Mitigating Incidental Captures of Fur Seals in Trawl Fisheries

A REPORT COMMISSIONED BY DEPARTMENT OF CONSERVATION

Project MIT 2006/09

SEPTEMBER 2009

John Cleal[1], George Clement[2] & Richard Wells[3]

1. JC Fishing Vessel Management Services Ltd; PO Box 1279 Nelson NZ john.fvms@xtra.co.nz
2. Clement and Associates Ltd; PO Box 6764, Wellesley St Auckland 1141 george@fishinfo.co.nz
3. Resourcewise Ltd 71 Hunter Avenue Richmond 7020 Nelson NZ richard@resourcewise.co.nz

TABLE OF CONTENTS

EXECUTIVE SUMMARY

New Zealand fur seals (*Arctocephalus forsterii*) have a history of non fatal and more often fatal interactions by capture and subsequent drowning in trawls used in New Zealand mid-depth fisheries. Mitigation of such interactions is desirable for this protected species. A particular design of exclusion device (Sea Lion Exclusion Device, or SLED) is successfully used in the squid trawl fishery to improve escapement of New Zealand sea lions (Smith and Baird, 2007).

Reviews of best international practice along with characteristics of trawl gear operation were undertaken to establish a best way forward in regard mitigating fur seal interactions with particular reference to the hoki (*Macruronus novaezealandiae*) fishery.

It was determined to trial a seal exclusion device (or SED) in the hoki fishery based on the squid fishery SLED. These devices work by physically separating the catch from the animal to be excluded using a rigid (steel) grid and providing an adjacent escape hole on the top side of the trawl. This hole has a hood designed to help prevent fish catch escapement and provide some surety that a drowned seal could not float or be washed from the trawl and thus not be reported.

The most significant construction difference in the SED used in this project compared to existing SLEDs was to reduce the bar spacing in the separator grid from 23 cm to 17 cm. This was done because the New Zealand fur seal is smaller in size than the New Zealand sea lion and, therefore , wider bar spacing may not act to separate fur seals from hoki catches.

Underwater cameras were used to record and make initial assessments of fur seal and fish interactions as well as SED performance.

Underwater camera records were constrained by reliability and visibility issues but a useful record of events was made in a structured manner. Review of video records remains a manual, often qualitative, and time-consuming process.

Fur seals were often seen near the vessel or feeding from the trawl when it was on the surface during the two trial voyages but none were captured and none were recorded by underwater camera.

The first trial of the SED in the Cook Strait hoki fishery during the spawning season when aggregations were available it was observed that the SED components operated properly but that target fish exited from the escape hole.

Hoki were observed to have a strong tendency to drift within the trawl with no consistent orientation. Other fish species were more likely to have directional mobility. This lead to hoki being particularly inclined to impact with or become trapped across the grid bars.

A second trial was carried out side of the spawning season, when catch rates were much lower than in the hoki season. It was possible to subjectively assess both rates of fish impact with the grid and grid blockage.

It appears that at high catch rates, hoki behaviour leads to processes at the grid face which allow for or even encourage escapement. A large proportion of hoki impact the grid bars while passing into the codend.

This work was based on the premise that a device that is efficient in allowing New Zealand sea lions to escape from squid trawls would also work in principle for New Zealand fur seals in the hoki and like fisheries. This appears to not immediately be the case.

PROJECT OBJECTIVES

The Department of Conservation (DoC) Project MIT 2006/09 (Conservation Services Programme 2006) has the overall objective to reduce incidental captures of fur seals in trawl nets.

The specific objectives of this project are to:

- Develop one or more methods that aim to reduce the extent of fur seal captures in trawl nets; and
- Test methods or equipment development in (a) above and determine likely effectiveness.
- The research approach is defined by DoC as below:

"Research should focus on the development and testing of effective mitigation measures aimed at reducing the incidental mortality of fur seals in trawl fisheries, particularly the hoki fishery. Designing an exclusion device suitable for fur seals and determining its efficacy is within the scope of this project, as is research investigating and applying novel methodologies. The exclusion device design should take into consideration the state of development of the current sea lion exclusion devices".

Project work was broken into the following segments:

- Design SED and build
- Initial trial of the SED during commercial fishing operations to assess fitness for purpose by camera observation
- Further trial of SED to collect video record of fish and fur seal interactions during fishing operations
- Review video footage, analyse and report.

INTRODUCTION

Incidental captures of New Zealand fur seals (*Arctocephalus forsterii*) are recorded as part of middle depth trawl fisheries, including therefore hoki (*Macruronus novaezelandiae*) in New Zealand fisheries waters. Incidental captures can result in mortalities (through drowning) or, less often, animals maybe released alive.and unharmed. The nature and extent of captures have been documented (e.g. Manly, *et al*. 2002; Abraham. & Thompson. 2009). There have been several reviews of factors leading to these interactions and of potential methods to reduce either any interactions or, more particularly, to reduce fatal captures (Rowe. 2007; Mormede. *et al*. 2008).

Concurrently research has been undertaken in Australian waters where similar fisheries are having similar interactions with Australian fur seals (*Arctocephalus pusillus doriferu)*, (Tilzey. 2000; Stewardson. & Cawthorn. 2004; Lyle,. & Willcox 2008). Research here is ongoing and includes a focus on the use of exclusion devices (M. Gerner, AFMA, *pers.comm.*).

This project uses and builds on experience and information coming directly from the development and use of sea lion exclusion devices (SLEDs) in the southern NZ squid trawl fishery (Mattlin. 2005). SLEDs are designed to allow the free passage of target fish species (in this case arrow squid, *Nototodarus sloanii*) into the codend while excluding adult and sub-adult sea lions which have free access out of the net via a permanently open escape hatch in the top panel of the net. Exclusion devices focus on allowing animals to exit the net of their own volition and maximise the likelihood of their survival. The schematic in Figure 1 below shows where a SLED is located in a trawl and its component parts.

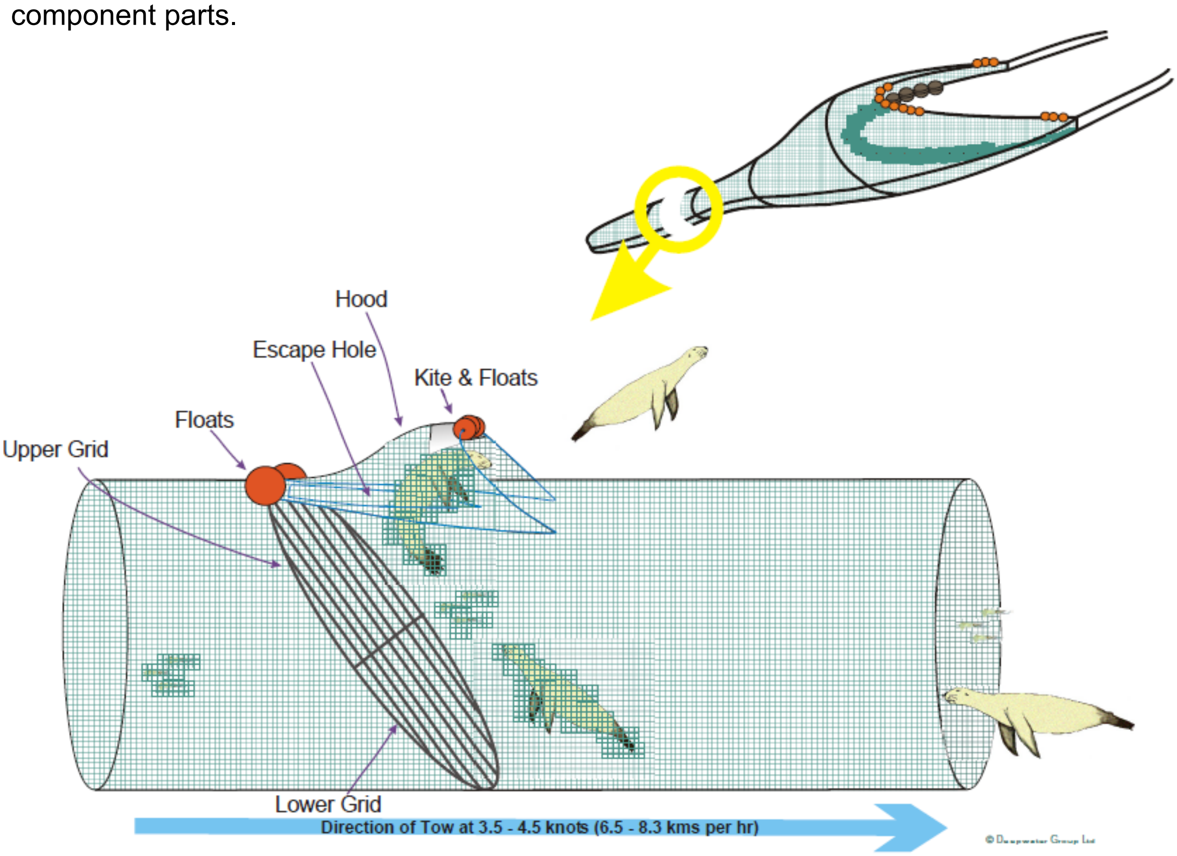


Figure 1: Schematic of SLED (not to scale). Note that when in operation, the codend would be attached to the net on the left of the diagram (Source DeepWater Group Ltd).

Note that these devices rely on several important principles:

- A hard grid separates the animal from the catch and excludes it (hence the name) from the codend of the trawl
- An escape hole allows the animal to make its way out of the trawl
- The escape hole is positioned and covered in a manner that allows only a live and competent animal to escape and loss of fish catch from the hole is minimised.

Key requirements of any seal exclusion device (SED) must include:

- Safe escape of fur seals
- Nil or very limited loss of fish catch
- Nil or very limited damage to fish catch
- Operationally safe and efficient in regard vessel, crew and trawl gear
- Affordable

There has been significant methodological learning from operating both SLEDs and underwater cameras in the squid (*Nototodarus sp.*) trawl fishery (Middleton, & Banks, 2008). This helped in selection not only of base SED design but also camera type, camera positioning, and protocols to manage the data collected, many of these being essentially reproduced from that earlier work.

A review of current best practice worldwide was undertaken as a subset of this project, "Review of Worldwide Best Practice to Mitigate Pinniped Incidental Capture in Trawls", Clement and Associates, May (2008) and is available for download from http://www.doc.govt.nz/mcs. This contains a description and further references to both the nature of the problem and research into mitigation.

Additionally a description was made in regard to the characteristics of the trawl fisheries posing particular risk to New Zealand fur seals, in particular the trawl gear used and the nature of interactions (see Appendix 1).

MATERIALS AND METHODS

SED design and build

The foundation for this design was the standard SLED currently used by trawlers in the SQU 6T fishery. The SED required modification on this base design to ensure:

- it was a proper fit with the commercial hoki trawl used by the trial vessel and;
- the exclusion grid had appropriate bar spacing for New Zealand fur seals to ensure separation between them and the catch
- the hood would not be prone to meshed escaping fish

A critical feature of exclusion device grids is the bar spacing, which must prevent all but the smallest seals from passing through into the codend. Gaps between the bars must be smaller than the average diameter of the animals likely to come into contact with the grid. The methodology for determining this is based on work carried out previously by DoC for sea lions and SLED grid bar spacing (Chilvers, 2005) and a full description of the calculation and associated references appears in Appendix 2.

The SED was constructed by Motueka Nets Ltd, a leading trawl manufacturing and repair company in Nelson (Figure 2). Motueka Nets have been heavily involved in the design and testing of the sea lion SLED design and construction from its inception.

The SED was built to general SLED design specifications and with a two panel grid. The bar spacing however was 17 cm (inside measurement) compared to 23 cm for sea lion exclusion, but the escape hole remained the same size as a 1.0 m wide base and 1.2 m long triangle. The grid was fitted into a 150 mesh round, four panel lengthener designed to fit directly into *FV Taimania's* trawl net. More information on the SED can be seen in Appendix 3.

Concerns regarding the potential for fish meshing (known as “stickers”) in the hood lead to constructing this component from 70mm inside mesh size netting. As this is less than the 100 mm minimum allowed by Ministry of Fisheries (MFish) regulations, a Special Permit was applied for and granted by MFish (S.P. Number 420).

Figure 2: SED during construction at Motueka Nets Ltd, Nelson, 2008

Vessel for trials

The vessel chosen for trials was the Sealord Group Ltd fresh fish trawler *FV Taimania* (see Appendix 4). This vessel has been involved in the hoki fishery for several years. It is an ideal platform for such trials because it:

- Uses gear that is representative of deepwater trawlers in New Zealand
- Lands fish on a regular and frequent basis to local ports
- Is operated by crew that have been involved in other research trials

Trawl gear

A net plan of *FV Taimania's* mid-water trawl is shown in Appendix 5. Mid-water trawl gear was chosen because they have been implicated in most fur seal captures in the hoki fishery, (e.g. 80% of captures in 2002-03 were by this method (Baird,. 2005 p8)). It has also been found in the squid trawl fishery that visibility is a problem in regard to video cameras on bottom trawls due to turbidity (Middleton, & Banks, 2008).

Trial area

FV Taimania operates principally in Cook Strait and on the east coast of the South Island of New Zealand. The areas where the two trials were carried out are shown in Figure 3 below.

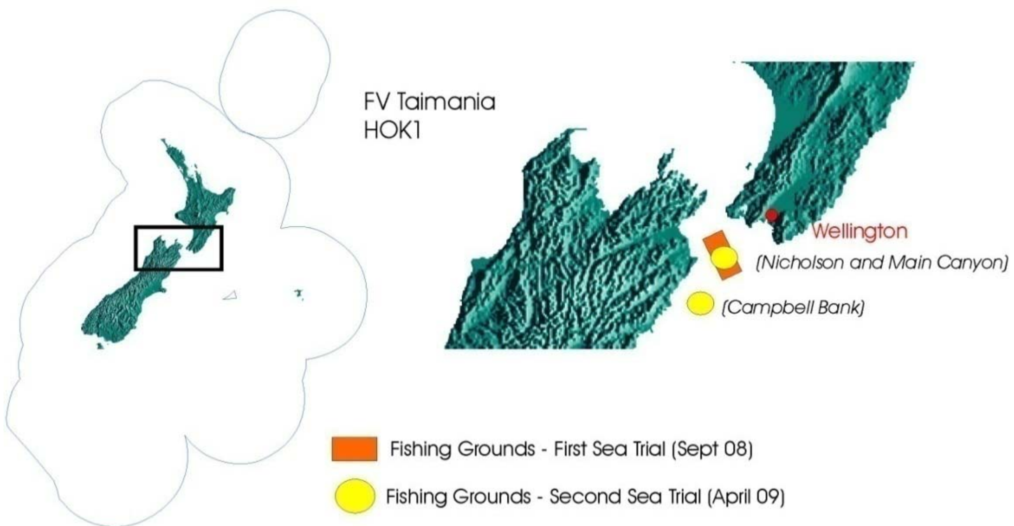


Figure 3: Hoki fishing grounds where sea trials were undertaken by *FV Taimania*, Sept. 2008 and April 2009

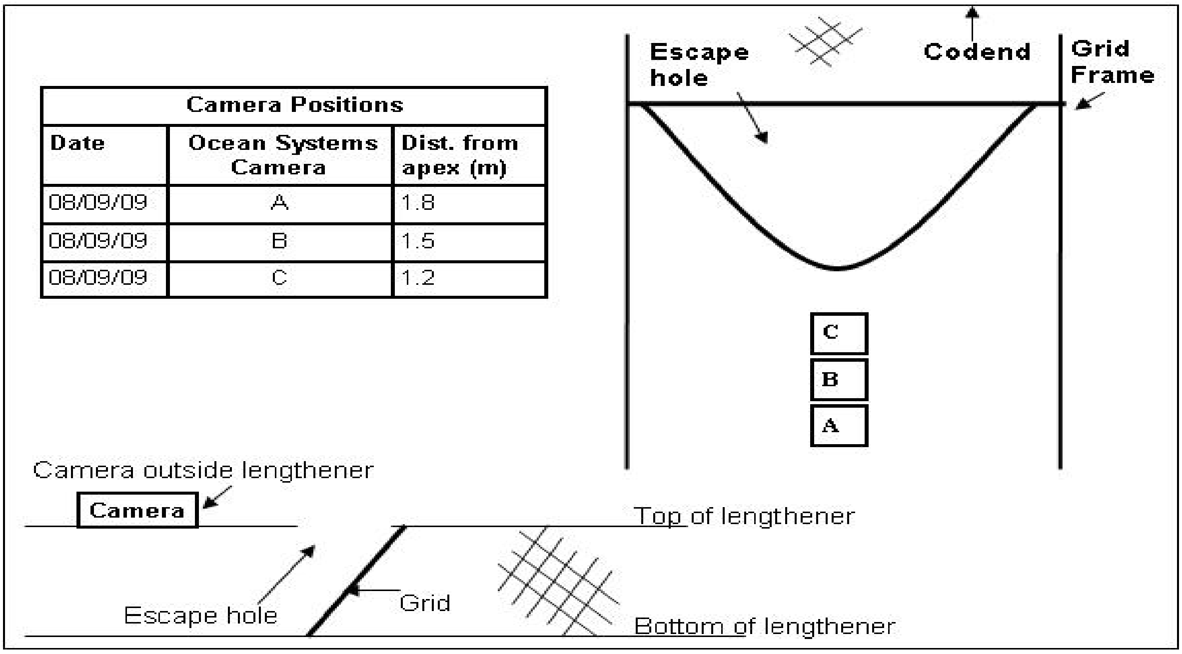
Underwater video record

Analysis of performance of the SED, any marine mammal interactions and effects on the fishing operation and catch was to be determined by using underwater cameras. These cameras record digital video data directly onto a hard-drive.

SED camera set-up for the initial trial

Initial testing of the SED was carried out using an Ocean Systems (OS) camera (specification Appendix 6) and was focused on assessing SED operational performance (i.e. how stable it was, if the lengthener, hood and kite deployed properly and if there were any other operational problems that needed to be rectified before further assessments were made).

The camera was deployed on the top of the SED lengthener looking aft towards the escape hole and hood and at distances ranging from 1.8 m down to 1.2 m from the escape hole apex as shown in Figure 4.



Camera Positions		
Date	Ocean Systems Camera	Dist. from apex (m)
08/09/09	A	1.8
08/09/09	B	1.5
08/09/09	C	1.2

Figure 4: Camera placement for the three tows undertaken during initial sea trials, side and plan views.

The video record was reviewed onboard so that any adjustments to the SED could be made during the voyage as required.

SED camera set-up for the main trial

Observation of the SED under operating conditions during the second sea trial used a Tritech Seacorder white light camera (see Figure 5, specification Appendix 6). This system has been used for work in the New Zealand SQU 6T trawl fishery (see Middleton, & Banks, 2008) and has proven to be relatively robust and reliable. As it was available, the OS camera was also taken to sea as a contingency in the event of failure of the Seacorder unit.

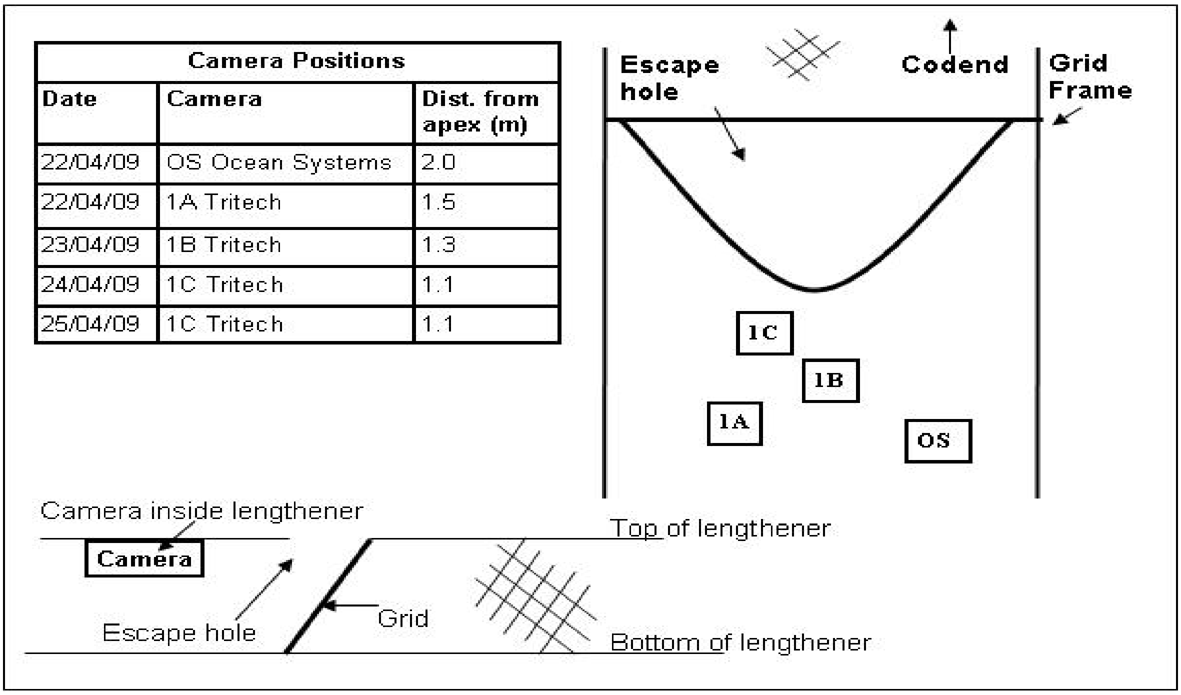
Figure 5: Tritech Seacorder white light camera. The Teflon base board and stainless protection bar were added to improve usability and protection. Ball point pen lying on top provides scale.

The Tritech camera creates AVI files; each file has 60 minutes recording time so a three hour tow will have 3 separate 60 minute files. These files were downloaded directly onto laptop PC either after each tow or after two or three tows (the 30 GB hard drive can hold up to 30 hours of footage). Back-up copies of files were always made onto an external hard drive before original files on the camera were deleted.

The SED was fitted to the midwater net with the aim to attach two cameras to the SED for as many tows as possible, including every daylight tow (as these were specifically mid water tows) for the trip and where possible also record night time tows.

Prior to each tow camera(s) was tested on deck, fitted to the net and started 2 to 5 minutes before the skipper would shoot the trawl. Depending on light and weather, hauls were able to be observed from the bridge, the deck at the stern, or from the aft gantry.

Camera placement in the trawl is shown in Figure 6. Note that the cameras were placed inside the trawl lengthener as opposed to on top as in the initial trial.



Camera Positions		
Date	Camera	Dist. from apex (m)
22/04/09	OS Ocean Systems	2.0
22/04/09	1A Tritech	1.5
23/04/09	1B Tritech	1.3
24/04/09	1C Tritech	1.1
25/04/09	1C Tritech	1.1

Figure 6: Camera placements for second sea trials, side and plan views. Note OS camera failed after two tows.

Data

Hard copy event data collection logs were used to record camera events and files; these were completed on two form types (see Appendix 9 for examples) during the trials:

1. **SED camera event log** was used to record when the camera was deployed on the net, when the camera was charged, when files were downloaded and other comments of note regarding the tow or camera
2. **SED camera file log** was used to record when files were downloaded, directory name, file number and name as well as any initial comments on quality of the footage

Analysis of data

The AVI files were converted to DivXTM files and then run on a DivXTM player, this allowed the video record to be viewed in 1/2x slow motion or speeds up to 2x, 4x or 8x normal speed.

All of the video record was viewed, noting that some assessments relied on subjective judgement. An event log was used to record the file names/numbers and start and end times of all relevant events viewed. The main focus in reviewing the footage was to:

- Record any fur seal interactions
- Rate visibility type during the tows (each type as a proportion of total record)
- Rate volumes of fish passing through the grid (fish per minute)
- Rate events showing fish lodging on the grid (levels of interaction type as a proportion of total record)
- Note events showing fish impacting the grid bars (levels of event type per minute)

- Note events affecting operational performance of the SED
- Note any other events worthy of further review or comment

Fish rates were estimated by counting the number of fish seen per minute passing through the SED grid and/or becoming lodged in the grid. A proportion of the video footage was viewed in slow motion several times to count how many fish were seen per minute during differing levels of fish density. Once “calibrated” in this way, the viewer could qualitatively assess the density of fish in all the subsequent footage and record an approximate number of fish per minute.

Three criteria were considered and rated when observed as per Table 1 below.

Table 1: Event criteria to record proportions of events viewed. The “no record” criteria denotes camera failure or time fishing and camera gear was on deck.

Video Viewing Event Log Criteria

Visibility	Fish Rate through SED	Fish Interaction with Grid
0 No record	0 No fish, visibility or no record	0 No visibility or no record
1 Good	1 Few fish (<20)	1 Grid clear
2 Average	2 Some fish (20-50)	2 Some fish lodged
3 Poor	3 Numerous of fish (>50)	3 Grid partial blockage
4 No visibility		

Number of fish impacting with grid

Ten video clips each of 1 minute duration were selected on the basis of having either average or good visibility and with a variety of fish catch rates. These were viewed in slow motion (50% normal speed) to enable a more accurate count of individual fish interactions with the SED. One clip was viewed twice to check precision. Counts were made as follows:

- Total numbers of fish passing through the SED grid into the codend
- Numbers of fish becoming lodged across the top of the SED frame
- Numbers of fish impacting on grid bars or frame while passing through to the codend

RESULTS

First Sea Trial - Initial SED Testing

The *FV Taimania* departed Nelson for the Cook Strait hoki fishery on the 6 and returned on 10 September, 2008.

Figure 7: Ocean Systems camera fitted on the trawl ready for deployment. Camera light can be seen operating, *FV Taimania*, September 2008

The SED was deployed on 3 tows commencing midway through the trip. While steaming to the grounds it was agreed with the captain that the first SED test would be on a very light or small fish mark so as to be sure the grid would not block up as this first tow was mainly concerned with the shape and operational dynamics of the SED.

The OS camera was positioned 1.8 m back from the apex of the escape hole and the lens elevated to see the top of the kite and floats to ensure a good record of these components (Figure 7).

The first tow video record was difficult to review as the gear and camera were not stable during trawling. This was caused by the connection between net lengthener and SED, however there was sufficient clear footage of the SED in regard its shape and hood/kite and float deployment to observe that everything was working. A catch of approximately 5 tonnes of fish was landed from the tow and while it was difficult to see the escape hole, some fish were observed swimming out of it.

For the next tow the trawl lengthener was moved behind the SED. This solved the stability problem observed in the previous tow. The camera was placed 1.5 m in front of the apex of the escape hole to improve video picture. The SED was now observed to be steady and with better shape; all the meshes in the SED were tight and the hood fully deployed as can be seen in Figure 8. During this tow fish hoki and silver warehou (*Seriolella punctata*) were clearly observed swimming out of the escape hole. Approximately 12 tonnes of fish (predominantly hoki) passed through the grid to the codend.

Figure 8: SED in operation during initial trials in Cook Strait, 2008. View of escape hole from apex looking aft towards top of grid frame. Netting meshes in hood and SED lengthener are assuming proper shape. Centre of grid where the two sections join is visible inside the lengthener, bottom of picture.

The final tow resulted in a 20-24 tonne catch, this being taken in approximately 10 minutes of towing. This is a typical catch rate for this size of vessel in the fishery at this time of year and similar to hoki season catches on the West Coast of the South Island.

Depending on fish levels passing through the SED, water flow appeared to change through the SED escape hole and hood. Whereas when there was little or no fish entering the lengthener, it appeared that water flowed into the SED escape hole or at least across it and passed out the back of the hood. Some fish could be seen held against the lower hood netting by this flow. When large amounts of fish enter the SED this flow appeared to stop and the hood area had little or no flow. During this type of event large numbers of fish were observed escaping from the SED as demonstrated in the video still image (Figure 9). While the grid was not observed to completely block up, the top section of the grid became congested when fish filled the escape hole and the hood area.

Figure 9: Hoki swimming freely from escape hole of SED during high catch rates achieved during initial trials, Cook Strait, 2008

The smaller (70 mm) mesh in the hood was successful in ensuring that no stickers (gilled or meshed fish) occurred in any of the tows despite the numbers of fish in the hood area and many being pressed against the hood mesh at times.

The hood remained properly deployed at all times including during net shooting and when numbers of fish became held within it; the meshes on the hood were well opened showing the kite and floats had adequate lift.

During most hauls 2 to 6 fur seals were observed at the stern of *FV Taimania* and regularly feeding from the codend however no captures or video record of any type interactions were made during the trip.

Second Sea Trial

Hoki catch rates in April during the “off-season” fishery are significantly different compared to the large volumes (10-25 tonne hauls) of hoki which are taken during the spawn in short (e.g. 30 minute) tows. Out of season hoki fishing is characterised by 3 to 4 hour tows and catches of 2 to 10 tonnes per tow with the potential for more by-catch of other fish species (e.g. ling (*Genypterus blacodes*), silver warehou, and spiny dogfish (*Squalus acanthius*)).

FV Taimania departed Nelson on the 21 and returned on 26 April, 2009.

Due to the observed level of hoki escapement in the first sea trial the vessel owner requested that there be no escape hole in the SED for this trial so the scope of this second trial was narrowed to focus on video recording the nature and level of fish interactions with the grid.

As in the initial trial fur seals were observed adjacent to or following the vessel and feeding from the codends during the haul. On this trip only 1 or 2 animals were usually seen and then for only approximately 30% of daylight tows (Figure 10). Again fur seals were neither captured nor recorded on video during the voyage.

A field trip log of the second sea trial is available as Appendix 8. It is instructive in regard operational issues and observations occurring while carrying out this type of project.

Approximately 80% of all the midwater trawl tows for the trip were recorded on video. As the bottom trawl was used most nights between 01:00 hrs and 06:00 hrs, this time was utilised to recharge the camera batteries sufficiently to ensure full camera deployment on the following day’s midwater trawl tows.

The OS camera failed (hard drive failure) on the second tow of the first day and could not be reactivated. The Tritech camera failed on two tows due to a fault with the end plug which allowed in moisture and caused the unit to shut down; once repaired the camera performed well for the remainder of the trial.

Figure 10: A New Zealand fur seal swallowing a hoki taken from codend at end of haul during second sea trial, Campbell Bank, 2009.

Cameras were deployed on 15 midwater trawl tows, as can be seen in Table 2 with three tow records lost due to camera failure; a total of 42 hours of underwater video was recorded.

Table 2: Details of camera deployment and video record achieved during second sea trial.

Date	Tow Start	Camera	Camera dist. from grid (m)	Files	Hours	Initial Comments
22 Apr	01:10:00	Ocean Sys	Port 1.8	00.1ASF	2	clear record, low catch
"	04:00:00	Ocean Sys	Port 1.8	failed	0	hard drive failure
"	01:10:00	Tritech	Starboard 1.5	V0330001,02	2	left on net do next shot
"	04:00:00	Tritech	Starboard 1.5	V0330003, 04,05,06,07	4	re-format HD
"	15:00:00	Tritech	Centre 1.3	failed	0	camera did not activate
23 Apr	10:00:00	Tritech	Centre 1.3	failed	0	camera failed, repaired
"	17:00:00	Tritech	Centre 1.3	V041001, 02,03	3	camera left on net
"	19:30:00	Tritech	Centre 1.1	V041004, 05,06,07	4	camera lens off target
"	07:45:00	Tritech	Centre 1.1	V0401001,02,03,04	4	good record
24Apr	13:30:00	Tritech	Centre 1.1	V0401001,2001,2002,2003	4	average visibility
"	17:30:00	Tritech	Centre 1.1	V0402004,2005,2006	3	average visibility
"	21:30:00	Tritech	Centre 1.1	V0402001,2002,2003,2004	4	poor visibility
25 Apr	06:00:00	Tritech	Centre 1.1	V0402001,2002,2003,2004	4	good visibility
"	10:00:00	Tritech	Centre 1.1	V0402005,2006,2007,2008	4	good visibility
"	20:30:00	Tritech	Centre 1.1	V043001,02,03,04	4	poor visibility
				Total Video Record Hrs	**42**	

Visibility

During review of the footage visibility of the grid was rated every minute by one of five visibility categories and recorded in the video event log. The entire grid was not always in full view as the camera was moved closer to the grid to be able to better observe the fish passing through the grid (as shown previously in Figure 6). While the field of view was variable between tows (as the camera placement was changed 4 times during the trials to improve the view), 60% to 70% of the grid was in the field of view for most tows unless there was a camera failure.

The midwater net is towed on the seabed at times when the fish are "hard down". Contact by the foot rope and trawl doors mean there was sufficient sediment passing through the net to affect visibility. Also what appeared to be hoki scales that may have been rubbed off by the netting within the lengthener or contact with the camera fitted inside the SED lengthener also reflected the camera's light, at times reducing visibility.

For 19% of all of the video records, it was not possible to see the grid bars (see Figure 11 below). At times turbidity was such that for the full duration of the tow the grid was barely or not at all visible.

Loss of visibility for 6% of recording was due to camera failure. There were two main failure event types:

- fish would become stuck in the camera covering the lens
- the camera lens was jolted and moved off target following impact on the stern ramp during shooting.

The number of hours of video record that received a "good" or "average" visibility rating accounted for almost half (47%) of the total and when viewed allowed the observer to see the SED grid bars and fish pass through them.

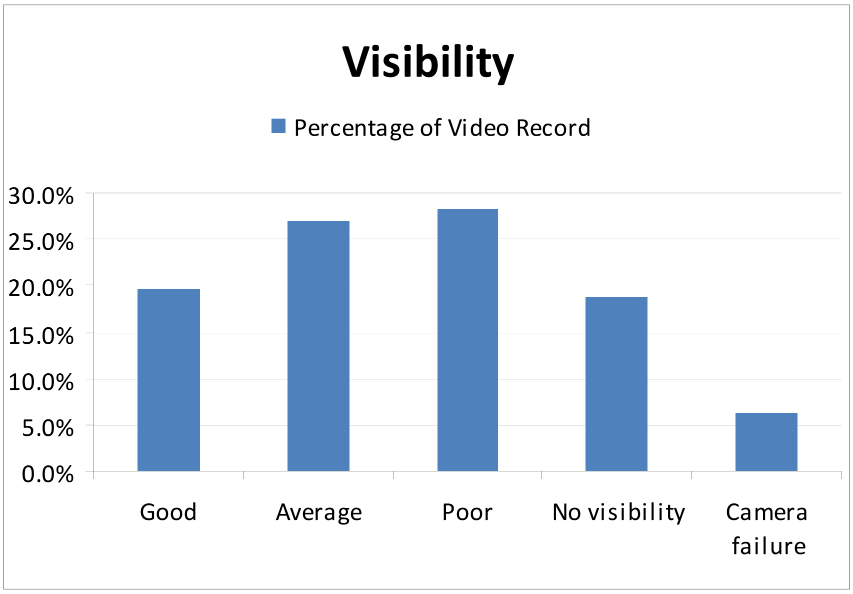


Figure 11: Visibility ratings as a percentage of the total 42 hours of video record of SED operation during second sea trial, April, 2009

Fish Rate Through SED

During this voyage's fishing operations hoki could be seen by the vessel's echo sounder (Simrad ES60) to be sparse. All of the tows recorded ranged from 2.5 to 4 hours in duration and all resulted in catches of less than 8 tonnes. Most of the tows had approximately 5 to 6 tonnes of catch, comprising mainly hoki with minimal by-catch. These catch rates are considered low by the crew even for this time of year.

Average tow duration might therefore be 3 hours and cover 18 km of towing distance to catch 6 tonnes of hoki. This equates to approximately 4000 individual 1.5 kg fish entering the trawl over 360 minutes or an average of 11 fish/minute entering the codend. Figure 12 shows differing rates of individual fish per minute passing through the SED as a proportion of the total record from the second trial.

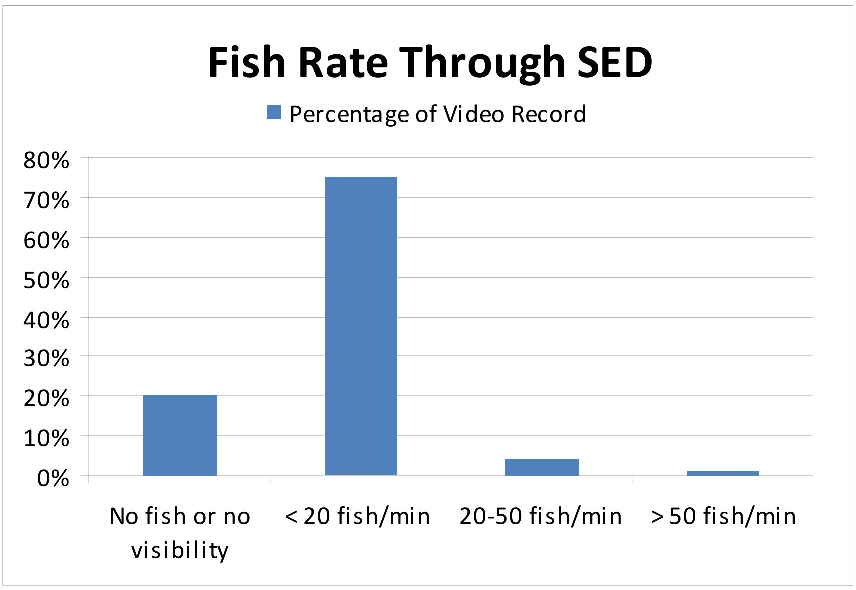


Figure 12: Estimate of fish numbers per minute passing through the SED, different rates as a percentage of total video record, second sea trial, April, 2009.

Because of lower fish density there were very few times the catch rate approached that of spawn fishing (initial sea trial) levels. During the Cook Strait spawn fishery tow length was as little as 30 minutes; actual gear fishing time on the fish aggregation was approximately 10 minutes and 15 to 30 tonnes of fish could be landed from each tow. Such seasonally high levels of fishing result in calculated levels of 750-1500 individual 2kg fish/minute passing into the codend in comparison to an estimated average of 11 fish /minute during this trip.

Fish Interaction with Grid

As noted earlier, during the second sea trial the escape hole was stitched closed to prevent the escapement of fish which was observed occurring during the initial trial. As a result, during this second trial, when fish encountered the grid bars they slid up them and would become lodged between the top of the SED frame/bars and the SED lengthener netting. This occurred on every occasion when fish were observed in the SED.

Figure 13 is based on total hours of visible video record and provides an assessment of fish lodging at the grid.

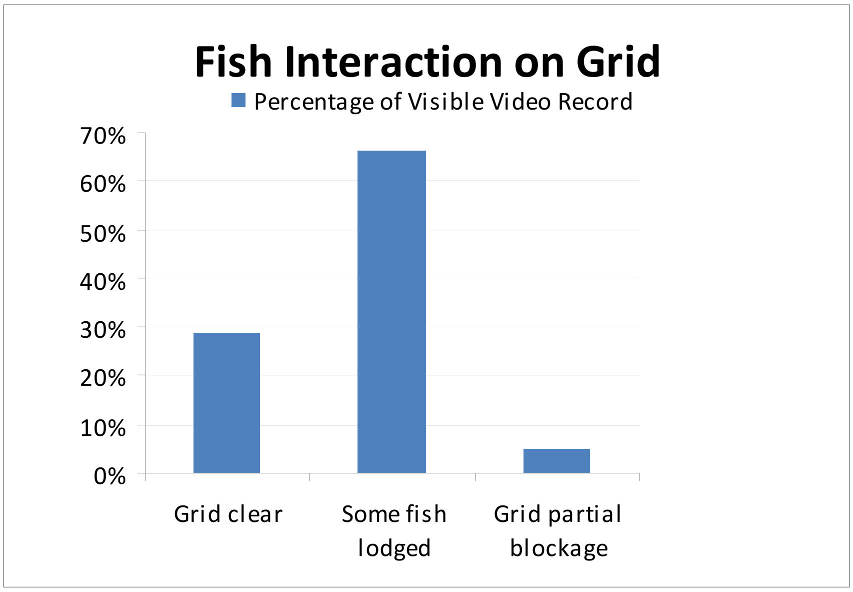


Figure 13: Assessment of fish interaction with grid by hoki. This shows event type as proportion of visible record, second sea trial, April 2009

When the density of fish was high (only 1% of the visible record as per Figure 12) the grid would become very congested but this was only observed for very short periods. At lower catch rates, again for short periods of some tows, fish lodged on the top half of the grid.

This lodged fish tended to "stack" against the top of the grid frame until unstable whereupon fish would break loose and pass through the grid into the codend. Some of this fish would remain trapped, held by water flow until such time as the water flow altered. This change could be caused by the volume of fish on the grid or if the vessel ceased towing and commenced haul. During hauling the vessel speed is reduced from 4 knots to 1 knot. It could then be observed that most of the fish stuck on the grid bars would fall back into the lengthener and only a small number of fish would remain against the grid (10 to 50 kg) when the SED arrived on the deck. Figure 14 shows the SED on deck with a single frostfish (*Lepidopus caudatus*) and a few hoki retained on the grid. Ling, bluenose (*Hyperoglyphe antarctica*) and frostfish were also recorded or seen lodged across the grid at times.

Figure 14: SED on deck after haul. A single frostfish (*L. caudatus*) is still retained across the bars. The placement position of the camera close to the apex of the closed escape hole and within the lengthener can be clearly seen, April, 2009

Hoki were observed to be poor directional swimmers when in the trawl lengthener. A marked difference was observed in the behaviour of species such as silver warehou or jack mackerel (*Trachurus sp*.) which appear very capable of forward and directional momentum within the lengthener section of the net (and while leaving the escape hole) and hoki which tend to “drift” in the water flow in a wide variety of orientations. Only when water flow in the SED area appeared to stop did hoki seem to swim freely and with purpose. Figure 15 below shows small hoki in a wide variety of orientations as they approach or impact with the grid.

Figure 15: Video still of hoki impacting on grid bars during tow. Note sideways orientation of many of the hoki, second sea trial, April, 2009.

Numbers of Fish Impacting with Grid

As can be seen in Table 3, for the video clips selected, nearly half of all fish passing through the SED hit the grid. A number lodged for a period of time against the netting where the escape hole would normally be open.

Table 3: Slow motion count of fish impacts with grid. **File 2*** was viewed again to compare to first viewing and check precision of counting.

	Total Fish Count	Fish Lodged		Grid Impacts	
		Numbers	**%**	**Numbers**	**%**
File 1	186	35	19%	81	44%
File 2	113	6	5%	42	37%
File 2*	**108**	**8**	**7%**	**37**	**34%**
File 3	17	4	24%	9	53%
File 4	73	7	10%	31	42%
File 5	70	9	13%	28	40%
File 6	28	3	11%	17	61%
File 7	64	4	6%	35	55%
File 8	14	2	14%	9	64%
File 9	24	1	4%	14	58%
File 10	115	30	26%	75	65%
Totals and Averages	704	101	14%	378	48%

DISCUSSION

SED design

The SED used in these trials was based on the existing SLED design used in the New Zealand squid trawl fishery. This design is demonstrated to allow for New Zealand sea lions to escape as the observed retention of sea lions in trawls has decreased since SLED use has become commonplace.

From an engineering and general handling perspective the SED operated acceptably. The hood and kite assembly worked well maintaining a constant opening above the escape hole. There were no particular issues with use of the SED in regard installation in the trawl, deck handling or other operations. Given the now extensive and continued use of this basic design (approximately 25 trawlers carry them for the squid fishery), this was as expected.

Camera observation

As a result of these trials and previous work in the squid fishery there is a growing body of knowledge in regard the use of cameras to observe trawls using mitigation devices. This has allowed for useful observation of major events in regard SED performance and fish behaviour. In the case of the squid fishery a few sea lion interactions have also been recorded.

However there are problems associated with this methodology:

- Underwater cameras are prone to failure
- Visibility is frequently partially or wholly obscured by turbidity
- Marine mammal events are uncommon occurrences
- Reviewing the video record is a manual process that is very time consuming
- Assessment of events, depending on their type can or must be subjective

Fish interactions with SED

By far the most significant observed result of the initial trial was the loss of commercial catch from the SED.

It would appear that when large catches occur, congestion at the grid face causes water flows in the SED area of the net to alter sufficiently to stimulate or certainly at least allow target fish species to escape. As the grid and hood area fills with fish it appears this situation intensifies, resulting in greater rates of fish escapement.

It may be that effects of scale in regard overall SED size, bar spacing of the grid, and catch rate or behaviour of hoki (or most likely a combination of these factors) make this observed escapement so much greater from that observed in the squid fishery, where squid catch escapement from mid water trawls has been measured to be relatively minimal (Middleton, & Banks, 2008).

When catch rates were high, many more target fish escaped from the SED as the congestion at the grid was greater. However, even at low catch rates, it appeared that some fish which were orientated transversely to the grid bars travelled up them towards the (closed) escape hole. If the escape hole was open as normal then these fish would have continued sliding up the bars and ended up in the hood area and likely have escaped.

The lower catch rates in the second trial allowed for better assessment of fish and grid interactions. Clearly a large proportion of fish impact the bars while passing through the grid even during low catch rate tows. This appears due to the inability of hoki to orientate (poor directional swimming capability) in the lengthener and the relationship between the size (length) of hoki and the bar spacing.

The level to which these impacts affect the quality of the hoki flesh in market terms is not determinable from these results. However it is believed by hoki processors that where hoki is caught with high levels of bycatch such as ling or spiny dogfish that levels of blemishes increase due to the impacts incurred. It is also notable that most fishing vessels now use knotless codends for hoki in an endeavour to reduce blemish levels (C. Williams, Sealord Group Ltd, *pers. comm.*).

Researchers report that hoki tire easily and suffer difficulties in swimming orientation. This, in conjunction with their delicate tissue structure, make them prone to blemishes, bloodspots and bruising from impacts incurred during commercial catching operations. Due to the costs of these effects on hoki value there has been considerable research into ways to reduce abrasion and impacts during capture (S. Black, Plant and Food Research, *pers. comm.*).

SED efficacy in releasing Fur Seals

Fur seals were commonly observed from the vessel either resting or following the vessel. Whenever the net was hauled any fur seals in the area would attend and feed from the codend. As no fur seals were caught during either trial and none were video recorded either in or near the trawl then it can be presumed that entry into the trawl is not a consistent behaviour. Many hours of video record from the SQU 6T fishery also produces very infrequent records. This makes it impossible to draw conclusions about fur seals use of the escape hole to exit or enter the trawl based on data collected.

Summary

A combination of factors appears to make the use of SEDs in a bulk finfish fishery a very different proposition to SLED use in the squid trawl fishery. Unfortunately most of the fisheries where fur seal interactions are most problematic are bulk fisheries (e.g. hoki and southern blue whiting).

The key factors causing difficulty appear to be:

- Fish density in the trawl (catch rate)
- Fish behaviour
- Fish size and required grid bar spacing
- Congestion at the grid face altering water flows
- Target fish escapement levels
- Fish impacts with bars

While the affects were not able to be quantified, even at low catch rates nearly half of the hoki caught impacted on the grid bars. For a species known to be prone to textural issues (especially hoki), this suggests a reduction in flesh quality and thus related value reduction.

Recommendations:

- Underwater video cameras are a rapid way to assess broad performance criteria of mitigation devices in trawls however they must be resourced properly and contingency devices are required
- Observations of water flows may be aided by use of twine tell-tales in and around the observation area, e.g. in front of escape hole, back of hood
- Visual assessment by experts (e.g. Plant and Food Research) may lead to better conclusions in regard potential effects of fish impacts
- While a “bolt on” solution is desirable in regard mitigating fur seal captures, considerable deliberation is required in regard the factors observed during these initial trials and before further work is undertaken. These could focus on:
    - Further communication with Australian researchers
    - Discussion with vessel operators in regard these initial findings will be necessary to gain an understanding of concerns regarding potential costs and risks associated with both fish damage and escapement versus benefits of mitigation fur seal interactions.

ACKNOWLEDGEMENTS

This project was funded by the Department of Conservation's Conservation Services Programme (www.doc.govt.nz/mcs) under project MIT2006/09.

Clement and Associates Limited would like to particularly thank the following for the help and support in this project:

Colin Williams and Bill Healey of Sealord Group Limited

Captain and Crew of *FV Taimania* - Sealord Group Limited

REFERENCES

Abraham, E & Thompson, F. (2009). Capture of protected species in New Zealand trawl and longline fisheries, 1998-99 to 2006-07. New Zealand Aquatic Environment and Biodiversity Report No. 32, 2009

Baird, S.J. (2005) Incidental capture of New Zealand fur seals (*Arctocephalus forsteri*) in New Zealand commercial fisheries waters, 2002-03". New Zealand fisheries Assessment Report 2005

Chilvers, L. (2005). Female New Zealand sea lion body size and SLED specifications. Unpublished report to SLED Working Group. June 2005.

Conservation Services Programme (2006). Conservation Services Annual Plan. Department of Conservation. Available for download from http://www.doc.govt.nz/mcs

Lyle, J.M. & Willcox, S.T. (2008): Dolphin and seal interactions with mid-water trawling in the Small Pelagic Fishery, including an assessment of bycatch mitigation strategies. Australian Fisheries Management Authority, Canberra, Australia. 39 p.

Manly, B.F. J. Seyb & D. J. Fletcher (2002). Bycatch of fur seals (*Arctocephalus forsteri*) in New Zealand fisheries, 1990/91 – 1995/96, and observer coverage. DOC Science Internal Series 41: 40p.

Mattlin, R. (2005). The use of sea lion exclusion devices in the New Zealand Auckalnd Islands Shelf trawl squid fishery. Unpublished. Paper to CCAMLR

Middleton, D. & Banks, D, (2008). Analysis of SLED video footage from the 2007 squid fishery. Seafood Industry Council report to Deepwater Group Ltd. January 2008

Mormede, S. *et al.* (2008). Factors that may influence the probability of fur seal capture in selected New Zealand fisheries. New Zealand Aquatic Environment and Biodiversity Report No. 19.

Rowe, S. (2007). A review of methodologies for mitigating incidental catch of marine mammals , Dept. of Conservation R&D Series 283

Smith, M.H. & Baird, S.J. (2007). Estimation of incidental captures of New Zealand sea lions (*Phocarctos hookeri*) in New Zealand fisheries in 2004-05, with particular reference to the SQU 6T squid trawl fishery. New Zealand Aquatic Environment and Biodiversity Report 12. Ministry of Fisheries, Wellington.

Stewardson, C. L. & Cawthorn, M. W. (2004). Technologies to reduce seal-fisheries interactions and mortalities Pp. 81-99 in Australian Fisheries Management Authority and Bureau of Rural Sciences (2004). Final Report of the Special SESSFEAG Meeting, Reducing Seal Interactions and Mortalities in the South East Trawl Fishery, 20-21 November 2003, Canberra, ACT. AFMA, Canberra, 16 January 2004. 1216p.

Tilzey, R. (2000). Seal bycatch mitigation in the blue grenadier fishery off west Tasmania in winter 2000. Report to the AFMA and Environment Australia, 24p.

APPENDIX 1: OPERATING PARAMETERS OF TRAWL GEAR

Operating Parameters of Trawl Gear in Relation to Fur Seal Mitigation

R Wells (2008)

Fishery Characteristics

The bulk fisheries that have the majority of fur seal interactions (hoki, southern blue whiting, squid) have the following relevant characteristics:

The majority of effort undertaken by large vessels (identical to, or similar to the squid fishery that utilise SLEDs)

Inshore fleet operator vessels from 700-2500 h.p.

Fishing gear can be broken down into two key types – bottom trawl and mid water trawl, some dimensional information is presented below:

	Mid water Trawl	Bottom Trawl
Overall Length (m)	70 - 250	20 - 70
Headline Height (m)	20 - 100	2 - 9
Netting – Head	1.8 – 40m	30, 25, 15 cm
Netting – Tunnel (cm)	20 - 80	15, 11
Netting – Bag end (cm)	12	11
Lengthener (cm)	11	11
Mesh round (meshes)	100 - 150	60 - 150
Codend (cm)	11	11
Mesh round (meshes)	100 - 150	60 - 150

- Mid water trawls are operated pelagically (off bottom) or semi pelagically (on and off) or full and continuous bottom contact. Head line heights when in pelagic mode are from 20-100m. This value will be halved when operated on bottom.
- Due to the bulk nature of the relevant fisheries most vessels are operating significant lengtheners (extension between net and codend) as well as multiple codend sections. This means there is a significant distance between the body of the net and the end of the codend. Experience suggests that placement of exclusion devices is best at the intersection of net body and lengthener.
- Tow speeds are generally similar and relatively high across the relevant trawl fisheries (3.5 – 5.5 knots) SLEDs are operable at these speeds. Scampi and orange roughy fisheries have slower tow speeds and differing operating parameters.

- Fishery operating parameters that may influence or increase interaction risk have been long discussed and attempts to mitigate made on the:

    - Offal discharge – attractant

    - Deck lights – attractant

    - Winch noise – attractant

    - "Stickers" in net – attractant

    - Doors up turns – higher risk

    - Gear on surface (breakdowns etc) – higher risk

- Vessels frequently operated in fleets e.g. squid and hoki season, that constrain navigation due to congestion on defined grounds. These fleets may number 20-35 vessels
- Trawling can be characterised in some fisheries by vessels turning 180o to tow back along their original tow path to re target the fish aggregation. This operation is variable in time taken depending on size of gear and horsepower of vessel. Turns with trawls at or near the surface have been implicated in captures
- It is considered that trawling depths for most relevant target species is greater than the preferred diving and fishing depth of fur seals (though not always greater than their range). This generally suggests that fur seals are at most risk during shooting and hauling or when the gear is held at or near the surface, not while it is in active fishing mode. Anecdotal evidence shows fur seals actively feeding from either "stickers" (gilled fish) or catch directly from the gear on the surface.

Procedures to help prevent fur seal captures have been documented and relevant parts are presented below.

Mitigation measures

All vessels should adopt the following practices to minimise accidental catches of marine mammals.

Shooting and hauling

- Before shooting gear, all stickers must be removed from the trawl so marine mammals are not attracted to the net.
- Shooting and hauling fishing gear must be undertaken as quickly as possible in order to lessen the risk of capture of marine mammals at or near the sea surface.
- Gear failures, particularly when shooting or hauling can create high risk situations for marine mammal captures. Evidence suggests that fur seal captures occur when there are gear failures and the gear is left on the surface of the water with the net mouth open. In the event of a gear failure which may delay the shooting or hauling of the gear the following should occur:

    - Keep the gear deep in the water even if this means re-shooting the gear – if the gear is to remain in the water the gear headline height should be at least below 50 m and preferably below 100 m.

- Bring the gear on board – or at least the ground rope and net headline to ensure the net mouth remains closed.

It is also critical that the net shape is maintained when trying to fix any gear failures as this can make it difficult for marine mammals particularly dolphins to escape the net.

Mitigation of risks

Whilst attempts have been made to mitigate these risks by industry codes of practice, to an extent there is uncertainty as to level of risk engendered or the risks are currently unable to be mitigated well by operational changes.

Probably the major incident risk is fishing gear on the surface due to deployment or retrieval failure, which appears to lead to multiple capture events.

APPENDIX 2: DEVELOPMENT OF A PROTOTYPE

Development of a Prototype Fur Seal Exclusion Device (SED)

M. Cawthorn (2008)

Following a broad range review of marine mammal exclusion devices in commercial trawls it is proposed to develop, construct and trial a fur seal exclusion grid of similar design to the sea lion exclusion devices (SLEDs) currently used in the SQU 6T squid trawl fishery for the following reasons:

- Advanced SLED design and construction technology already exists in New Zealand;
- Similar devices continue to be effectively used in the trawl fishery for squid in New Zealand waters and in the hoki/blue grenadier fishery in Tasmanian waters where Australian fur seals (albeit larger than New Zealand fur seals) are incidentally captured
- Video evidence[1] has demonstrated 'soft' grids are not as efficient as the 'hard' grids currently used in New Zealand. Their inherent flexibility allows animals to sink into the mesh and does not readily direct animals to the escape hatch;
- The only major modification necessary to the existing SLED design will be an alteration to grid bar spacings to exclude smaller animals.

Determining appropriate bar spacings

Seal exclusion devices in commercial trawls are designed to allow the free flow of undamaged target fish species into the codend while excluding adult and sub-adult seals which have free access out of the net via a permanently open escape hatch in the top panel of the net.

A critical feature of exclusion device grids is the bar spacing, which prevents all but the smallest seals from passing through into the codend. Spacings between the bars must be smaller than the average diameter of the animals likely to come into contact with the grid. The greatest circumference of a fur seal or sea lion is measured immediately behind the insertion of the fore flippers at the "armpit" or axilla encompassing the powerful shoulder and pectoral muscles and the rib cage.

Initially, bar spacings in SLEDs were set at 28cm. However in 2005 Dr. Louise Chilvers[2] (DoC) noted that up to 22% of the of female sea lions anaesthetised and measured over 4 years in the field could pass through bars at this spacing. Anaesthetised sea lions are fully relaxed and their lungs are inflated; the girth measured at the axilla is the maximum. To calculate the diameter of sea lions at this point Chilvers divided the girth by Pi(3.14159) getting an average diameter of 35.8cm (0.2cm s.e., range 30.6 – 40.7). Chilvers suggests the axillary girth in water would be more than 5cm smaller as the sea lions' muscles are tensioned when swimming, the lungs are empty of air, and water pressure compresses the rib cage. To compensate for this reduction, Chilvers therefore suggested the bar spacing should be reduced to 23cm to prevent 95% of the adult NZ sea lions measured, at their expected underwater diameter, from passing through the bars. This suggestion was considered and adopted by the SLED WG and 23cm bar spacing (inside measurement) became the standard SLED bar spacing used in the SQU6T fishery.

New Zealand fur seals, like sea lions and other otariid seals, are sexually dimorphic. The females are about 50% of the weight of males, axillary girth is 15%-20% less, and the circumference of their skulls about 15% smaller than males. Unlike sea lions, which are insulated from the cold seawater by a layer of dense subcutaneous fat (blubber) underlying the skin, New Zealand fur seals' insulation is provided by air trapped against the outside of the skin by the dense underfur overlain by guard hairs. Like sea lions, New Zealand fur seals empty their lungs before submerging, their rib cage is compressed and their muscles when swimming are contracted. Thus their in-water dimensions are expected to be less than when relaxed on land. To calculate minimum bar spacings for exclusion of fur seals, measurements from the 5th percentile of axillary girth of New Zealand fur seals was used. Measurements recovered during autopsy of by-caught fur seals provide the basis for this as per Table 1 below.

Table 1: New Zealand fur seal diameter calculations based on autopsy measurements reported by Duignan et al (2003):

New Zealand fur seals	Females	Males	Both sexes
Number of animals	32	94	126
Average girth at axilla (cm)	83.9	103.7	98.7
Average diameter at axilla (cm)	26.7	33.0	31.4
5^{th} percentile of girth (cm)	71.7	72.6	70.8
Diameter (cm)	22.8	23.1	22.5
Diameter - 5 cm (cm)	17.8	18.1	17.5

Using Chilvers' method for deriving diameter (girth/π) a minimum inside bar spacing of 17.5cm (i.e. 5th percentile axillary girth/π - 5cm) would be required to stop 95% of fur seals of a size composition represented by the by-caught animals autopsied from passing through the grid bars.

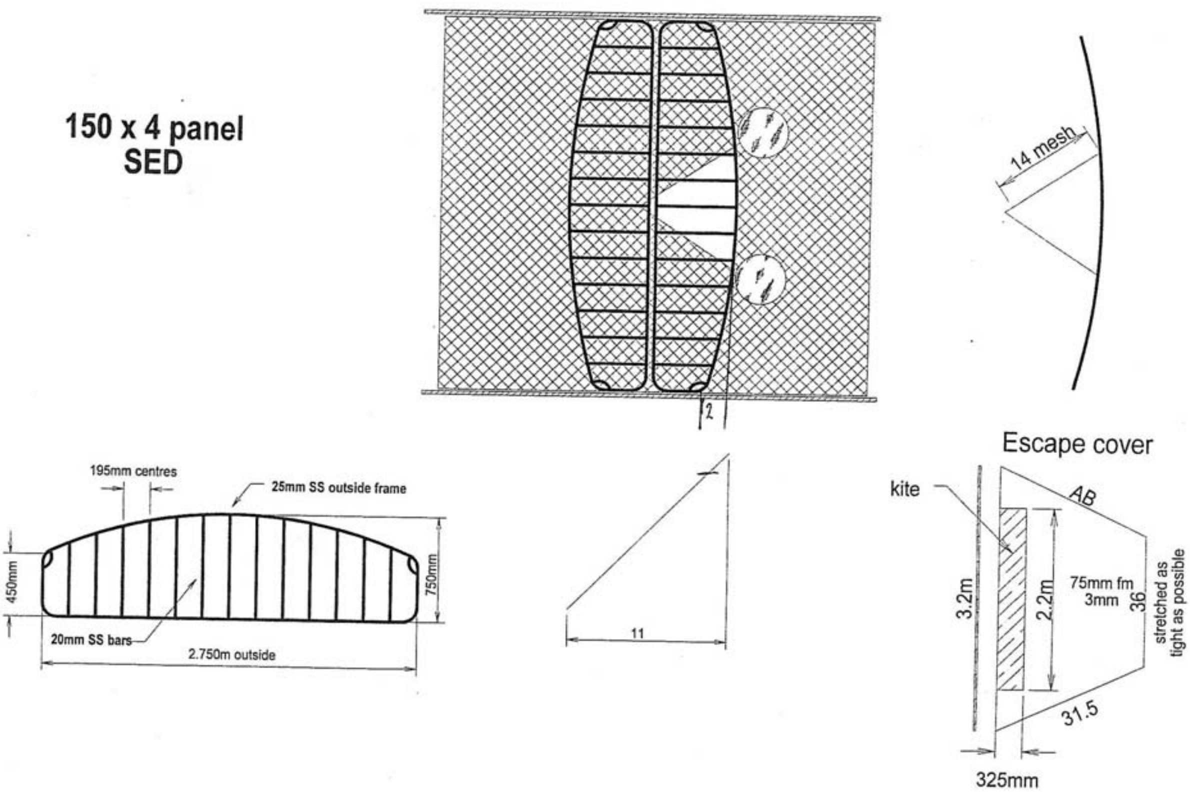
[1] Lyle, J..M. and Willcox, S.T. 2008. Dolphin and seal interactions with midwater trawling in the Commonwealth Small Pelagic fishery including an assessment of bycatch mitigation strategies. Final report. Project R05/0996 TAFI.

[2] Chilvers,L. 15 June 2005. Female New Zealand sea lion body size and SLED specifications. Unpublished report to SLED Working Group.

[3] Duignan, P. et al 2003. Autopsy of pinnipeds incidentally caught in fishing operations 1997/98. DoC Science Internal Series 118. May 2003.

APPENDIX 3: SEAL EXCLUSION DEVICE

Figure 16: SED viewed from behind, final lengthener and codends attach at end closest to observer.



APPENDIX 4: VESSEL SPECIFICATIONS

FV Taimania

Fresh fish stern trawler:

- 43 m length overall
- 2500 horsepower
- 798 gross registered tonnes

Targets hoki in the Cook Strait spawn fishery (June-September), steams from Nelson and fishes Cook Strait and lands fish to Picton, before returning to Nelson. Also catches hoki on adjacent grounds throughout remainder of the year.

All fish placed whole/green in 50 litre bins, iced and placed in the refrigerated hold.

Fishing gear

Midwater trawl - 28-17 Sealord midwater net; 36 - 42 m headline opening

Bridles – 150 m

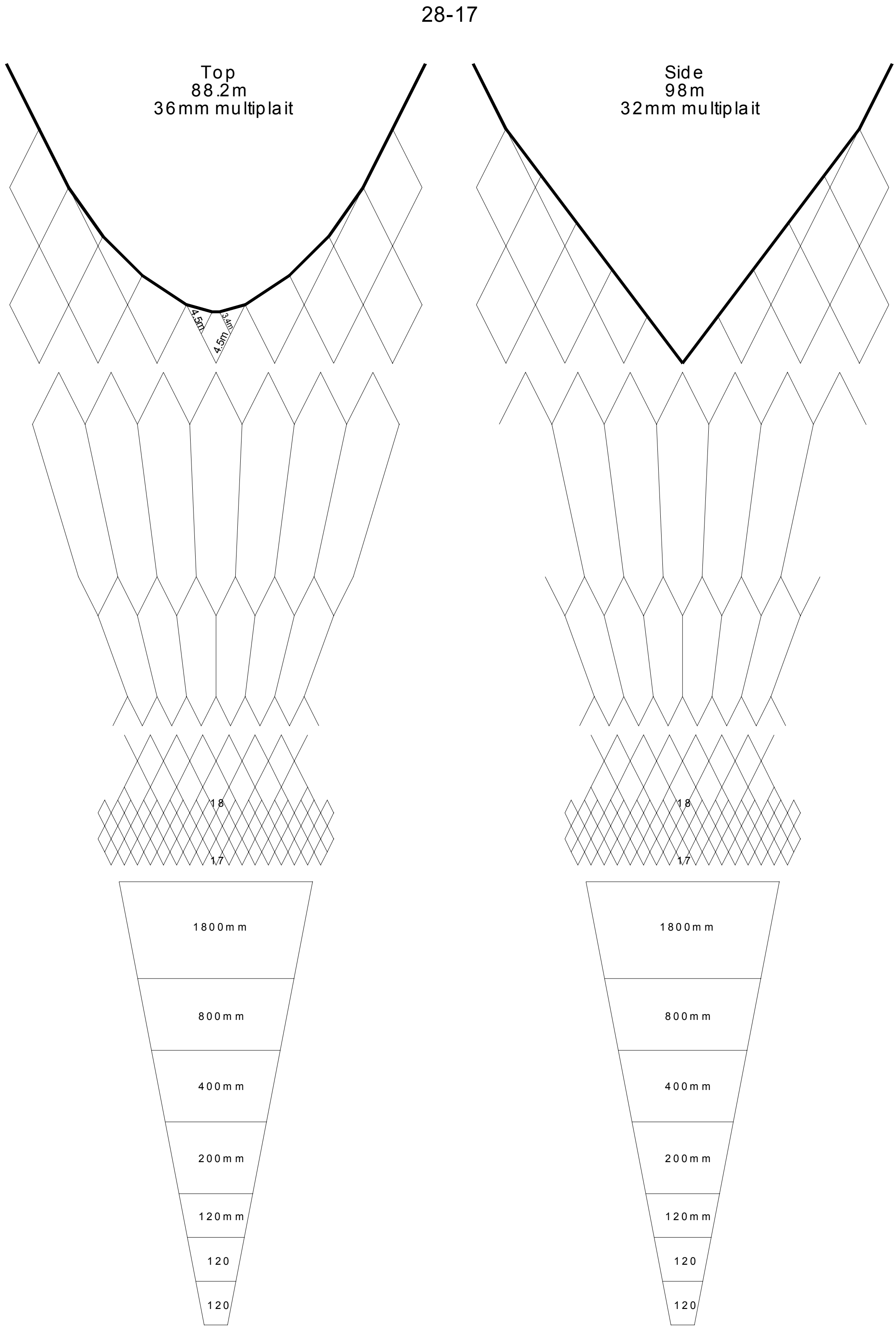
Trawl doors - 6.5 m2 high aspect ratio super-vees

Crew

Total crew -15

APPENDIX 5: TRAWL NET DIAGRAM

FV Taimania 188m 28 -17 midwater trawl



APPENDIX 6: UNDERWATER CAMERA SPECIFICATIONS

Ocean Systems Camera

Video Platform

- Pressure Bottle 4″x18″ (rated 2500 m)
- Delta Vision Colour Camera
- Mustek (PVR – H140) video recorder
- Portable 1500 m Led Lamp
- NI – MH 9 AH battery
- Video recorder and battery stored into the pressure bottle

Delta Vision Industrial Colour Camera Features:

- 420 TV lines of resolution
- Low light operation - (0.5 lux) without LED's engaged
- Virtually indestructible stainless steel camera housing
- Military grade umbilical cable – 700 lb. BS – 250 lb. Working
- Switchable internal ultra bright LED's for illumination
- Recessed lens Borsolite lens
- Camera field of view 75^o
- Image NTSC composite video
- Lens: 3.6 mm
- Iris: electronic
- Operating temp: $^-$10 to 55^c
- Input volts: 12 VCD
- Current consumption: 270 MA
- Visibility 6 m in clear water

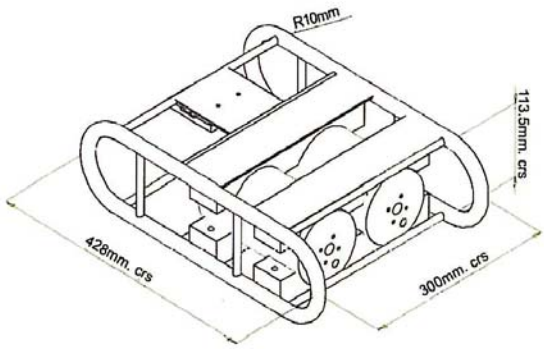
Tritech Seacorder Camera

Tritech INTERNATIONAL

innovative underwater technology

www.tritech.co.uk

Specifications



VIDEO CAMERA	
Sensor	High resolution 1/3" DSP Sony colour CCD
Effective pixel	NTSC 768 (H) x 494 (V) PAL 752 (H) x 582 (V)
Horizontal resolution	480 lines
Minimum illumination	0.1 Lux at f 2.0
Synchronising system	Internal
Scanning system	NTSC 525 lines PAL 625 lines
Video output	1.00v peak to peak composite 75 Ohms
Signal/Noise ratio	More than 50dB (Automatic Gain Control off)
Back Light Compensation	Automatic
Shutter speed	NTSC 1/60 - 1/100 second PAL 1/50 - 1/100 second
Gamma correction	0.46
White balance / colour temp.	2100°K - 8200°K auto
Gain control	4dB - 30dB auto
Smear effect	0.005%
Focus control	Preset (+/- 12V to 24V)

LIGHTING	
Typical light level	>120 lumens MTBF 50,000 hours
Dynamic Light Control	Automatic
VIDEO RECORDER	Based on an Archos engine MPEG-46 SP and stereo sound, optimised resolution for TV up to 640x480 @ 30 f/s, in AVI format.
Interfaces:	USB 2.0 high-speed device, compatible USB 1.1, PC & Mac. USB Host port compatible Mass Storage Device.
Video Recorder Capacity:	30 Gb* Hard drive Stores up to 30 hours of video
BATTERY PACK	16.8V/8.2A Operational duration 10 hours Charging time: 14 hours
OPERATIONAL DEPTH	2000metres

All specifications are subject to change in line with Tritech's policy of continual product development.

Ref: EDS-CAM-009.1

Tritech International Limited
Peregine Road, Westhill Business Park, Aberdeen, AB32 6JL, United Kingdom

T: +44 (0)1224 744111
F: +44 (0)1224 741771
Email: sales@tritech.co.uk

Marketed by:

APPENDIX 7: IMPACT ASSESSMENT FILE RECORD

Detail of video clips used for slow motion counts of fish impacts with grid.

File	File Code	Visibility/fish numbers	Video Time
File 1	T3 V041002	good visibility / numerous fish	00:35 to 00:36
File 2	T10 V0402006	good visibility/some fish	00:49 to 00;50
File 3	T5 V0401001	avg. visibility/few fish	00:53 to 00:54
File 4	T9 V0402005	good visibility / numerous fish	00:21 to 00:22
File 5	T9 V0402006	good visibility/some fish	00:48 to 00:49
File 6	T9 V0402007	good visibility / numerous fish	00:45 to 00:46
File 7	T9 V0402005	good visibility / numerous fish	00:15 to 00:16
File 8	T9 V0402002	good visibility / few fish	00:05 to 00:06
File 9	T10 V04006	good visibility / few fish	00:35 to 00:36
File 10	T3 V0401002	avg. visibility/numerous fish	00:53 to 00:54

Second Sea Trial Field Log

John Cleal (2009)

Daily observations

21 April

Steamed for 12 hours to Cook Strait, during the steam the SED was fitted by the crew to the back of the midwater (MW) net, the T90 lengthener panel was fitted behind the SED and then 1x lengthener and 2x codends followed.

The two cameras were installed into the body of the SED lengthener. On the port side the Ocean System's unit was fitted 1.5 m from the top of the grid and on the starboard side the Tritech unit fitted 1 m back from the top of the grid.

Both units were tied to the top of the mesh inside the SED lengthener. The cameras were tilted down 15 degrees to view the centre of the grid and on the Tritech unit (as it was fitted closer to the grid) we also fitted netting packing to the camera board as packing to give another 15 degrees downward angle (Figures 1 and 2).

Figure 1: Deck crew fitting the cameras to the SED with netting packing to improve field of view, *FV Taimania*, April 2009

Figure 2: Both cameras fitted inside the SED lengthener, *FV Taimania*, April 2009

22 April

The first mate shot the trawl in the Cook Strait main canyon at 01:30 hrs, short tow, hauled the trawl at 03:00 hrs for only 1 tonne of fish. Recorded footage with both cameras.

Steamed to new tow line and shot trawl 04:00 hrs, deployed both cameras (used 30 minute delay on the Tritech unit) towed until 08:00 hrs hauled (2 tonnes fish) removed both cameras to download footage and recharge.

Ocean Systems camera has a main recorder hard drive fault and won't start up. Couldn't get the unit to respond, placed the Tritech unit on charge for 6 hours.

Steamed one hour to the Nicholson Canyon, third tow shot away 11:00 hrs with no cameras. Hauled at 14:30 hrs two fur seals seen feeding from codend. Deployed fully charged Tritech unit shot away at 15:10 hrs on a 30 minute timer delay.

Not able to repair the Ocean Systems camera so this has been packed away, not a great start, down to one camera on the first fishing day.

Retrieved Tritech unit at 19:00 hrs, unit was not running. (7 tonne catch) One large bluenose was blocking the top part of the grid. Went to download the file, no file as camera had not started, the 30 minute delayed timer had not activated, test run unit all OK, tested 30 minute delayed timer, all OK, I cannot trust this timer so will by-pass this feature next time.

The hood is full of hoki; it is because the escape hole is stitched up so small fish getting out of the lengthener are getting caught in the smaller mesh of the hood (Figure 3). This has occurred every tow, so decide to let crew cut hood/kite off.

Figure 3: Some small hoki escaping from lengthener were retained in the hood *FV Taimania*, April 2009

23 April

Vessel fished south of Campbell Bank in the early morning with the bottom trawl.

Midwater net shot away at 10:00 hrs at the Campbell Bank fitted the Tritech camera (Figure 20).

The camera was activated on deck but failed before the trawl was shot. I reset the camera and it was turned on but I saw the light switch off just as the net was shot away. Trawl hauled at 15:00 hrs, camera had not reactivated and there was no recording file.

The unit was taken into the cabin and tested where it worked fine. It recorded for 30 minutes; I down loaded the footage and all systems were as per normal. I noted the end plug had a tear in the rubber. I called the New Zealand agent/technician and it was thought this crack in the rubber end plug could let moisture in to the pins at the rear of the camera which could force the unit to turn off.

Further weight was given to this reasoning as each time the unit was in the cabin and the end cap removed so battery charging and file down load could commence the unit performed well, each time the end plug was fitted on deck ready to deploy the unit failed.

For the next trawl shot the end plug was dried, glued and taped up by the chief engineer.

Fitted camera back into the SED, shot trawl at 17:00 hrs unit active and was still running when the trawl was hauled at 20:30 hrs, turned off the unit. Catch of 4 tonnes of fish, and many had been caught in the grid, these were now lying in the lengthener, two large frost fish lay across 20% of the top of the grid.

Left the camera in place, reactivated the unit, the trawl was shot again at 21:30 hrs, hauled again at 23:30 hrs camera still on and running, removed the unit from the SED and down loaded 7 files from tows 8 and 9. Two of the files from tow 8 have good footage of fish impacting with grid bars. The 4 files from tow 9 did not have suitable footage, the camera lens had moved (40°) with impact on the stern ramp during shooting and was not positioned to film the grid. Charged the unit overnight ready for a morning shot tomorrow.

24 April

Vessel had two bottom tows during the night as it did the previous night with the Alfredo bottom trawl. The mid-water net was then set up in the morning. Placed Tritech camera on the SED at 08:30 hrs, shot the trawl at 08:45 hrs.

Appears the issues with the camera have been resolved and the end cap plug repair has fixed the problem of moisture getting into the pins and the rear of the unit causing it to stop recording. Now have almost two continuous days of footage.

Hauled tow at 11:45 hrs (6 - 7 tonnes hoki) camera running all OK, lot of fish stuck across the grid. Four files down loaded, good visibility, showing plenty of fish hitting and getting stuck across the bars. Grid top section becomes practically blocked. The 2nd and 4th files have the most useful footage.

Three seals around vessel today, appears same guys follow the vessel most of the day (like the birds). They sit around the surface for the full tow, waiting to attack the codends once they reach the surface.

During the 10 minutes the codends are available to them they are hardly seen staying under the codend ripping out fish from the meshes. Once they have a fish they come to the surface to eat then disappear back under the codend.

The net has a few meshes ripped; captain decides to change midwater nets over. This gives me time to recharge camera back up to full charge. Other MW trawl is identical, and the SED is placed in the same position directly behind the trawl in front of the T90 lengthener and codends.

Deployed the camera at 13:30 hrs, moved the camera back 200 mm in the SED lengthener to get a better picture of the grid.

Hauled at 16:30 hrs (6 tonnes catch) left camera running on the net, shot the net again at 17:00 hrs, hauled at 19:30 hrs (1 tonne catch) down loaded 7 files, gave the unit 30 minute charge.

The footage from the second tow is full of silt and difficult to view. The camera lens had also moved approximately 10 degrees moving the view slightly away from the centre of the grid target.

I re-tightened it and checked the camera for further damage as it must take a hard knock to shift the camera lens, no other damage found. I placed the camera back on the net at 20:30 hrs for a tow in the Nicholson Canyon.

Haul tow at 23:00 hrs down load 3 files place unit on the charger for the night to top up to full charge.

25 April

Placed the camera on the trawl at 06:00 hrs, fully charged it should do all of the MW tows today. Fishing the Campbell Bank today, hauled at 10:15 hrs, left camera on deck running as shooting straight away again. Camera working fine, 6 tonnes catch from tow.

Trawl shot away at 10:30 hrs camera still recording. Skipper hauled the net at 13:30 hrs (2 tonnes) of fish. Charged unit, down loaded 8 files, placed camera back on trawl at 20:30 hrs for last tow.

Camera is working very well, have 38 hours of underwater footage though with a few tows with silt making viewing the footage impossible so the more footage the better.

I would think there are 20 hours of good usable footage, and only a few hours or so of fish hitting the grid, the lack of catch this trip is a noted by the crew, this is one of the vessel's quietest trips for several months.

The Alfredo bottom trawl is going on for the night and the vessel will start steaming back to port tomorrow morning, this would be the last shot with the camera.

26 April

The vessel is steaming 12 hours back to Sealord wharf at Port Nelson ETA 20:00 hrs.

APPENDIX 9: SED CAMERA EVENT AND FILE LOGS

SED camera event log

Vessel		**Camera operator**	

Trawls and SEDs – identify each trawl and SED in use on the vessel

	SED ID (stamped on grid)	*In trawl (e.g. port/starboard, MW/BT)*
S1		
S2		
S3		

Camera event log

Date (dd/mm/yy)	**Time** (hh:mm)	**Event**							**SED-trawl ID**	**Notes**
		Recording on	Recording off	On charge	Off charge	Download start	Download end	Other		

Version 2.0, 23 Dec 2008

SED camera file log

Vessel			Camera operator	

File log – complete one line for each file

Date Checked (dd/mm/yy)	Directory name	Filename	Action start	Action End	Video okay (Y/N)	Gear okay (Y/N)	Comments

Version 2.0, 23 Dec 2008