COLTO Gear Workshop, 15-16 August 2024, Oslo, Norway

Executive Summary

COLTO held a longline gear workshop for its members and interested stakeholders on 15-16 August 2024, in Oslo, Norway. The workshop was convened by Rhys Arangio, COLTO Executive Officer. The workshop was attended by 35 participants from 14 COLTO member organisations, 13 different toothfish vessels, and 5 different toothfish vessel flag states (see Appendix). All vessels that were represented use the demersal autoline method of fishing for Patagonian and Antarctic toothfish both inside and outside the CAMLR Convention Area. As well as fishing vessel / fishing company representatives there were also attendees from various parts of the fishing gear industry as well as the Norwegian Directorate of Fisheries and the Global Ghost Gear Initiative.

The aims of the workshop were to discuss the various aspects of using and maintaining demersal autoline gear in toothfish fisheries, in relation to how to minimise gear losses, and increasing the chances of recovering lost gear. The workshop also discussed gear end-of-life use.

In addition, given discussions at CCAMLR-42 on gear marking (CCAMLR-42 para 7.60), the workshop also discussed elements of the FAO Voluntary Guidelines on the Marking of Fishing Gear and how current CCAMLR longline requirements compare.

Contents

Background

The workshop was provided with a summary of what led to the development of this workshop, with previous member discussions on lost longline gear, including virtual gear workshops for COLTO members in 2023. It was noted that:

- gear losses in toothfish fisheries are comparatively low in a global sense (member data from 2018-2022 show autoline toothfish fisheries vary between 0 and 3% gear loss – referring to the percentage of hooks/mainline lost), and that the causes of these losses vary (bottom topography, ice/no ice, crew experience, gear condition, etc.).
- the Spanish line method of fishing for toothfish has even lower gear losses reported than autoline.
- demersal longline gear does not ghost fish when lost (noting that there is an initial fishing mortality when baited hooks are taken), which is confirmed regularly when previously lost gear is recovered with no catch attached to bare hooks.
- gear recovery occurs at different scales across the various fisheries, with domestic quota managed fisheries having more opportunity and less 'red tape' when it came to recovering gear compared to a CCAMLR high seas fishery.

Gear Handling

Typically, it was thought that new gear needs some breaking in before being used to its full potential. This may include hosing or soaking the line for a period before its first use. Some skippers will also set new gear slower than usual until it is broken in. If these measures are not undertaken, there is the possibility of increased tangles/breakages due to new line being more brittle.

When setting gear, autoline vessels tend to use better condition magazines at either end of a line with the older or more worn magazines in the middle to reduce risk of large quantity losses, because if a line breaks in the middle, you still have access to it from the other end via its surface buoys. If fishing on shallower/easier ground, then the skipper may use the older gear and save the newer gear for deeper/harder to fish ground.

Generally, there is more risk of tangles on the 'A' end of a longline (the first end that is deployed when setting gear) because of the downward force of the anchor as it is deployed. It was thought in some fisheries that tangles are the main source of line breakages. To try to alleviate tangles, some vessels will use a drogue on this 'A' downline to reduce the speed of the anchor in the water column. Some vessels will also maneuver the vessel in an 'L' shape when deploying this downline to avoid tangles at this 'A' end. Some vessels use floating rope, non-floating rope, or mainline without hooks as a 'freeline' between the anchor and mainline (up to 800m depending on skipper preference, weather and tide conditions, or topography) to minimise these 'A' end tangles on the mainline. The 'B' end will have a shorter freeline between the mainline and the anchor.

Downline setups, including anchor type, and the way that the anchor is connected to the downline and the freeline or mainline is highly skipper dependent and will change according to conditions. Most vessels use 40-60kg grapnels as anchors, however some use roller weights, chains, or gillnet anchors (which are more favoured on sandy bottoms and when fishing in strong currents) (Figure 1). Some skippers prefer using 50kg of 32mm chainlinks (comprised of several short lengths) instead of anchors as they don't get stuck as much. Some skippers are

making the anchor the weak point of a line, by using a trip line, so that if the anchor is the point that is stuck, that will disconnect, while keeping a connection between the downline and the mainline, therefore minimizing mainline loss.

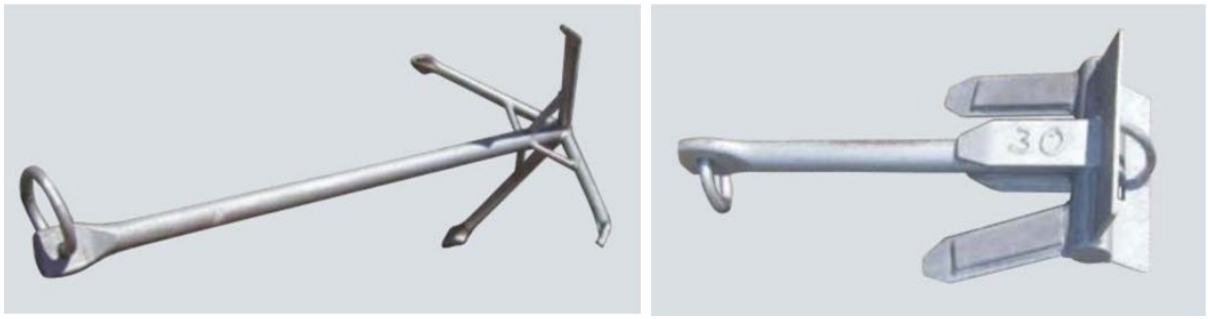

Figure 1: (left) 40-60kg grapnel and (right) 20-80kg gillnet anchor that are commonly used at either end of a mainline as anchors.

Gear Maintenance

Crew education and retention is perhaps the most important component of gear maintenance and handling. Understanding what to look for in 'good' or 'poor' condition gear is vital as looks can be deceiving. While hard to describe, 'feel' can also help inform this. A physical inspection can be undertaken by opening the braid of the mainline and visually seeing if there are strands that have been stretched. As mainline is composed of both stretch (polyester) and rigid (danline – polypropylene and polyethylene) fibers, the danline will be looser if it has been damaged by being overstretched.

It was discussed whether there could be some type of mechanical break load test on board, however it was explained by Fiskevegn that a manual test can be just as effective. A manual test can be undertaken when it is thought that gear is getting close to end-of-life by opening the braid of the mainline and pulling on the individual braids vigorously (Figure 2). If the line is weakened or damaged, these braids will break, indicating it would be time to replace that section of line.

When lines break, that section of line as well as the break point should be examined closely to try to understand the reason for the break - a clean cut could mean it has been sheared off due to a sharp rock, or frayed strands could mean the line was stuck and has broken by force that exceeds its breaking strain.

It is important to understand at what stage 'poor' quality gear should be replaced to reduce risk of breakage and loss. This can be aided through a magazine register, where 'traffic light' grading for magazines is implemented with categories such as 'new - green', 'used - yellow' or 'old - red' can be tied into the line (Figure 3) to help keep track of specific magazines – how long they have been in circulation, whether they have broken before, etc. It was discussed that further labelling of these magazines with an ID number could enhance this by linking additional information and the ability to track and analyse each magazine and its use, therefore providing the vessel with even more information to help make better decisions on gear replacement. This would help elucidate where the sweet spot lies between costs involved in replacing this poorer condition gear versus the lost time and lost fish associated with breaking lines and losing gear.

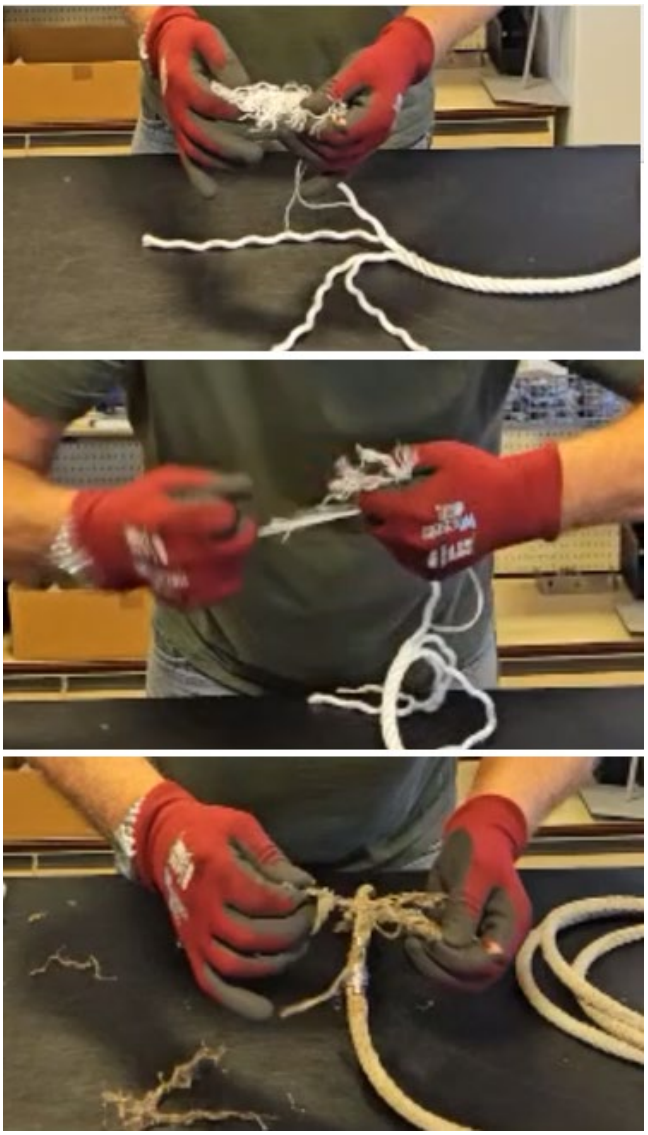

Figure 2: Manual break load test showing (i) (top) a new mainline being separated and braid being exposed; (ii) (middle) a new mainline being put under manual strain, and not breaking; and (iii) (bottom) a worn mainline having been separated and put under manual strain and breaking.

Figure 3: Mainline 'traffic light' system for grading magazines.

Other ways to assess the mainline's condition is by measuring the spacing between hooks. Most toothfish gear is set up with hook spacings of 1.4m. Over time, as gear wears, and line is stretched, this spacing will increase. By monitoring this measurement and understanding this measurement at break-point, it will give the vessel an additional indicator on how to grade a magazine, or know when to replace it.

Measuring line diameter is another variable that may provide a similar gauge. Most autoline toothfish vessels use 12mm integrated weighted mainline (IWL) – as it stretches, this diameter will decrease, and its strength properties are compromised. Knowing at what point this decreasing diameter begins to increase risk of breakage is therefore important. It should also be noted that when mainline stretches and its diameter decreases, it will not grip in the hauler's sheaves as it is meant to. This creates slippage and that creates additional wear on the line. In addition, because of the stainless steel stoppers and swivels on the mainline, when a stretched line decreases in diameter, it will mean that these metal parts of the line will increase contact and therefore increase wear on the sheaves, which will again create more wear on the line.

In the past some vessels have had issues with sheaves wearing prematurely, increasing slippage of the line on the hauler and increasing risk of line break. It was thought that it was perhaps an issue with the quality of the metal that was used in these particular sheaves, and it is therefore important to have quality control of products from suppliers.

Other factors that will cause damage to the line include kinks and tangles. If a line is kinked or tangled then that part of the line is likely damaged and should be monitored closely or removed. Splices can also become weak points if not maintained, and they should be cut away and re-done periodically. Joining splices should be about the width of a hand, using 3-4 tucks, and then another 2 being tapered – albeit too many tucks can cause line slippage on the hauler. The eyes on a splice should be monitored and some vessels are re-doing these after each one million hooks are hauled. Crew should be mindful of any sharp points on a fid that may damage the line during splicing, and hone this tool as required.

All of the above examples of line stretching, kinks, or tangles will also cause friction inside the line between the rope fibers and the integrated weight, causing additional weakness on these fibers from the inside.

Sand/silt can damage the line by getting between the fibers. This can be minimised by hosing down the line as it comes back on board. This can also help with excess oil from remaining bait that may accumulate on the hauling sheaves as well, which may increase slippage and increase wear. It is also important to ensure gear is hosed down at the end of the trip with freshwater and that hooks are lightly oiled to prevent rusting. Gear should be covered in plastic at the end of trip to protect it during the unload or refit period as well as whenever cleaning chemicals are used in the area.

Gear Turnover

Most participants used new gear to start the season. For some operators this start of season refers to their domestic fishery, for others it refers to the Ross Sea fishery. Typically, gear will last around 12 months as toothfish fishing is hard on the gear, fishing on deep, sandy bottoms and sometimes on hard ground. For those vessels with shorter seasons, or those fishing in fisheries that are less damaging to gear, it may last 2 years. It was noted that not all new gear is used at once at the start of a season, but the gear gets worked through as the season progresses.

Minimising Gear Loss

It was thought that the rate of gear loss is better now than in the past due to a variety of reasons (such as advancement in tension meters, moon pool vessels, crew retention and fishing ground knowledge) and that a fulsome analysis of gear loss over a period longer than the 4-year summary provided to the workshop would be useful to understand.

The workshop considered the various things that are being done on vessels to minimise gear loss. This included:

- **Hauling speed**: The faster a line is hauled, the greater the strain that is put on that line. Fiskevegn shared some information from simulated tests that showed a marked increase in risk of the line breaking as the hauling rate increased from 30 hooks per minute (low risk), through to 45 hooks per minute (moderate risk) and over 60 hooks per minute (high risk). This was confirmed by fishers in the room who stated that a 'normal' autoline hauling speed in toothfish fisheries is between 32-42 hooks per minute, and that at times this could be pushed to 50 hooks per minute if conditions allowed (shorter lines, shallower water, clean bottom type, good weather).

- **Fishing location and weather events:**
    - Fishing on areas of foul ground increase the risk of gear sticking and breaking. Choices are made depending on weather (swell, currents, wind) as to whether these riskier grounds are fished at particular times. Marine Navigation software such as TimeZero is also used to help inform these decisions.
    - Choices can be made to shorten line lengths if the weather conditions are forecasted to deteriorate. This reduces strain on the line, therefore reduces risk of loss, and reduces the number of hooks lost if breaks occur, while still enabling the vessel to fish during poor weather.
    - Fishing in conditions where floating ice is present increases risk of gear loss due to floats being dragged under or downlines being sheared off. This can be mitigated by choosing not to set during times when floating ice is known or predicted to be present or moving, or by using gear finding software/hardware such as the Notus Gearfinder, which some NZ vessels are using by attaching sensors on downlines about 50m below the surface. If the floats are lost, then a transducer on a pole is hung over the side to attempt to locate them (having approximately a 2km range).
    - **The workshop also discussed and recommended starting the Ross Sea season later to avoid the higher ice periods in December which often results**

in fishing gear being lost. This would also provide additional benefits of vessel safety, and reducing the risk of localised depletion due to ice cover being reduced and more of the fishery being open to fish. This would also help with tag bias issues in stock assessment.

- **Whale depredation**: If encountering whale depredation, ensure the line is in good condition, which allows you to haul faster (reducing effectiveness of depredating whale) with a lower chance of breaking than if the line in poor condition. As per above, shortening lines also helps with this and reduces breakage risk.

- **Crew:** Ensuring crew are well trained in the relevant aspects of gear maintenance and gear handling plays a significant role in minimising lost gear. Crew retention obviously helps with this.

- **Mechanical / technical improvements**
    - **Tension Meters:** Over the last 10 years it has become common for all vessels to now use digital tension meters to inform fishers of the instantaneous tension on the line. This allows decisions to be made to back off hauling pressure when tension becomes too high.
    - Many new autoline vessels have central **moon pools** to haul the line through, which helps reduce tension on the line due to reducing the effect of pitch and roll of the vessel.
    - **Roller circumference** can be increased to ease the pressure on the line as it goes over the roller.
    - **Sheaves** maintenance is important to ensure the hauler is working efficiently and there is not additional wear and tear on the line
    - **Electric haulers** are a new and important development in relation to minimising gear loss (as well as having many other benefits). The response of an electric hauler is far quicker than a hydraulic hauler and the software that accompanies this can be linked to other pieces of equipment to improve efficiencies and reduce risk of breaking gear.
    - **Mainline specifications:** Increasing the thickness of a line will increase its breaking strain and resilience, however this comes with increased cost and increased drag in the water column. 12mm IWL seems to be the current sweet spot for use in toothfish fisheries. Newer and stronger fibers are also being developed, however also at increased costs, and therefore need to be balanced against the potential improvement in performance. Different coatings can be applied to the line to make it resistant to ingress from sand/silt and therefore increase its resilience. It was suggested by the gear manufacturers that the bitumen-based 'tarred' coating which is commonly used in Norway provides a better barrier to sand and silt than the clear copolymer that is used in most toothfish fisheries and therefore could improve resilience and longevity of the line.

It was noted that all autoline vessels are reporting gear loss to their flag state within 24 hours as per their domestic requirements, and that it is important to record a detailed reason for breakage so that this may help in future analyses about reasons for gear loss.

As part of this agenda item the workshop received three presentations from invited guests:

Norwegian seabed clean up expedition

Kristian Landmark Skaar, senior advisor at the Norwegian Directorate of Fisheries, presented to the workshop on Norway's annual seabed clean up expedition, which began in 1983 and spends several weeks per year at sea recovering lost fishing gear. The initiative is jointly funded by Government and the fishing industry. During the presentation, the workshop was lucky enough to be joined via live stream at sea by Gjermund Langedal, leader of the current expedition, who showed some lost gear being recovered and answered some questions from the group.

The Directorate of Fisheries gets relevant data via a web-based portal that Norwegian fishers are required to report any lost gear to. From this information the Directorate of Fisheries plans their annual cleanup voyage, focusing on gear that is considered retrievable. Importantly, fishers are interviewed to discuss specific gear loss incidents to help determine this before the voyage begins.

Over the years, grapnel designs have evolved and become more efficient, and these designs vary depending on the gear being recovered (gillnet / longlines / traps). It was noted that:

- the grapnels used now have 4 to 8 'tooths' and a chain is also attached to keep it steady on the bottom;
- when recovering in deep water, a horizontal steel beam with three grapnels attached is used.
- wire is typically 1.3 to 2 times the water depth;
- towing speed is 1 to 1.5 knots.

Workshop participants were particularly interested in one of the grapnels used and have requested design details from the Directorate.

It was discussed that knowing where the grapnel location is relative to the vessel and the target position in water would be an important next step in gear recovery, and that the technology already exists, but cost vs risk vs reward would need to be factored in.

Depending on its condition, some of the recovered gear is given back to fishers. If this cannot be arranged, then nets and metals are able to be recycled. Lines, ropes, and buoys that cannot be reused go to landfill.

PingMe

Andreas Vie Murvold from Ocean Space Acoustics provided an update on their PingMe technology. Ocean Space Acoustics is a Norwegian company, established in 2018, with goals to reduce ghost gear but also to optimise catch.

PingMe is a buoyancy neutral transponder that can be connected to the fishing gear, which then speaks to a transducer (either hull mounted or dropped over the side). The ping rates can be modified depending on the requirements of the user. Current transponders have a depth rating of 1000m, with a 2000m model being released in early 2025, and have a 2000m horizontal acoustic range. Transponders can be used for multiple months before requiring recharging which can be done on the vessel (full charge will take 4 hours). If the transponder is lost it will

go into a battery saving mode where it will poll at a lower rate and still be able to be found at least 1 year later.

Included in each ping back to the transducer includes GPS location, depth and temperature and this data is concurrently uploaded to a cloud service. There is also functionality to integrate the data into 2D or 3D chart plotters. Transponders are locked to the owner, and in the case of loss, if another vessel using PingMe comes within range, the original owner will be notified of its current location through the cloud service.

SonarBell

Graeme Symes from Clearwater Hyrdoacoustics provided an update on their SonarBell Technology - an omni-directional, fully passive reflector that provides a strong acoustic return to sonars and echosounders, often featuring multiple echos. It contains no electrics or batteries.

SonarBell was originally designed for military operations and was later commercialised from the UK Ministry of Defence in 2008 and is in-service with a number of military organisations. It is currently being evaluated for subsea cable marking, and there have been fishing gear trials undertaken with Fiskevegn at depths of 50 – 800m with promising results.

The units can be produced in different sizes and specialist materials. Plastic versions are available in "off the shelf" sizes of 50, 100, 150mm, 200mm, and aluminium versions in any size required up to 600mm. It is likely that the resilient 'plastic' variety will have the best utility for fishing vessels. Due to their free-flooded nature, they can be used at all depths, and buoyancy can also be determined during the design phase depending on user requirements.

In addition to the vessel's sonar/echosounder showing the acoustic return signal on its display, there is also an auto-detect software package being developed that can be used to more clearly display this information.

It was noted that the SonarBell could be particularly useful for COLTO members who fish in the ice, and encounter situations where floats can be taken by ice floes. If SonarBells are placed along the longline, then the vessel could still see the location of the line via their sonar/echosounder, so long as the gear remains in range of the vessel's equipment.

The workshop participants and Clearwater Hydroacoustics both showed a keen interest for further follow up and testing.

Gear recovery discussion

A member from the COLTO sub-Committee on gear recovery provided a summary of the groups' discussions highlighting the different types of recovery grapnels being used. Depending on the fishery rules, depth and bottom type these recovery grapnels are being used at various levels of success.

In toothfish fisheries, the decision to attempt to recover a specific longline is determined by the presumed chance of success. Factors that influence this include depth, length of lost line, whether that line is stretched out along the seafloor or bundled in a heap (depending on how it

broke) and weather conditions. Some fisheries, such as Macquarie Island, have hard, sticky ground and make gear recovery much harder.

When attempting to recover gear, the length of drag line is important for gear retrieval, and needs to be around 3 times the working depth. Care must be taken, and this process shouldn't be rushed. The vessel speed should be around 1.5kn during the recovery process and the vessel should approach the gear from a perpendicular angle. Some vessels prefer to approach the lost line about one third of the way across it, so that the line is not doubled over and too heavy to haul. Some vessels prefer to approach the lost line from the middle (increasing the chance of finding it), and to deal with the doubled over weight, will buoy the line off, and then tackle it from further up where it will be elevated off the seabed.

Typically there needs to be around 100kg at the end of the recovery unit which is normally composed of weights and a grapnel. A separately mounted winch with wire can help with efficiently recovering gear so the vessel's longline hauler does not have to be utilised.

The Australian toothfish fisheries have domestic allowances for recovery of gear outside of the longline season. This has allowed and incentivised industry to recover large amounts of gear over recent years. To help with this, the companies that fish in these fisheries share gear loss locations, so that there can be increased chances of gear recovery, and this also helps to minimise further gear losses. Since 2016, one of these Australian fishing companies has recovered around 475km worth of previously lost IWL and the associated 340,000 hooks from the Heard Island and McDonald Islands toothfish fishery, which has resulted in a net loss of gear reduce from 1.3% between 2008 and 2015 down to 0.4% between 2016-2023 for this company.

It is recommended that CCAMLR allow the recovery of fishing gear from its high seas fisheries outside the fishing season so that vessels can dedicate time to this practice as well.

COLTO associate member presentations

Brunvoll presentation

Brunvoll presented their new BruCon Fish Pilot – an autopilot solution for fishing vessels. Autopilot has been used on fishing vessels for a long time but this is generally only utilised when in transit, not much during fishing. The BruCon Fish Pilot takes the next step by improving maneuvering and steering while fishing – improving fuel efficiency, baiting efficiency and crew safety, and reducing gear loss and crew fatigue.

The Fish Pilot will control the vessel's thrusters and includes the functionality of a regular autopilot, as well as navigation steering, adaptive speed control (better control of speed while hauling/setting), propulsion optimization, force control, track following, and position hold. It can also receive inputs from ECDIS/charts, GPS, gyros and wind sensors to enable a comprehensive package to improve automated vessel control.

Mustad Autoline presentation

Mustad presented their new electric hauler that has now been installed on 3 longline vessels, including one toothfish vessel. R&D began on this project in 2016, before its eventual launch in 2021.

Compared to the conventional hydraulic hauler, the new e-hauler improves vessel efficiency in several ways. It will save on fuel, requires less piping to be installed on a vessel and has no risk of oil spills, reduces noise, is more robust and durable, has improved communication capabilities, and most importantly, enhanced hauling control.

All hardware can be linked with sensors, software and technology that connects and exchanges data between the baiting machine, hook separator, magazine racks and hauler. This information is passed through the control system which summarises key data for the user (with different interfaces for the captain, engineer and the on-land technician). It also has capability for predictive maintenance alerts and hardware diagnostics (however this is not yet underway because there have not yet been any failures to help inform predictions).

The adaptive control system allows autonomous reaction to vessel movements and results in more accurate tension control and consistent hauling even in rough seas. This provides a lower risk of losing fish when hauling due to a smoother haul, and a lower risk of breaking gear as well as less wear on mainline.

The electrification of this part of the vessel will allow for future programable solutions within the software to novel challenges encountered by the vessel.

Morenot presentation

Morenot presented on their new DX-line, which has an increased breaking strength of 50% compared to regular line. It has the same properties of elasticity, weight and coiling ability, and it has a significantly longer lifespan. There is not yet an IWL version but this is being developed.

The stronger DX-line reduces risk of breaking line through increased breaking strain. It allows the fisher to reduce the diameter of the line while having at least equivalent strength – this reduces resistance in water meaning the line sinks faster and is less susceptible to being influenced by currents. With a smaller diameter the vessel is able to hold more gear on board.

Currently there are 3 vessels from Greenland and Norway using this line and reports from have been very positive, including that there have been no incidents of line breakages so far.

Morenot have also developed a fully electric automatic longline system, Linetech, inclusive of magazine storage, baiting machine, hauler, and hook separator. Reports from one vessel indicate 44,000 L of fuel has been saved in its first year through use of the electric system compared to its old hydraulic system.

Fiskevegn presentation

Fiskevegn provided an update on their new 13.7mm longline which is used by the Ocean Azul in the Prince Edward and Marion Island toothfish fishery because of the use of Sago Extreme pods (lightweight aluminum cages that encapsulate the fish as the gear is hauled to protect the catch from depredation). This line has an increased breaking strain over the standard 12mm line and due to its larger diameter, can better withstand cuts and abrasions meaning a lower risk of gear breakage. Due to the way this vessel is set up with a setting pool at the stern, allowing the line to be much lower in the water by the time it exits the vessel, this 13.7mm line does not need integrated weighting to pass CCAMLR's sink rate test.

It was noted that IWL used in toothfish fisheries are still constructed in Norway for quality control purposes. In addition, the company has just installed an additional line making machine which will increase production capacity, reduce lead time, and also provide for the ability to create larger diameter line if required.

Fiskevegn are also working on several R&D projects including different types of retrieving grapnels and developing stronger downlines. There are stronger fibers available today that could be incorporated into mainlines as well, but this would come at additional cost and therefore feedback is required from industry as to whether a more expensive line with a higher breaking strain is something that is wanted.

New Gear Developments

The workshop discussed potential future gear developments to aid with minimizing gear loss.

In relation to the new electric hauling systems now on the market, this included:

- integrating sensors/RFID/barcode tags into the mainline (at mag joins) which would automatically capture information on magazine use/quality/wear/degradation. This could capture when a certain magazine is set, is hauled, and gets broken. It was clarified that the most practical unit of measurement would be per magazine, not per coil.
- being able to automatically measure the distance between the swivels to help better understand line resilience and breaking points.
- the programable software dedicated to this hardware will lend itself to being able to record many things, and so over time it is expected that new ways of analysing use and performance of gear will come to light.

The other development which had been mentioned already during the workshop was the advancement in line properties that allow for more stretch and increased strength. Stronger lines are already newly available, but it was unclear whether industry would be willing to pay for it when breaking strain is already considered good. It was thought by some that if a line is really stuck, it is going to break regardless of the breaking strain on the line. There was interest, however, in being able to reduce line diameter while keeping its strength, as this would reduce the effect of tides/currents on the through the water column. Again there are new lines available that achieve this.

Gear end-of-life / disposal / recycling

Global Ghost Gear Initiative

Global Ghost Gear Initiative (GGGI) is a cross-stakeholder alliance of fishing industry, private sector, NGOs, academia and governments focused on solving the problem of lost and abandoned fishing gear worldwide. They believe the solution to this problem lies in working together across all sectors to achieve maximum impact for our ocean and the life within. Joel Baziuk from (GGGI) provided an overview of the organisation as well as examples of gear recycling projects they have been involved with. With COLTO having recently joined as Members of GGGI, it was a good opportunity for members to engage with Joel and discuss the different elements of lost gear, gear recovery and gear end-of-life and gear recycling.

Some of the key challenges discussed included:

- Legal barriers to recovering gear – many jurisdictions will not allow the fisher to haul gear that is not theirs
- Lack of / inaccessible / expensive disposal facilities
- Mixed-material nature of fishing gear and the high cost to separate these materials before recycling can be considered. Longline gear is one of the most difficult to recycle because of this, particular mainlines with metal cores.
- Finding recycling facilities near the relevant port that will accept the fishing gear, or else transport costs become prohibitive.
- It may be possible to find recyclers willing to take some of the gear components if enough can be gathered in one place to make shipment worthwhile. More specifications on the gear itself (polymers used in which pieces) and gear accoutrement could also shed light on potential recycling options.
- Where recycling is impossible due to lack of facilities or prohibitive costs of logistics/transportation, other options such as re-use or waste to energy can be considered.

Examples of existing solutions / recycling programs for fishing gear include:

- Bureo
- ANLRS
- Ocean Legacy
- SOFER
- Net Your Problem
- Enalea
- OceansWide

Gear end-of-life discussions

The workshop discussed the various ways that participants were disposing of their longline gear once it was no longer usable. In most cases, the gear goes to landfill because most of the ports that are used for unloads/refits are not equipped with facilities that are able to recycle this gear. It was noted that landfill is not a cheap way to dispose of gear.

The main challenge in recycling this gear is that it composed of multiple materials – metal hooks, stoppers and swivels; polyester snoods; and a mainline composed of polyester,

polypropylene and polyethylene surrounding a metal core, which all need to be separated and this is not an easy or cheap process. If separation is not practical or cost effective, then finding next users for this gear is key to extending the life of this product before it ultimately goes into landfill or is eventually recycled.

Some examples that are being undertaken by participants included:

- Several vessels were removing hooks and selling them as scrap metal.
- IWL has been donated to vineyards in NZ to weigh down their bird netting or to farms in Stanley to be used as fences.
- IWL and downlines have been donated to shallow water coastal fishers in Mauritius, Reunion and Stanley, however they do not need the full quantities that are disposed of each year.
- A trial in Norway where longlines were delivered to a facility that burns waste to find out if longlines could be incinerated in a furnace. It worked very well, however it became too expensive due to costs involved in transport and incineration.
- Perhaps the most encouraging example was one vessel's IWL with hooks and snoods already removed being donated to farmers in Madagascar which has been ongoing for several years. Here, the farmers have set up their own production line where the stainless steel swivels and stoppers are removed – these are sold as scrap metal. Then, the IWL is connected to a spinning wheel which unwinds the braids so the metal core can be removed (again, to be sold as scrap metal). Once the core is removed, the braids are re-wound and the line can be re-used or sold on. For the vessel, the shipping cost to Madagascar is similar to landfill costs, however at least the gear is receiving a second life.

In terms of 'easy wins', it was thought that removing hooks to sell as scrap metal is something that all vessels could be undertaking. Farmers in Madagascar are using a hammer and anvil to remove swivels and stoppers, but this is time consuming and not practical to be undertaken on board. It was thought if a 'de-clipping' tool were developed that made this process efficient then perhaps this is something that could be done on board, which would (i) increase the scrap metal volume that could be sold, and (ii) increase the likelihood that the IWL could be re-used elsewhere, and make it one step closer to being recyclable.

Additionally, because snoods are a single material – polyester – that these could be removed on board, stored and accumulated, and sent to a recycling facility once a sufficient volume was acquired. It was also thought that danline (used as downlines), which is made up of polypropylene and polyester could be sent for recycling in many ports. It was noted however that many ports used by toothfish vessels are not set up for recycling these types of waste. The workshop discussed some of the key toothfish ports around the world used by autoline vessels – Stanley, Reunion, Mauritius, Hobart, Nelson and Dunedin – and noted that critical mass of certain types of waste from multiple vessels could facilitate important next steps in creating demand for these materials.

Storage space on fishing vessels is typically in high demand. In situations where vessels recover large amounts of gear that is not their own (this has happened with toothfish vessels recovering old gillnets, or large tangles of historic IUU Spanish line), space becomes an issue, and so sorting and separating this gear is not possible. A unique toothfish vessel that has recently come into service after a major redesign, the Ocean Azul, has space aboard especially set aside for the storage of recovered gear.

The workshop also discussed the potential for biodegradable fibres. Gear manufactures have looked into this but there has not yet been anything found that retains strength over the required timeframes. For example, a biodegradable snood would need to last at least as long as the mainline is in use for it to be practical, and most mainlines are used for approximately 1 year. If a snood loses its strength within that period then there is risk of lost catch.

CCAMLR Gear Marking

The workshop noted that current CCAMLR requirements for gear marking in CM 10-01 only require the buoys to be marked:

> *(5) Marker buoys and similar objects floating on the surface and intended to indicate location of fixed or set fishing gear shall be clearly marked at all times with the letter(s) and/or numbers of the vessels to which they belong*

The workshop noted that the FAO Voluntary Guidelines on the Marking of Fishing Gear (Guidelines) are based on the principle that a gear marking system should be put in place for all fisheries with the complexity based on necessity and practicality and importantly, should be built on a risk-based approach and be simple, pragmatic and cost effective.

The workshop also noted that there are some toothfish vessels that belong to COLTO members who employ the additional marking of hooks, which stems from the domestic licencing requirements in the 48.3 toothfish fishery.

It was highlighted that with regard to gear marking, gear loss and gear recovery, that each toothfish fishery is different in terms of the number of vessels/operators in the fishery, the environmental conditions (weather, ice/no ice), the lost gear information that is shared with/between vessels/operators, CCAMLR vs domestic licencing conditions, and the understanding of the level of historic IUU fishing in that fishery.

It was noted that additional forms of gear marking on longlines may interfere with the hauler or the hook separator and that this would need to be taken into consideration and be tested before further requirements are considered.

As such, the workshop recommended that any further consideration for gear marking in CCAMLR's longline fisheries be based firmly on the FAO Guidelines as it relates to risk, necessity, practicality and it needs to be simple, pragmatic and cost effective.

Appendix

Participant list

Rhys Arangio	COLTO
Kjell-Gunnar Hoddevik	Atlantic Seafish AS
Bruce Miller	Austral Fisheries
Darryn Maynard	Austral Fisheries
Cheyne Robinson	Australian Longline
Malcolm McNeill	Australian Longline
Marty Johnson	Australian Longline
Nick Osborne	Australian Longline
Warwick Beauchamp	Beauline International
Arne Tennoy	Brunvoll
Frode Bloch	Brunvoll
Stig Helland	Brunvoll
Tugdual Poirier	Cap Bourbon
Graeme Symes	Clearwater Hyrdoacoustics
Knut Kolbeinshavn	Ervik Havfiske
Geir Rune	Evrik Havfiske
Stig Ervik	Ervik Havfiske
Frode Baade	Fiskevegn
Jakob Hals	Fiskevegn
Sunniva Oldeide	Fiskevegn
Joel Baziuk	Global Ghost Gear Initiative
Bruce King	Lyttelton Shipping & Marine Agencies
Fred Helge Kaald	Morenot
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Svein Erik Bakke	Mustad Autoline
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Andreas Vie Murvold	Ocean Space Acoustics
Phil Hough	Peter & Una Fishing Co.
Ingunn Elise Sorvik	Sago Solutions
Linn Solveig Sorvik	Sago Solutions
Dean Jurasovich	Sanford
Patrick Peron	SAPMER
Hamish Tijsen	Talley's