Australian Government

Australian Fisheries Management Authority

Electronic Monitoring Trial

Feasibility and effectiveness of electronic monitoring in the Commonwealth Trawl Sector of the Southern and Eastern Scalefish and Shark Fishery

Executive Summary

A 12-month electronic monitoring (e-monitoring) trial (the trial) was conducted in the Commonwealth Trawl Sector (CTS) from October 2018 to October 2019. The objective of the project was to determine whether e-monitoring, as a monitoring tool, was capable of collecting the CTS's required data for fisheries management. To achieve this objective, questions were posed relating to the ability of e-monitoring to detect fishing activities, determine the catch composition and detect interactions with Threatened, Endangered and Protected (TEP) species and the use of appropriate mitigation measures.

The project plan involved four steps:

1. Install e-monitoring systems on two otter board trawl vessels and one Danish seine vessel in the South East Shark and Scalefish Fishery (SESSF);
2. Record, review and analyse video and sensor data;
3. Compose a report detailing the analysis of data and e-monitoring system installation outcomes; and
4. Upon completion, provide the report and options/discussion paper to the South East Management Advisory Committee (SEMAC).

The trial successfully installed two Archipelago Asia Pacific (AAP) e-monitoring systems, one on the *Western Alliance* using otter board trawl gear and the second on the *Rhylan* using Danish seine gear. A third system sourced from Saltwater Inc. was not able to be installed due to constraints with the acquisition of the system from the United States of America. E-monitoring data recorded on on-board hard drives was reviewed and analysed by Australian Fisheries Management Authority (AFMA). AAP undertook additional review of sensor data using their review software to determine whether fishing operations could be identified.

One of the limitations for this trial was in having an installation configuration which tried to assess a broad range of monitoring objectives. The need for clear monitoring objectives can influence the success of e-monitoring systems in the collection of various data requirements and as such should be clearly articulated during the installation of e-monitoring systems. Effective e-monitoring programs rely on experience and capacity of reviewers and may also require amended fisher behaviour relating to catch handling practices and mandated maintenance of systems such as cleaning cameras.

Other e-monitoring programs and trials have previously shown the efficacy of e-monitoring to collect data to fulfil a broad range of monitoring objectives. As such, the following findings from the trial are only applied to the systems set up on the *Western Alliance* and the *Rhylan* and should be read in isolation from what e-monitoring can achieve more broadly.

The trial resulted in successful collection and review of data from approximately 20 fishing events during the trial period. Key findings from the trial include:

- data collected when e-monitoring system sensors (rotation and hydraulic) were operational supported the detection of fishing events, which, reduced review times and could result in efficiencies for program costs.
- e-monitoring outcomes were best achieved when the system was installed in a clean and well-lit location and maintained accordingly, particularly over the processing area.

- e-monitoring was able to detect and verify:
    - net deployment and offal discharge events.
    - large TEP species interactions and mitigation device deployment.
- based on the footage from the trial, e-monitoring would be able to detect whether crew-based data collection programs were occurring, despite not operating as part of trial.
- based on the footage from the trial, e-monitoring was able to monitor catch processing and assess if crew were handling catch in line with AFMA guidelines. This strongly suggests that e-monitoring would be able to detect and verify any animal mistreatment although no such events were recorded in the trial.
- mixed results as to the effectiveness of e-monitoring in assessing catch composition and the life status of quota and key bycatch species, and
- with the equipment configuration and review protocols used in the trial e-monitoring was not able to verify:
    - catch volumes (landed/discarded); and
    - the presence of small TEP species.

General recommendations for the potential use of e-monitoring in CTS include:

- E-monitoring can inform a range of the CTS data needs, but the trial was not able to collect all of the required data needs in the fishery's data plan (for example, catch, discard species composition and volume).
    - If used, an e-monitoring program would need to be designed to complement other monitoring tools (e.g. observer coverage and/or port monitoring).
    - Future trials and implementation of e-monitoring would benefit in exploring refined configurations and catch handling practices to improve the efficacy of e-monitoring in achieving monitoring requirements.
- An e-monitoring program requires systems to undergo ongoing maintenance and cleaning by the crew to ensure that the footage gathered delivers the requisite standard to undertake review.
    - This is generally done through a fishery specific direction for e-monitoring.
- Clear expectations of installation needs to be given when implementing an e-monitoring program. Cameras require appropriate frame rates and resolution, and need to provide a clear view of catch handling and processing areas to allow catch verification, and identify catch handling, events and TEP species interactions. This would also enable verification of crew collected data programs if they were in place.
- An assessment of the cost of using e-monitoring as a data collection tool to verify life status of catch, whether crew-based monitoring programs are being executed properly and whether discarding is occurring needs to be considered before these are collected as part of a broader e-monitoring program.

Contents

Version	Updates	Approver
1.0	James van Meurs, Dan Corrie	Claire van der Geest, Fiona Hill

1 Introduction

Legislative objectives of the *Fisheries Management Act 1991* (the Act) requires that the Australian Fisheries Management Authority (AFMA) collect fisheries dependent and independent data. These data are collected using a range of fisheries monitoring tools. Electronic Monitoring, or e-monitoring, along with fisheries logbooks and observer data, are some of the monitoring tools used by AFMA to collect the required data.

E-monitoring has been successfully used in the Eastern and Western Tuna and Billfish fisheries since 2015, and in the Gillnet, Hook and Trap (GHaT) sector of the South East Shark and Scalefish Fishery (SESSF) since 2011 and the midwater trawl sector of the Small Pelagic Fishery (SPF) since 2015, This type of monitoring provides a critical source of independently verified data focussed mainly on catch and effort for commercial and bycatch species, and interactions with threatened, endangered and protected (TEP) species.

Catch and effort data in the CTS is currently collected through fisher logbooks, catch disposal records (CDRs), and is independently verified through the observer based Integrated Scientific Monitoring Program (ISMP), and Vessel Monitoring Systems. Until recently, fishery independent data was also collected as part of the Fisheries Independent Surveys (FIS), however this was discontinued as it was not cost effectively delivering usable outcomes to support the management of the fishery.

The ISMP provides coverage for approximately 3.5 per cent of fishing effort, and while this is considered an effective approach for collecting some data for the fishery, including discard estimates, catch composition and biological data; e-monitoring was identified as a potential tool for collecting and verifying a broader range of data for the fishery.

A key consideration when designing the trial in CTS was whether e-monitoring could be used to provide similar information to that in the GHaT, SPF and Tuna fisheries, for the trawl method, with a particular focus on catch and effort data and interaction with TEPs. Further detail on the objectives and key questions under the trial are detailed below.

1.1 Aims and Objectives

The objective of the trial was to determine whether e-monitoring was capable of collecting data used to inform management decisions in the CTS by reviewing sensor data and video footage from an otter board trawl and Danish seine vessel. An agreement was executed with the South East Trawl Fishing Industry Association (SETFIA) in September 2018 to undertake the trial. In October 2018, AFMA developed a Project Plan with a number of questions concerning monitoring requirements in the CTS. To achieve this objective, e-monitoring systems were installed on two trawl vessels, with sensor and video data collection occurring between October 2018 and October 2019, and analysed to specifically answer the following questions from the project plan:

1. Can the sensor data be reliably used to identify fishing operations?
2. Can the discharge of offal be observed?
3. Can the deployment of net/doors be identified?
4. Can an estimate of total catch be made?

5. Can TEP interactions be captured?
6. Can deployment of TEP mitigation devices be observed?
7. Can catch handling and/or mistreatment be detected?
8. Can the life status of quota and key bycatch species be assessed?
9. Can crew-based data collection programs be monitored?

2 Methods

2.1 Boat selection

The trial began in October-2018 with AFMA and the South East Trawl Fishing Industry Association (SETFIA) identifying two vessels to have the e-monitoring systems installed:

1. *Western Alliance*, a 21 metre demersal otter board trawl vessel, and
2. *Rhylan*, a 17 metre Danish seine vessel.

The vessels were selected based on their history of positive engagement with the trial, AFMA and SETFIA, but also because of the areas and species they fish and the expectation that the key questions outlined above could be answered.

Participation in the trial was voluntary and concessions on installations (such as installation of only one sensor and camera locations) were made which may have reduced the efficacy of the systems to answer the questions from the project plan.

AFMA sought to install a third system from an alternative e-monitoring provider, Saltwater Inc. on an otter board trawl vessel however this did not occur because of constraints with the acquisition of the system from the United States of America.

2.2 Installation process and system description

The e-monitoring systems used for this trial are manufactured by Archipelago Marine Research Ltd, the parent company of AAP, and is currently used in other Commonwealth fisheries. A schematic diagram of a typical system (**Figure 1**) includes closed circuit television cameras, a GPS receiver, a rotation sensor, a hydraulic sensor (pressure transducer), an uninterrupted power supply, and a system control box.

The rotation sensor and the pressure transducer indicate when fishing events occur and trigger video recording. The GPS receiver provided ‘hot stamping’ on the imagery indicating the vessel’s position and time, as well as the vessel’s cruise track for the trip. The satellite transceiver modem provides real-time reporting of system status, also known as the System Health Statement Data, which sends an hourly update on the status of the system via satellite communication while e-monitoring systems are powered.

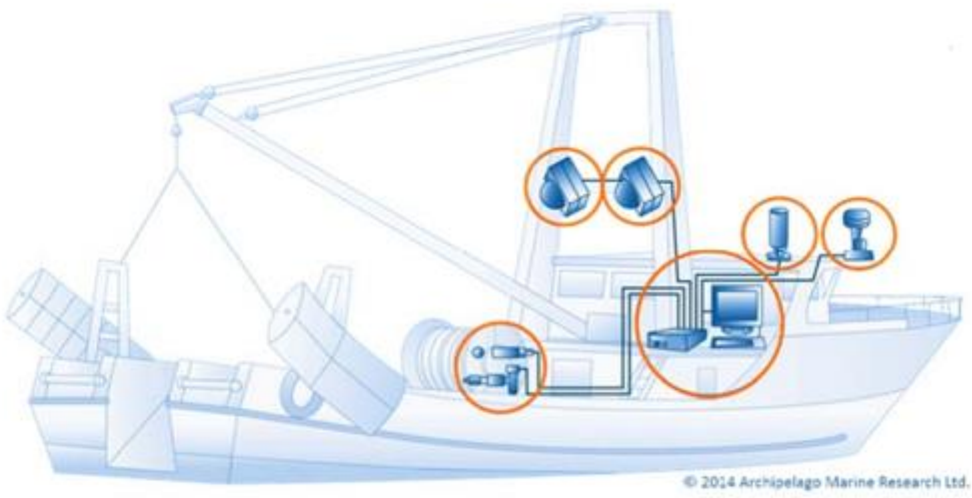

Figure 1 Schematic diagram of AAP's e-monitoring system

Western Alliance:

The *Western Alliance's* e-monitoring system consisted of five closed circuit television cameras, a GPS receiver, a satellite modem, a rotation sensor on the codend winch, an uninterrupted power supply, and a system control box.

The e-monitoring system installation required 54.75 hours over two initial visits in September – October 2018. This was considered by the contactor to be unusually high, with trawl vessel installations typically averaging around 30 hours. Providing clearer installation expectations to the vessel operators and instructions to the contractors may in future, expedite the installation process.

The *Western Alliance* had two cameras positioned on the gantry providing video coverage to the stern of the vessel, specifically one camera covering the back deck and warp wires as they entered the water and the second covering the pound, two cameras covering the port and starboard processing areas and discharge chutes and one camera position over the middle pound.

There were nine post-install visits to the vessel by the contractor involving changes to the system as requested by AFMA or the vessel, or to provide maintenance on damaged equipment and address installation issues.

Rhylan:

The *Rhylan's* e-monitoring system consisted of three closed circuit television cameras, a GPS receiver, a satellite modem, one hydraulic sensor (pressure transducer), an uninterrupted power supply, and a system control box.

The system installation was completed during August 2018, requiring 25 hours over two visits.

The *Rhylan* had one camera above the wheelhouse facing forward and focussed on the pound, a camera on the forward rigging (mast), facing down with a full-screen view of the pound and a third camera on the rear gantry facing aft of the vessel to capture setting and hauling activity.
There were implementation issues requiring five post install visits to the vessel, to resolve a system stability issue. The follow up visits were due to a systematic investigation of the fault which was only found after the contractor reviewed the sensor data on the first Hard Disk Drive (HDD). The first HDD was submitted three months after the install date and once identified, the issue was

resolved in under two weeks. If the HDD was reviewed earlier, unnecessary follow up maintenance visits from the contractor could have been avoided.
For future projects, review of the HDD after the first trip should be considered a priority to identifying system issues as early as possible.

The installation of the *Rhylan's* e-monitoring system required 25 hours of labour time by the contractor and was inflated due to the time spent resolving the system stability issues, which could be expedited with earlier identification of issues in future installations.

2.3 Review process

The e-monitoring systems recorded fishing events from October 2018 to October 2019. To answer the questions under Aims and Objectives, AFMA staff with operational experience reviewed video data and AAP reviewed sensor data.

AAP was tasked with reviewing sensor data to verify whether sensor data could reliably be used to identify fishing operations. To do this, AAP completed sensor data reviews for 33 trips (21 trips from the *Rhylan* and 12 trips from the *Western Alliance*) in early 2020 using the sensors installed on both vessels: the *Western Alliance* had one drum rotation sensor and the *Rhylan* had one hydraulic pressure sensor installed. AAP reviewed fishing events between May and September 2019 which was stored on five separate hard drives.

From July to September 2019, AFMA staff reviewed video data from approximately 20 fishing events and analysed the data against the questions detailed under Aims and Objectives. Video data was reviewed using VLC media player software. Noting the limitations of VLC video review software, using bespoke software such as AAP's *EM interpret* would likely lead to increased efficacy in catch review.

3 Results and recommendations

3.1 Fishing detection

This section considers the three questions regarding the ability to detect fishing events and related activity using both sensor data and video data.

3.1.1 Can the sensor data be reliably used to identify fishing operations?

Finding: When operational, a rotation sensor and hydraulic sensor can accurately identify fishing events. AAP was able to successfully use sensor data to identify fishing haul events in the *Rhylan* only. Fishing events were not able to be easily detected using the sensor data on the *Western Alliance* due to damage to the codend winch sensor. A decision not to replace the sensor by the vessel led to difficulty in detecting fishing activities, discussed further below.

The ability to quickly and efficiently identify fishing events using sensor data enables the reviewer to focus their time on collecting and verifying the data required by AFMA and it can considerably reduce the review times. Even without the operational sensors, AAP was able to use other e-monitoring data, including GPS location and vessel speed, to identify fishing operations on the *Western Alliance*.

To understand and demonstrate the benefit of having complete sensor data, the annotated data from an Australian mid-water trawler with an existing e-monitoring system consisting of complete sensor data (two sensors recording the drum rotation and the hydraulic pressure), is compared with the data collected from the *Rhylan* and *Western Alliance*, **Figure 2** and **Figure 3** respectively.

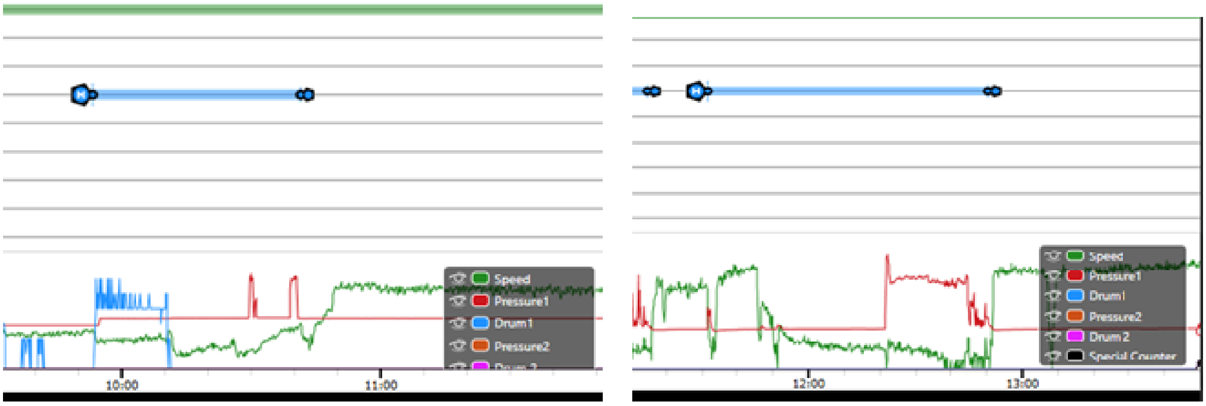

Figure 2: Sensor review data from the existing e-monitoring system on an Australian mid-water trawler with the drum rotation and hydraulic sensors (left) versus the data collected from the *Rhylan* with one hydraulic sensor operating (right). The drum rotation is represented in blue, the hydraulic pressure is represented in red and the vessel speed is represented in green in Figures 2 & 3 below. The thick blue line represents the annotated start and finish of the shot.

AAP highlighted that the sensor data did not detect the start of the fishing event (net setting) on the *Rhylan* with its single sensor. Instead, AAP used the vessel's speed to estimate the start of the setting event and to annotate the data. The haul events on the *Rhylan* were easily detected, represented by the peaked red line indicating when the hydraulic sensor was operating. The trial only installed a single sensor, but the use of multiple sensors is recommended.

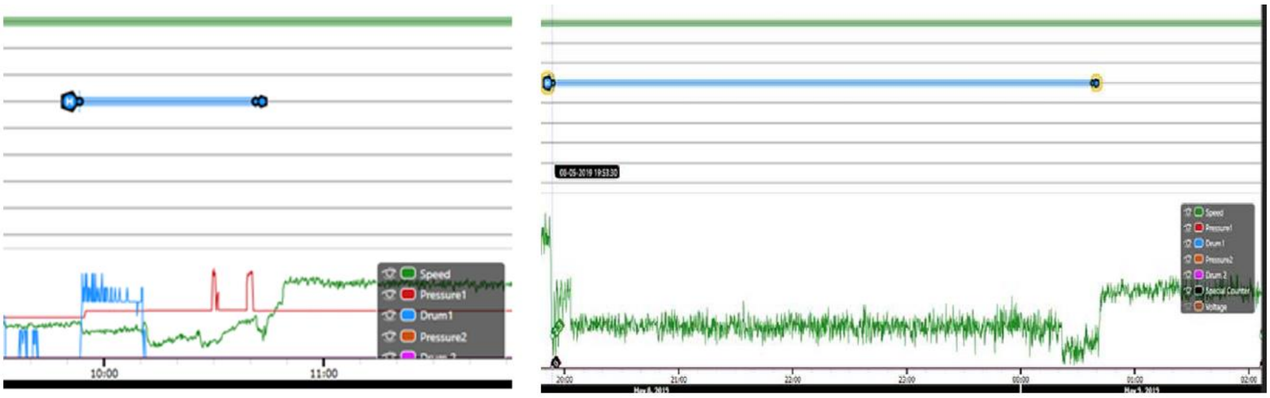

Figure 3: Sensor review data from a mid-water trawler (left) vs the *Western Alliance* (right).

The *Western Alliance* had a rotation sensor installed on the codend winch however it was damaged during the trial and not operational in the shots analysed by AAP. As such, AAP used GPS location and speed to verify and annotate the fishing events for the *Western Alliance's* fishing events.

As identified above, the sensor data provides a valuable tool for quickly and efficiently detecting fishing events. On-board, the hydraulic and drum rotation sensors are used to trigger video recording. As such, a damaged sensor resulted in a compromised setup, wherein a geofence was set up to continuous record video on the *Western Alliance*. On the *Western Alliance* a large quantity of unnecessary video data was recorded and stored on hard drives due to the sensor damage and consequently, identifying fishing events took much longer than if reviewing using sensor data. Similarly, the *Rhylan* relied on sensor data from one sensor due to the vessel's requested preferences and if there was a failure in that sensor it too would have resulted data collection failure.

Noting that there are alternative data sources that can be used to detect fishing events, for example, the vessel's GPS and speed, building in a contingency for the sensor data is an important lesson from the trial as it has significant implications for review times. Noting that concessions were made to boats due to voluntarily participation in the trial, standard installations involving the best sensor configuration would address the issues discussed above.

Recommendation:

1. To ensure that sensor data can be used to accurately identify fishing events and provide a sensor failure contingency, it is recommended that a rotation sensor is installed on the warp drums to identify and trigger recording at the start of the shot and a sensor is installed on net drum hydraulics to identify and trigger recording on hauling events.

3.1.2 Can the discharge of offal be observed?

<u>Finding</u>: Offal discharge could be reliably observed on both vessels, noting that there is minimal offal generated from the Danish Seine fleet.

To ensure optimal footage, it was important that cameras were maintained and kept clean. When clean, the dedicated cameras in processing areas on both vessels and on the aft of the *Western Alliance* allowed for reviewers to monitor offal discharge however, this was less effective when dirty. The cameras overlooking the back deck of both vessels also provided a comparative view of fishing activities while discharging offal was occurring on the otter trawl and Danish seine boats (**Figure 4** and **Figure 5** respectively).

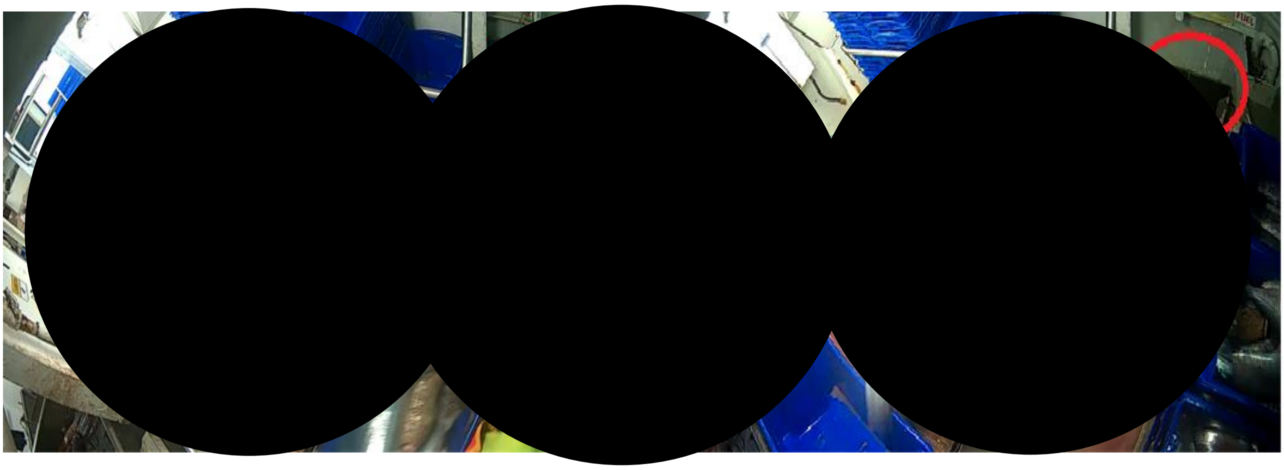

Figure 4: *Western Alliance*'s starboard camera showing an open chute with offal discharge (left) versus closed chute (right). Images not shown for privacy and commercial-in-confidence reasons

Figure 5: Discarding of catch (by hand) from the *Rhylan* using Danish seine fishing gear (wheelhouse sorting table camera). Images not shown for privacy and commercial-in-confidence reasons

Recommendations:

2. To monitor the discharge of offal, dedicated cameras need to be installed over catch processing areas and that vessel operators are directed to ensure the cameras are regularly cleaned (NB: maintenance and cleaning of the cameras applies for all recommendations).

3.1.3 Can the deployment of nets/doors be identified?

Finding: E-monitoring footage and sensor data was successful in detecting the deployment of nets and doors on both the *Western Alliance* and *Rhylan.* The placement and installation of the dedicated cameras on both vessels enabled easy observation by reviewers.

Placing cameras over areas where gear is deployed allowed the reviewers to observe setting for the *Western Alliance* and hauling for both vessels. Triggering the video recording and detecting this activity using sensor data was possible on the *Western Alliance* because of the rotation sensor on the codend winch (data prior to it being damaged later in the trial). However, on the Rhylan, confirming that the nets had been set was only possible after the hydraulic sensor had triggered recording when the vessel commenced hauling.

Recommendations:

3. That dedicated cameras are installed on net/door deployment areas and are activated using rotation sensors on net drums to capture deployment of fishing gear.

3.2 Catch Composition analysis

This section considers the three questions regarding catch composition analysis.

3.2.1 Can an estimate of total catch be made?

Finding: With the trial's camera set up and crew's catch handling practices, e-monitoring could not be used to provide reliable estimates of catch, however, it could be used to establish presence or absence of discarding.

Total catch estimates, including the retained and discarded weights of target species and bycatch, could not be made during the trial. The catch in each shot is variable, including the weight of retained target species and bycatch. This natural variability meant that the e-monitoring system was not able to provide reliable estimates of total weight. Although the trial demonstrated that bin counts and the presence or absence of discarding could be verified, reliable estimates of the weight of target and key bycatch species was not able to be estimated with any reliability using e-monitoring at this time.

The trawl shots reviewed typically included a mixture of species, which were initially released into the pound together. Unlike gillnet or hook vessels, fish cannot be individually counted, nor can they be organised into groups without significant changes to deck configuration and handling practices. Future technological advancements, for example Artificial Intelligence or improved sensors, may provide opportunities to estimate total catch with a greater certainty.

Recommendations:

4. If verifying whether discarding has occurred is part of a future e-monitoring program, it is recommended that dedicated cameras are installed in catch handling areas. If total catch estimates are to be included in a future e-monitoring program, clear monitoring objectives and updated catch handling requirements need to be set to achieve these monitoring outcomes.

3.2.2 Can the life status of quota and key bycatch species be assessed?

Finding: E-monitoring can be used to determine life status of some species where they are alive and vigorous. However, this requires an intensive review of the footage and dedicated camera angles.

The e-monitoring trial produced mixed results in its ability to assess the life status of quota species and key bycatch species. To detect life status, e-monitoring would require appropriate placement and maintenance of cameras over the pound and sorting areas. Future programs would benefit from clearly defined installation and data collection plans to meet the desired monitoring objectives.

Identification of quota and bycatch species groups was possible on the *Western Alliance.* However, species-level identification of quota species and bycatch, such as deep-water sharks, was not reliable and could not be assessed. This was potentially due to the resolution settings of video footage, clarity of cameras when dirty, and limitations of the VLC viewer's controls to enhance footage. It was not possible to differentiate between an animal which was dead against those that were alive but 'sluggish'. However, for larger animals like stingrays, skates and some sharks, e-monitoring could be used to verify life status, but only where animals were alive and vigorous.

The presence or absence of quota and bycatch species groups could also be assessed on the *Rhylan,* and in some cases it was possible to identify bycatch to the species level due to higher quality video footage (cameras were usually cleaner due to fishing inshore and resultant better weather conditions) and the smaller quantity of catch during processing. Catch survivability on Danish seiners is typically better compared to otter board trawlers due to shorter tows and shallower fishing events. Similar to the Western Alliance, life status was observable for species which were alive and vigorous, but discerning between 'alive and sluggish' and 'dead' could not be done with confidence.

While determining life status is possible for some species, it would require a considerable amount of time and effort compared to collecting other data, such as a TEP interactions or even piece-counts in hook fisheries.

Recommendation:

5. If considering e-monitoring as a data collection tool in the Danish seine fleet for life status of quota and key bycatch species, the time and effort required to collect this data should be considered against other priorities such as monitoring TEP interactions and discarding practices.

3.2.3 Can crew-based data collection programs be monitored?

Finding: E-monitoring footage could be used to monitor crew-based data collection programs, depending on the placement of the cameras. While this trial did not consider verification of crew-collected data, it has been demonstrated in other fisheries.

With appropriate placement and maintenance of cameras, e-monitoring may be used to either:

a) verify that crew-based data collection protocols are being adhered to (whether random or size-graded samples are collected); or
b) to facilitate the collection of data (crew holding catch up to the camera or placing fish on colour-coded measuring boards).

Apart from logbook data, there were no crew-based data collection programs in place on either boat during the trial. While a recent trial of catch handling monitoring in the Antarctic and seabird handling in the ETBF have demonstrated that (b) is possible in other fisheries, this trial did not explicitly consider whether e-monitoring could be used to collect this type of data. However, there was sufficient footage to determine whether e-monitoring could be used to verify that crew-based data collection program protocols are being adhered to.

Provided cameras are maintained and placed in well-lit handling areas, e-monitoring footage could be used to verify whether crew-based data was being collected. For example, footage could be used to determine the number and even species of fish measured provided cameras were placed over processing benches, or that fish are being randomly sampled.

An ongoing e-monitoring program that included monitoring of crew-based data collection programs would need to take into consideration the installation of dedicated cameras to capture the relevant areas of the vessel. This would include placing cameras where the catch is handled and processed, and ensuring the cameras are regularly cleaned and maintained and that they are placed in well-lit areas.

Recommendations:

6. If a crew-based data collection program was to be considered in any ongoing e-monitoring program as a complementary monitoring tool, the cost of doing so would need to be weighed against the option of simply verifying that sampling protocols were followed.

7. Dedicated cameras in catch handling and processing areas are installed and are well-lit to ensure video clarity, that there are specifications outlining the cleaning and maintenance of the cameras by the crew, and that standards regarding the quality assurance/quality control system is agreed and operates within the crew-based data collection.

3.3 TEP species interactions and mitigation devices

This section considers the questions regarding the detection of Threatened, Endangered and Protected (TEP) species interactions and use of mitigation devices.

3.3.1 Can TEP interactions be captured?

Finding: Only interactions with large TEPs could be reliably observed. Interactions with seabirds, could not be reliably observed and small TEP species could not be observed.

For the purpose of the trial, TEP species were classified as either 'large' TEP species (e.g. seals and dolphins), 'seabirds' or 'small' TEP species (e.g. seahorses, pipefish and sea-dragons).

Large TEP species interactions

E-monitoring successfully detected interactions with large TEP species on both the *Western Alliance* and the *Rhylan* (**Figure 6**). During the trial there were interactions with seals and e-monitoring successfully verified these interactions with the vessels logbook data. Importantly, verification of interactions reported in logbooks was possible with e-monitoring even in poor conditions, for example low light or where there was sea spray on the cameras. Cryptic mortality (death of an animal due to the fishing operation undetectable by the e-monitoring system, observers or the crew) of large TEP species from bag bursts and/or drop outs was not observed nor was it expected to be observed as part of the trial as this would have required underwater cameras in the nets.

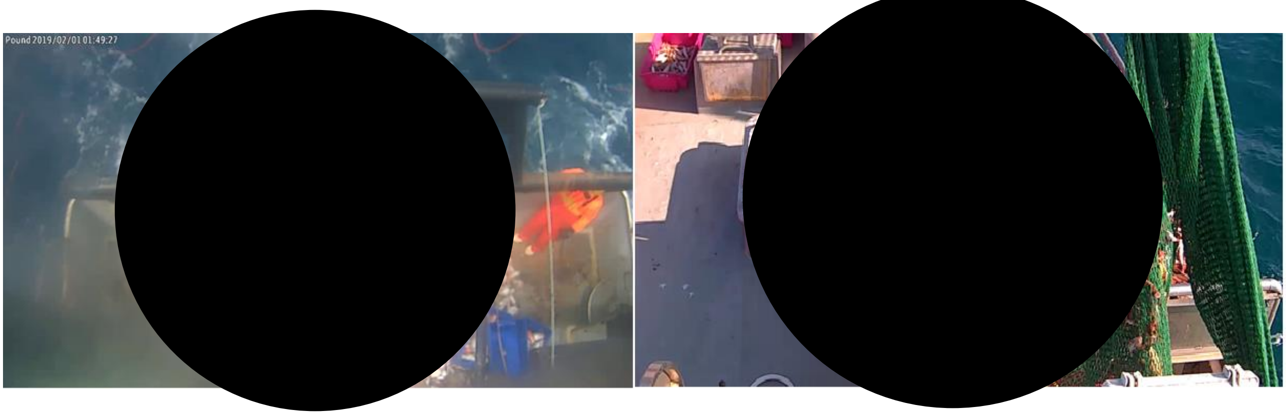

Figure 6: Video footage of capture of large TEP species, seals, on the *Western Alliance* (left) and the *Rhylan* (right). Even when the footage is poor the seal can be clearly seen and therefore verified.

Images not shown for privacy and commercial-in-confidence reasons

Seabird Interactions

E-monitoring footage could be used to observe presence / absence of seabird aggregations during fishing events, including in areas of high risk, for example, near warp wires. While individual strikes with the warp wire could not be reliably observed, footage could be used to observe interactions with seabirds where they were brought onto the deck (either in the net or trawl door) and verify the logbook data, thus providing important independent verification of seabird interactions in these instances.

Seabirds often form large aggregations at the stern of the vessel, and aggressive feeding behaviour combined with poor weather conditions and video quality meant e-monitoring footage could not reliably be used to observe interactions with warp wires. These interactions are also often cryptic, adding to the difficulty of using e-monitoring to observe interactions.

<u>Small TEP species Interactions</u>

E-monitoring footage could not be used to observe small TEP species such as pipefish and sea dragons. From observer experience, when small TEPs are present they are mixed in amongst large volumes of catch of other species, and so regardless of weather, lighting conditions, or video resolution, they could not be reliably observed.

Recommendations:

8. To enable monitoring of TEP interactions, dedicated cameras should be installed over key interaction locations on the vessel such as warp wires and catch handling areas.

3.3.2 Can deployment of TEP mitigation devices be observed?

<u>Finding</u>: the trial demonstrated that e-monitoring can be used to verify the deployment of TEP species mitigation devices.

On the *Western Alliance,* TEP species mitigation measures used included bafflers and pinkies attached to the warp wires to mitigate seabird interactions. These devices are clearly visible in the e-monitoring footage (**Figure 7**). While other potential TEP mitigation devices such as Seal Exclusion Devices and discard chutes were not used, a clear view of the deck, port and starboard side of the boat would have allowed verification of their use. In-net bycatch reduction devices such as square mesh and T90 panels could not be verified in the trial.

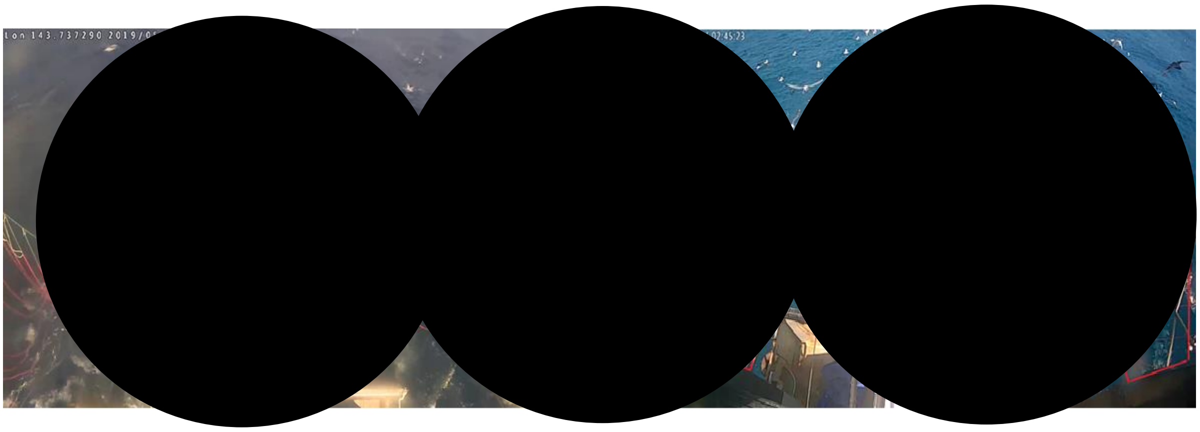

Figure 7: E-monitoring footage clearly shows the use of seabird mitigation devices in use on the *Western Alliance* in poor conditions (left) and good conditions (right). Images not shown for privacy and commercial-in-confidence reasons

Recommendation:

9. To monitor the use of TEP mitigation measures, dedicated cameras need to be installed and placed appropriately.

3.3.3 Can catch handling and/or animal mistreatment be detected?

There were no instances of animal mistreatment detected during the trial. However, dedicated cameras on catch handling areas on both vessels provided sufficient quality of footage to determine that catch handling could be observed within view of cameras. There is a high degree of confidence that e-monitoring could be used to successfully detect catch handling techniques, noting that this does require that the catch be handled in the camera view.

Recommendations:

10. With appropriate placement of cameras, e-monitoring could be used to detect animal mistreatment.

4 Summary and Recommendations

Below sets out the findings from questions posed in the trial, the specific and overarching recommendations.

Question	Findings		Recommendation
	Western Alliance	*Rylan*	
3.1.1 Can the sensor data be reliably used to identify fishing operations?	yes	yes	1. To ensure that sensor data can be used to accurately identify fishing events and provide a sensor failure contingency, it is recommended that a rotation sensor is installed on the warp winch to identify and trigger recording at the start of the shot and installed on net drum hydraulics to identify and trigger recording on hauling events.
3.1.2 Can the discharge of offal be observed?	yes	yes	2. To monitor the discharge of offal, dedicated cameras need to be installed over catch processing areas and that vessel operators are directed to ensure the cameras are regularly cleaned (NB: maintenance and cleaning of the cameras applies for all recommendations)).
3.1.3 Can the deployment of nets/doors be identified?	yes	yes	3. That dedicated cameras are installed on net/door deployment areas and are activated using rotation sensors on warp winch to capture deployment of fishing gear.
3.2.1 Can an estimate of total catch be made?	no	no	4. If verifying whether discarding has occurred is part of a future e-monitoring program, it is recommended that dedicated cameras are installed in catch handling areas.
3.2.2 Can the life status of quota and key bycatch species be assessed?	no	yes	5. If considering e-monitoring as a data collection tool in the Danish seine fleet for life status of quota and key bycatch species, the time and effort required to collect this data should be considered against other priorities such as monitoring TEP interactions and discarding practices.

3.2.3 Can crew-based data collection programs be monitored?	yes	yes	6. If a crew-based data collection program was to be considered in any ongoing e-monitoring program as a complementary monitoring tool, the cost of doing so would need to be weighed against the option of simply verifying that sampling protocols were followed. 7. Dedicated cameras in catch handling and processing areas are installed and are well-lit to ensure video clarity, that there are specifications outlining the cleaning and maintenance of the cameras by the crew, and that standards regarding the quality assurance/quality control system is agreed and operates within the crew-based data collection.
3.3.1 Can TEP interactions be captured?	Large TEP species yes Seabirds: presence absence Small TEP species: no	Large TEP species yes Seabirds: presence absence Small TEP species: no	8. To enable monitoring of TEP interactions, dedicated cameras should be installed over key interaction locations on the vessel such as warp wires and catch handling areas.
3.3.2 Can deployment of TEP mitigation devices be observed?	yes	n/a	9. To monitor the use of TEP mitigation measures, dedicated cameras need to be installed and placed appropriately.
3.3.3 Can animal mistreatment be detected?	yes	yes	10. With appropriate placement of cameras, e-monitoring could be used to detect animal mistreatment.

It should be noted that the specific recommendations were derived from the installation of systems on the two boats in the CTS and limitations of the trial. As such, the findings are specific to the trial and not a comment on e-monitoring more broadly. The general recommendations for the potential use of e-monitoring in CTS include:

- E-monitoring can inform a range of the CTS data needs, but the trial was not able to collect all of the required data needs in the fishery's data plan (for example, catch, discard species composition and volume).
  - If used, an e-monitoring program would need to be designed to complement other monitoring tools (e.g. observer coverage and/or port monitoring).
  - Future trials and implementation of e-monitoring would benefit in exploring refined configurations and catch handling practices to improve the efficacy of e-monitoring in achieving monitoring requirements.
- An e-monitoring program requires ongoing maintenance and cleaning by the crew to ensure that the footage gathered delivers the requisite standard.
  - This is generally done through a fishery specific direction for e-monitoring.
- Cameras need to be installed to provide a clear view of catch handling and processing areas to allow catch verification, and identify animal mistreatment events and TEP species interactions. This would also enable verification of crew collected data programs if they were in place.

- An assessment of the cost of using e-monitoring as a data collection tool to verify life status of catch, whether crew-based monitoring programs are being executed properly and whether discarding is occurring needs to be considered before these are collected as part of a broader e-monitoring program.