 | Albany | 7 | 49 | Day | Rowan Kleindienst |
| 16/04/2013 | Augusta | 4 | 20 | Day | Todd Bond |
| 16/04/2013 | Augusta | 4 | 20 | Day | Todd Bond |
| 17/04/2013 | Augusta | 3 | 15 | Day | Todd Bond |
| 17/04/2013 | Augusta | 3 | 15 | Day | Todd Bond |
| 18/04/2013 | Augusta | 4 | 20 | Day | Todd Bond |
| 18/04/2013 | Augusta | 3 | 15 | Day | Todd Bond |

## 7. RESULTS

Summary statistics for each of the five trips are presented as separate sections.

Albany 2011

The first trial deployment of cameras on the gillnets was undertaken off Albany on the 2nd and 3rd of November 2011. Two cameras were deployed in a net on the 2nd (10 hours of imagery) and 8 cameras in a gill net on the 3rd of November (40 hours of imagery). Water visibility was at least 10 metres (judged by the ability to see the next float in front of the camera). A total of 169 fish from 14 families were recorded (Table 2). The most common species seen were the Melbourne Silver Belly (*Parequula melbournensis)* (43.1% of the fish seen), Sea Sweep (*Scorpis aequipinnis*) (16.2% of the fish seen) and Southern Goatfish (*Upeneichthys vlamingii*) (12.6% of the fish seen).

Table 2. Families of fish seen around and interacting with demersal gillnets nets from two deployments near Albany.

| Family | Standard Name | Number sighted |
|---|---|---|
| Carcharhinidae | Whaler Sharks | 1 |
| Dasyatididae | Stingrays | 2 |
| Gerreidae | Silver Bellies | 72 |
| Heterodontidae | Horn Sharks | 1 |
| Labridae | Wrasses | 22 |
| Monacanthidae | Leatherjackets & Filefishes | 2 |
| Mullidae | Goatfishes | 21 |
| Myliobatididae | Eagle Rays | 4 |
| Ostraciidae | Tropical Boxfishes | 1 |
| Platycephalidae | Flatheads | 10 |
| Rhinobatidae | Shovelnose Rays | 3 |
| Scorpididae | Sweeps | 28 |
| Triakidae | Houndsharks | 1 |
| Urolophidae | Stingarees | 1 |

Of the 169 observations made there were 4 observations (2.4%) where a fish interacted with the net. During one event a Gummy Shark (*Mustelus antarcticus*) hit the net and became entangled briefly before pushing its way through. Two events were recorded where a Southern Eagle Ray (*Myliobatis australis*) hit the net and swam away without becoming entangled. The same was recorded for Southern Fiddler Ray (*Trygonorrhina fasciata*). No dropouts were recorded.

Augusta 2011

On the 22nd and 23rd November 2011 8 cameras were placed in each of 2 demersal gillnets (recording 112 hours of imagery). The water visibility was at least 10 metres (again based of the ability to see the next float in front of the camera). A total of 147 fish (including 6 squid

(*Sepioteuthis australis*)) from 21 families were recorded (Table 3). The most common species seen were, the Black-head Puller (*Chromis klunzingeri*) (19.9% of the fish seen), the Lined Butterflyfish (*Chaetodon lineolatus*) (18.5% of the fish seen), the Western King Wrasse (*Coris auricularis*) and the Western Footballer (*Neatypus obliquus*) (7.5 % each).
Of the 147 observations, there were 18 events (12.3%) where fish were observed to interact with the net.

Three Southern Eagle Rays (*Myliobatus australis*) and a Southern Fiddler Ray (*Trygonorrhina fasciata*) swam into and out of the net without becoming entangled. Two Herring Cale (*Odax cyanomelas*), 2 Lined Butterflyfish (*Chaetodon lineolatus*), a False Senator Wrasse (*Pictilabrus viridis*) and a Barred Longtom (*Ablennes hians)* were seen to swim through the net without entanglement. One Dusky Morwong (*Dactylophora nigricans*) was seen to hit the net and swim away while a second became entangled. A Port Jackson Shark (*Heterodontus portusjacksoni*) was observed attempting to feed on the Dusky Morwong, before swimming out of the net only to become entangled on its third encounter. The Dusky Morwong was not in the observed section of the net when the net came on board where it was recorded and it was not witnessed dropping out of the net while the cameras were recording. A Ringed Toadfish (*Omegophora armilla*) and a squid (*Sepioteuthis australis*) were observed to hit the net and swim away.

Table 3. Families of fish seen around and interacting with demersal gillnets nets from two deployments near Augusta.

| Family | Standard name | Number |
|---|---|---|
| Belonidae | Longtoms | 2 |
| Carangidae | Jacks & Trevallies | 5 |
| Chaetodontidae | Butterflyfishes | 27 |
| Cheilodactylidae | Morwongs | 11 |
| Dasyatidae | Stingrays | 6 |
| Diodontidae | Porcupinefishes | 1 |
| Heterodontidae | Horn Sharks | 3 |
| Labridae | Wrasses | 18 |
| Loliginidae | Squid | 3 |
| Monacanthidae | Leatherjackets & Filefishes | 2 |
| Mugilidae | Mullets | 2 |
| Myliobatidae | Eagle Rays | 8 |
| Odacidae | Cales & Weed Whitings | 6 |
| Ostraciidae | Tropical Boxfishes | 1 |
| Pentacerotidae | Armourheads, Boarfishes | 1 |
| Pomacentridae | Damselfishes | 29 |
| Scorpididae | Sweeps | 12 |
| Sillaginidae | Whiting | 1 |
| Sparidae | Snapper & Breams | 7 |
| Tetraodontidae | Pufferfishes | 1 |
| Triakidae | Houndsharks | 1 |

Dongara 2011.

Two deployments were recorded at Dongara on the 2nd and 3rd of December 2011. These deployments were for shorter setting times (~ 6 hours) enabling both the deployment and retrieval to be recorded. Eight cameras were placed into a gillnet deployed and retrieved during the day. The second deployment occurred at night on the 3rd of December. Eight cameras were deployed with blue lighting.

Diurnal recordings

Of the eight diurnal recordings only three of the eight cameras were oriented correctly so that they could see along the net. From the 18 hours of useable video imagery total of 88 fish from 3 families (84 Labridae, 3 Mullidae and 1 Cheilodactylidae) were seen. The most common species seen were the Western King Wrasse (*Coris auricularis*) (59.1% of the fish seen), Baldchin Groper (*Choerodon rubescens*) (14.8% of the fish seen) and the Orange-Spotted Wrasse (*Notolabrus parilus*) *(*13.6% of the fish seen).

Of the 88 observations of fish, 4 events where fish interacted with the net were observed. Two Baldchin Groper (*Choerodon rubescens*), one Queen Snapper (*Nemadactylus valenciennesi*) and one Western King Wrasse were observed swimming through the net without getting caught.

Nocturnal recordings

During the nocturnal recordings (~48 hours) a total of 112 fish from 16 families were sighted (Table 4). The most common species seen were Australian Herring (*Arripis geogianus*) (23.6% of the fish seen), Stripped Barracuda (*Sphyraena obtusata*) (20.8% of the fish seen) and Western Butterfish (*Pentapodus vitta*) *(15.1%* of the fish seen).

Of the 112 observations, three events were observed where fish interacted with the net. One Orange-spotted Wrasse (*Notolabrus parilus*) and 2 unidentified sharks were seen to swim through the net.

Table 4. Families seen around nets from one nocturnal deployment near Dongara.

| Family | Standard Name | Number |
|---|---|---|
| Apogonidae | Cardinalfishes | 4 |
| Arripidae | Australian Salmon | 25 |
| Carangidae | Jacks & Trevallies | 5 |
| Carcharinidae | Whaler Sharks | 6 |
| Enoplosidae | Old Wifes | 1 |
| Labridae | Wrasses | 4 |
| Latidae | Bass | 3 |
| Monacanthidae | Leatherjackets & Filefishes | 5 |
| Mullidae | Goatfishes | 4 |
| Nemipteridae | Whiptails & Spinecheeks | 16 |
| Pempherididae | Bullseyes | 1 |
| Plotosidae | Eeltail Catfishes | 4 |
| Sillaginidae | Whiting | 2 |
| Sphyraenidae | Barracuda | 22 |
| Terapontidae | Trumpeters & Grunters | 7 |
| Tetraodontidae | Pufferfishes | 3 |

## Albany 2013

Recordings were made in 6 gill net deployments off Albany between the 6th and 9th of February 2013. Seven cameras (one flooded on the first deployment leaving 7 working systems to record imagery rather than the 8 planned) were placed into each of 4 gillnets set during the day (196 hours of imagery) with a further two deployments using blue lights occurring at night. Some of the recordings took place during large swells and the daytime visibility ranged from 5 to 10 metres. The visibility on the nocturnal deployments did not exceed 5 metres (a limitation of the lighting).

### Diurnal

A total of 420 individual fish from 44 species and 23 families (Table 5) were observed on video from the four deployments. The most common species seen were Maori Wrasse (*Ophthalmolepis lineolata*) (seen on 32.1% of the videos), Western Smooth Boxfish (*Anoplocapros amygdaloides*) (seen on 28.5% of the video), Queen Snapper (*Nemadactylus valenciennesi*), Slender Bullseye *(Parapriacanthus elongates),* and a variety of Trevally species *(Pseudocaranx spp)* (seen on 21.4% of the videos). Small trevally of the *Pseudocaranx* family were lumped as they are not easily distinguished visually.

Of the 420 observations of fish around the nets during the day only 7 events were recorded (1.7%) where fish interacted with the net. Three fish (a Moonlighter (*Tilodon sexfacisatus*), a Western Seacarp (*Aplodactylus westralis*) and a Smooth Stingray (*Dasyatis brevicaudata*)) hit the net, but were not entangled. On one occasion a Queen Snapper (*Nemadactylus valenciennesi*) swam into the net and became entangled, but after four minutes it became disentangled from the net and swam away. Another Queen Snapper did become entangled and was retained in the net. A Port Jackson Shark (*Heterodontus portusjacksoni*) and a Moonlighter (*Tilodon sexfasciatus*) also became entangled in the net and were retained. These three fish were all recorded in the final on-board catch data.

Table 5. Families of fish seen around nets from four diurnal deployments near Albany.

| Family | Standard Name | Number |
|---|---|---|
| Aplodactylidae | Seacarps | 2 |
| Berycidae | Nannygais & Red Snapper | 2 |
| Carangidae | Jacks & Trevallies | 170 |
| Cheilodactylidae | Morwongs | 9 |
| Dasyatidae | Stingrays | 5 |
| Diodontidae | Porcupinefishes | 8 |
| Heterodontidae | Horn Sharks | 2 |
| Hypnidae | Numbfish | 1 |
| Kyphosidae | Drummers | 5 |
| Labridae | Wrasses | 36 |
| Monacanthidae | Leatherjackets & Filefishes | 9 |
| Myliobatidae | Eagle Rays | 6 |
| Odacidae | Cales & Weed Whitings | 1 |
| Ostraciidae | Tropical Boxfishes | 12 |
| Parascylliidae | Collared Catsharks | 1 |
| Pempherididae | Bullseyes | 57 |
| Platycephalidae | Flatheads | 1 |
| Pomacentridae | Damselfishes | 46 |
| Rhynchobatidae | Shovelnose Rays | 2 |
| Scorpididae | Sweeps | 16 |
| Serranidae | Rockcods, Groupers & Basslets | 18 |
| Tetraodontidae | Trumpeters & Grunters | 9 |
| Urolophidae | Stingarees | 2 |

Nocturnal

Of the 14 cameras deployed 4 cameras failed to record and one light failed after it was placed into the net leaving a total of 63 hours of imagery that were analysed. A total of 234 fish (including squid) from 10 families and 15 species were recorded around the nets at night (Table 6).

The most abundant species was the yellowtail scad (Trachurus novaezelandiae, 146) followed by the slender bullseye (*Parapriacanthus elongates*, 54) and the orange-barred pufferfish (*Polyspina piosae*, 8).

Table 6. Families of fish seen around nets from two nocturnal deployments near Albany.

| Family | Standard Name | Number |
|---|---|---|
| Carangidae | Jacks & Trevallies | 151 |
| Diodontidae | Porcupinefishes | 6 |
| Hypnidae | Numbfish | 1 |
| Loliginidae | Squid | 8 |
| Monacanthidae | Leatherjackets & Filefishes | 3 |
| Ostraciidae | Cales & Weed Whitings | 1 |
| Pempherididae | Bullseyes | 54 |
| Platycephalidae | Flatheads | 1 |
| Tetraodontidae | Trumpeters & Grunters | 8 |
| Urolophidae | Stingarees | 1 |

Of the 234 sightings of fish (including squid) 11 events (4.7% of the total sightings) involved interactions with the net. A squid (*Sepioteuthis australis*) was seen to become entangled temporarily. Ten events were recorded where small fish (Slender Bullseye (*Parapriacanthus elongates*), Yellowtail Scad (*Trachurus novaezelandiae*) and Chinaman Leatherjacket *(Nelusetta ayraudi*)) were seen to pass through the net without becoming entangled. On three occasions squid (*Sepioteuthis australis*) were seen to attack Yellowtail Scad.

Augusta 2013

On the 16th, 17th and 18th of April 2013, 4 cameras were placed into each of 6 gillnet deployments. 4 cameras were used in the 2 gillnets deployed. We chose to place 2 cameras in each of the nets deployed. The visibility was at least 10 metres (judged by the ability to see the next float in front of the camera). Of the 24 camera deployments only 21 recordings (~105 hours of imagery) were analysed due to 3 camera failures

A total of 810 fish (including observations of 3 cuttlefish and 17 squid) from 25 families and 32 species (Table 7) were recorded. The most common species seen were the Yellowtail Scad (*Trachurus novaezelandiae*, 35.8%), Trevally (*Pseudocaranx spp*, 21.8%), the Western

King Wrasse (*Coris auricularis*, 8.3%) and the Western Australian Salmon (*Arripis truttaceus*, 7.2%).

Of the 810 observations of fish we observed 9 events (1.1%) where fish interacted with the net. We recorded two events where a Southern Eagle Ray (*Myliobatis australis*) hit the net and swam away without becoming entangled. Two Smooth Stingrays (*Dasyatis brevicaudata*), a Striped Stingaree (*Trygonoptera ovalis*) and a Queen Snapper (*Nemadactylus valenciennesi*) were recorded hitting the net and swimming away from it. A Dusky Morwong (*Dactylophora nigricans*) was recorded swimming under the bottom of the net without becoming entangled. Similary, a school of trevally (*Pseudocaranx spp*) was recorded swimming through the net without becoming entangled. A Gummy Shark (*Mustelus antarcticus*) was recorded becoming entangled in the net and was recorded in the catch on-board. Clips of examples of the deployments are attached to a DVD accompanying this report (see Appendix III).

### Effects of demersal gillnet use on substrates

From the underwater footage captured it appeared that demersal gillnets have a negligible impact on the substrate, with the gillnets set over seagrass and weed beds, sandy bottoms and sand/rock substrate. The results of the camera observations indicate that demersal gillnetting is a passive, non-desructive and largly selective method of fishing. Such results may prove valuable to third party reviewers and certifiers such as the Marine Stewardship Council. However, care should be taken in interpreting these results given the limited sample size.

Table 7. Families seen around nets from 6 deployments near Augusta.

| Family | Standard Name | Number |
|---|---|---|
| Arripidae | Australian Salmon | 59 |
| Carangidae | Jacks & Trevallies | 469 |
| Carcharhinidae | Whaler Sharks | 1 |
| Chaetodontidae | Butterflyfishes | 2 |
| Cheilodactylidae | Morwongs | 6 |
| Dasyatidae | Stingrays | 16 |
| Gerreidae | Silverbiddy | 4 |
| Heterodontidae | Horn Sharks | 2 |
| Labridae | Wrasses | 84 |
| Loliginidae | Squids | 17 |
| Monacanthidae | Leatherjackets & Filefishes | 3 |
| Mullidae | Goatfishes | 4 |
| Myliobatidae | Eagle Rays | 18 |
| Oplegnathidae | Knifejaw | 5 |
| Pempherididae | Bullseyes | 16 |
| Pomacentridae | Damselfishes | 3 |
| Rhinobatidae | Shovelnose Rays | 5 |
| Scorpididae | Sweeps | 4 |
| Sepiidae | Cuttlefishes | 3 |
| Serranidae | Rockcods, Groupers & Basslets | 22 |
| Sillaginidae | Whiting | 8 |
| Sparidae | Snapper & Breams | 1 |
| Sphyraenidae | Barracuda | 52 |
| Triakidae | Houndsharks | 2 |
| Urolophidae | Stingarees | 4 |

## 8. DISCUSSION

During 5 field trips we placed cameras onto 18 gillnets and recorded 673 hours of deployments. We observed 1980 fish (including squid and cuttlefish) from 84 species around the nets. Of those 1980 fish seen, only 2.6% (52 fish) of the observations were recorded fish interactions with the net.

We observed 7 Southern Eagle Rays (*Myliobatis australis*), 3 Smooth Stingrays (*Dasyatis brevicaudata*), 2 Southern Fiddler Rays (*Trygonorrhina fasciata*) and a Striped Stingaree (*Trygonoptera ovalis*) hitting the net without becoming entangled. All of these fish were able to turn in the net and swim along, or out of it. The Myliobatidae, Rhinobatidae and Urolophidae do not have body features (example dorsal, pectoral and ventral fins) which are prone to entanglement. Our observations suggest that of those that are caught represent a very small proportion of the interactions that occur between these species and demersal gill nets. We also observed fish such as Gummy Sharks (*Mustelus antarcticus*), Moonlighters (*Tilodon sexfacisatus*), Western Seacarps (*Aplodactylus westralis*) and Queen Snappers (*Nemadactylus valenciennesi*) becoming entangled in the net (for up to 4 minutes) before escaping. Observations of Gummy sharks escaping and swimming through the net suggests that the mesh size (>114mm used in Zones covered by the Joint Authority Fishery and >48mm used in the West Coast Zoned Fishery) used as one of a suite of management tools by the WA Department of Fisheries effectively excludes undersized sharks from being caught in the fishery.

Similarly, we observed byproduct species such as Baldchin Groper (*Choerodon rubescens*), Queen Snapper (*Nemadactylus valenciennesi*) swimming repeatedly through the net without becoming entangled, particularly smaller fish or juveniles. Many of the smaller fishes, which make up the large proportion of the reef fish assemblages, did not appear to be disturbed by the net and swam through it without being caught. These included species such as the Western King Wrasse (*Coris auricularis*), Herring Cale (*Odax cyanomelas*), Two Lined Butterflyfish (*Chaetodon lineolatus*), False Senator Wrasse (*Pictilabrus viridis*), Barred Longtoms (*Ablennes hians*), Orange-spotted Wrasse (*Notolabrus parilus*), Slender Bullseye (*Parapriacanthus elongates*), Yellowtail Scad (*Trachurus novaezelandiae*) and Chinaman Leatherjacket *(Nelusetta ayraudi*).

While many species of reef fishes such as the Western Blue Groper (*Achoerodus gouldii*), Queen Snapper (*Nemadactylus valenciennesi*) and Dusky Morwong (*Dactylophora nigricans*) are reported as bycatch the video imagery we have collected and recorded shows many reef fishes swimming along the net without touching it, swimming through the net, hitting and swimming out of it, or becoming temporarily entangled and escaping. The numbers of fish retained are low by comparison to the numbers of fish seen in the imagery around the net.

We did observe fish getting caught in the net. A Port Jackson Shark (*Heterodontus portusjacksoni*), a Moonlighter (*Tilodon sexfasciatus*), a Queen Snapper (*Nemadactylus valenciennesi*) and a Gummy Shark (*Mustelus antarcticus*) were all recorded by the cameras being caught and were also recorded in the catch in the same section where the camera was recording.

We also recorded a Port Jackson Shark (*Heterodontus portusjacksoni*) attempting to feed on a Dusky Morwong (*Dactylophora nigricans*). This was the only predation event that we recorded and the Dusky Morwong was not in net when it was retrieved. The question remains whether the the fish was consumed or dropped out during retrieval? We did not record any dropouts in the sections of the gillnet where cameras were located, although some drop outs of reef fishes were observed by staff on board the vessels.

## CHALLENGES, LIMITATIONS AND POTENTIAL SOLUTIONS

### Coverage of video imagery

The results of this research need to be treated with some caution due to the small area of the net actually sampled by the video. During days of good visibility fish were able to be identified out to 10 metres from the cameras. If we had 8 cameras in the net we may have covered 80 metres of net. For the imagery collected from Dongara the nets were 1 km in length resulting in approximately 8% coverage. If any further data were to be collected we recommend that imagery be recorded from 5-10% of the net. On a 1 km net 10% coverage would require 10 cameras being placed in the net for diurnal recording and up to 20 for nocturnal recordings. We have selected this number because statistical experience suggests that sampling 5-10% of a population provides a robust enough sample size to extrapolate the results.

### Length of recordings

After discussions with the fishermen in the field it was determined that nets are deployed for between 4 and 24 hours. This has implications if the goal is to record dropouts and not just interactions because the cameras need to be recording from the time the nets are first deployed to the time they are retrieved and fish are taken out of the net. The longer time periods can be addressed by using some of the new flash hard drive cameras which have the capability of recording for up to 40 hours or by increasing the size of the memory cards. The technology with memory cards is changing quickly and 64 GB cards (and larger) are now becoming affordable. While it is possible to increase the memory, most camcorder manufacturers do not produce a battery which lasts longer than 7 or 8 hours maximum.

Outside of this project we have built and trialled a small converter which links an external battery pack and housing to the video camera which provides sufficient power for up to 40 hours of recording.

### Nocturnal deployments

Further consultation with fishers highlighted that they do fish during both day and night. Hence, there is a need to not only record for longer time periods, but also during the dark. We trialled the use of a blue light which was attached to the camera and recorded fish swimming around and through the net. Again, providing sufficient power to a light during a whole deployment is a challenge. One solution is to build a timer which switches the light on at a predetermined time. Outside of this project a timing mechanism has been developed and tested which switches lights on and off at a predetermined time. Currently it is feasible to get 5 to 6 hours of illumination out of the lights that we used in these trials. The battery life can be extended either by increasing the length of the light housing so it could take a larger battery or using more efficient LEDs.

One of the challenges of adding cameras and lights to a net is the weight and how that effects the performance of the net. On several occasions the net was seen to sink toward the seafloor rather than remaining up in the water column. It is possible that the camera system was not neutrally buoyant and caused the net to sink.

### Number of trials

The original proposal stated that imagery would be collected from 30 deployments. Imagery was recorded from 18 deployments. This was partly due to the unavailability of commercial fishers to be part of the trial and partly caused by the need to develop and trial equipment as technical limitations necessitated that the task changed. An announcement by a major retailer to discontinue selling Western Australian caught shark resulted in a noticeable decline in market demand for WA shark, and thus a decline in the level of fishing effort in the fishery. Fishermen either stopped gill net fishing entirely, fished using other methods or sought alternative employment. As such the ability to conduct research from gillnet vessels became increasingly difficult.

The technical challenges/limitations which effected the delivery of the number of deployments have been outlined above (Modifications to planned methods after industry consultation, Discussion).

## 9. BENEFITS

The project highlights the willingness to address issues faced by the fishery, perceived or otherwise, and promote the sustainable harvest of sharks from Western Australian waters. But the project also highlighted the risks associated with achieving objectives due to fishers not being able or willing to continue to contribute to the project as a result of changes to circumstances or other events removing them from the fishery albeit temporarily.

In light of recent negative media attention directed at commercial shark fisheries in Australia, good conclusive results from this report could have helped better inform the general public and related stakeholders as to the professional and sustainable manner in which commercial fishermen operate. The project did show the potential of the use of video on gillnets and the trials resulted in technological improvements to camera design for potential future use. Whilst the findings were encouraging, this unfortunately was not the case and more work will be needed to reach a greater level of confidence in the findings.

## 10. FURTHER DEVELOPMENTS

While no dropouts were recorded from the sections of the net where video cameras were deployed the coverage was sufficiently small that the generalisation to the rest of the net can be questioned. Observers on the boat reported, but did not quantify dropout of fish at surface recorded from the rest of the net. The addition of a wide angle surface camera mounted over the roller which was switched on during recovery of the net would help to document dropouts at the surface. It is possible that the system could be constructed of a cheap wearable camera such as a GoProHero’s, Drifts or Contours. These cheap camera systems can be controlled by wireless allowing the camera to be switched on during retrieval.

# 11. PLANNED OUTCOMES

Realistically, there are no outcomes except for the potential for better designed cameras if the need to use them arises in the future. However, the following comments are provided to show the potential.

One of the planned outcomes was to clarify the perceptions about demersal gill nets in Western Australia. There is a perception that they are “walls of death”. During the 673 hours of video imagery that was analysed only 2.6% of fish observed interacted with the net and only a small proportion of these were caught. This was largely due to the mesh size used.

The second planned outcome was to measure scalefish dropout rates. This proved to be challenging due to the video cameras not recording the full duration of the set, especially when deployment times were longer than seven hours. Of the 5 fish that became entangled in the recorded field of view only one was not counted when the net came on board. This fish may have been predated upon.

The third planned outcome was to identify the stages throughout fishing activities which may result in higher levels of dropouts. This outcome is not achieved due to the requirement of video recordings which cover both the deployment and recovery of the nets.

The fourth planned outcome was that the data collected during this project would complement existing fisheries data and benefit future management arrangements.

The fifth planned outcome was that the data would be valuable in the pre-assessment requirement for third party ecological certification and affirm industry’s access rights through amicable resource sharing arrangements.

## 11.1. Action Plan

The results from this research are yet to be presented to the steering group which is comprised of the WA Demersal Gillnet and Longline Association, Recfishwest, Western

Australia's Department of Fisheries, the Conservation Council of Western Australia, OceanWatch Australia and the Western Australian Fishing Industry Council. They need to consider whether the issue of dropout and the interaction of non target species with demersal gillnets is still an issue of concern for the Western Australian fisheries and whether the project needs further development or not.

## 11.2 Communications during Project

A steering group committee was established in April 2010, consisting of representatives from WAFIC, professional fishermen, Recfishwest, the WA DoF, the Conservation Council of WA and OceanWatch Australia in response to the urgency in developing a project to measure dropout rates from commercial gillnets. A steering group meeting was held prior to the commencement of the project to confirm project timelines, additional meetings were held midway through the project and at the completion of data collection.

## 11.3 Communications after the Project

The project results and final report has been made available to members of the steering committee, Recfishwest website, professional fishermen, WA Department of Fisheries and the general public via WAFIC's website.

# 12. CONCLUSION

Measuring dropout rates from commercial demersal gillnets in Western Australia proved to be a challenging undertaking. After a great deal of persistence the placement and orientation of cameras provided enlightening footage into the fishability of commercial demersal gillnets and how they interact with the substrate and fauna.

While this project did not meet all the objectives it set out to achieve it has highlighted that Demeral gillnets do not catch all the fish that they encounter and that many species are not caught at all. Similarly, that many of the target and marketable byproduct species escaped from the nets even after they became entangled.

No dropouts were recorded and a number of fish that were recorded as visually caught in the nets were removed from the section of the net where the camera recorded them. A caveat is that the sample size and the number of observations supporting this statement is small, however, it would appear that fish falling out of the net is much less of an issue than believed. In an ideal research environment the video imagery would cover both the deployment and the recovery of the net. Two options present themselves if future research is required. The first is that the length of the deployments is limited to the capability of the existing video technology so that sufficient replication can be achieved. This would require collaborating with fishers that were prepared to fish during daylight hours for periods of less than 7 hours and recording enough replicate deployments from throughout the range of the fishery to be able to make statistically valid claims and conclusions. However, as noted above results would need to be adjusted to enable valid comparison and to reflect the real commercial fishing event if possible.

The second option is to further develop video technology which is capable of meeting the operating conditions of the fishers. We believe that it is feasible to develop cost effective and robust systems which can record for longer periods of time and integrate a lighting system for nocturnal recording. Sufficent units would need to be constructed and deployed to ensure adequate replication to cover 5-10% of the nets set and again enough replicate deployments from throughout the range of the fishery to be able to make valid comparisons.

The physical impact the fishing gear has on the substrate was also shown to be negligible, and it is unlikely that demersal gillnets pose a threat to the natural structure of the benthos. From the 673 hours of video imagery collected from the 18 deployments we did not observe any threatened, endangered or protected species (TEP's) interacting with Demersal gillnets. Greater replication across the range of the fishery would assist the robustness of this statement.

## 13. RECOMMENDATIONS

The results from this research were encouraging despite the objectives not being met. It is therefore recommended that in light of recent technological advancements in underwater cameras and lighting, further field trials could be conducted using this new camera technology. This recommendation comes as pressure to close areas and to further reduce effort of Australian demersal gillnet fisheries by Federal Government Agencies and Conservation groups increase. These potential imposts should require good information that is scientifically rigourous and have appropriate assessment of risk based on the best available information. Therefore, an appropriately designed research program that is scientifically rigorous and robust could provide evidence to support sound decision making.

## 14. REFERENCES

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## 15. Glossary

| | |
|---|---|
| CWA | Conservation Council of Western Australia |
| DoF | Western Australian Department of Fisheries |
| JASDGDLMF | Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery |
| OWA | Ocean Watch Australia |
| UWA | The University of Westyyern Australia |
| WADGDLA | WA Demersal Gillnet and Longline AssociationWCDGDLMF West Coast Demersal Gillnet and Demersal Longline (Interim) Managed Fishery |
| WAFIC | Western Australian Fishing Industry Council |

## **Appendix I.** Intellectual Property

No intellectual property was developed under this project and any knowledge gained through this project is available to the broader Australian fishing and seaffod industry.

Appendix 1: Video Clips showing examples of gillnet deployments attached as a DVD.

## **Appendix II.** Staff

The following staff were involved with this project;

| | | |
|---|---|---|
| Neil Macguffie | WAFIC (now at Oceanwatch) | Principle Investigator |
| Euan S Harvey | UWA (now at Curtin) | Co Investigator |
| Andrew Rowland | RecFishWest | Co Investigator |
| Richard Stevens | WAFIC | RD&E Manager Advisor |
| Jeff Cook and Crew | WADGDLA | Professional Fisherman |
| Terry & Jeff Cockman and Crew | WADGDLA | Professional Fisherman |
| Jay Shoesmith | OceanWatch Australia | Staff |
| Ryan Bradley | WADGDLA | Professional Fisherman |
| Matthew Birt | UWA | Staff |
| Jordan Goetze | UWA | Staff |
| Laura Fullwood | UWA (now at Curtin) | Staff |
| Damon Driessen | UWA (now at Curtin) | Staff |
| Rowan Kleindienst | WAFIC | Casual staff |
| Todd Bond | UWA | Staff |

## **Appendix III.** Video Footage

Video footage of gillnet interactions is attached as a DVD to this report.