CANADIAN CENTRE FOR FISHERIES INNOVATION

COMMERCIAL EVALUATION OF A ROPE ON COMMAND (ROC) FISHING SYSTEM FOR THE NEWFOUNDLAND AND LABRADOR LOBSTER AND CRAB FISHERIES

March 31, 2023

Fisheries and Oceans Canada | Pêches et Océans Canada

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Executive Summary

This report summarizes project activities for the Commercial Evaluation of a Rope on Command (ROC) Fishing System for the Newfoundland and Labrador Lobster and Crab Fisheries. The project was undertaken between March 2022 and April 2023 by the Canadian Centre for Fisheries Innovation (CCFI) and is an initiative of the Whalesafe Gear Adoption Fund (WGAF) through the Department of Fisheries and Oceans (DFO) Canada. The WGAF was initiated to address concerns with fishing gear entanglements with the North Atlantic Right Whale.

The North Atlantic Right Whale (NARW) has been listed as endangered under the Canadian Species at Risk Act (SARA), with experts estimating there are less than 350 left. Primary threats to the species include entanglement in fishing gear, vessel strikes, climate change that is altering migratory patterns and feeding areas, and the impacts of ocean noise on the whale's ability to communicate, find food, and navigate.

An ROC system is intended to enable harvesters to fish for crab, lobster and other species using fishing gear without tethered to surface with ropes and floats while fishing. Traditional trap harvesting processes involve placing fishing gear, either individual traps or fleets of trawls at or close to the bottom of the ocean to harvest various species often with rope extending to floatation devices on the surface to enable the gear to be located and retrieved at a later point in time. It is these vertical ropes that have been identified as posing significant entanglement threats, and priority has been placed on finding an alternative approach to harvesting.

DFO enlisted CCFI to lead a project to advance ROC technology development and adaptation goals in Newfoundland and Labrador. CCFI is a not-for-profit Separately Incorporated Entity (SIE) of Memorial University. Since 1989, CCFI has supported industry related projects to drive innovation and technological advancements in solving industry problems related to the sustainability, efficiency, and profitability of those involved in the sectors. CCFI actively promotes research and development in the aquaculture, capture fishing, and fish processing sectors while utilizing both the human and facilities assets and resources of the Marine Institute (MI), Memorial University, and other academic and research institutions.

The project evaluated a ROC fishing system being developed by Ashored Inc. in partnership with eSonar Inc. Activities included:

- Rigorously testing the technology to ensure it meets functionality, quality, endurance and adaptable to current harvester fishing practices in NL fishery. The testing methodology allowed identifying deficiencies and supported informed modifications to equipment/technology prototypes prior to CCFI harvester trials. A reliable and usable system will ensure easier adoption by harvesters and industry as a whole.
- Support training of harvesters on the use and maintenance of the ROC system. Training also included staff at MI's Centre for Sustainable Aquatic Resources (CSAR), the Centre for Applied Ocean Technology (CTec), along with CCFI. This allowed for the ongoing training and tech support to harvesters required after two year project.

The scope of fisheries for this project includes inshore and offshore snow crab (Chionoecetes opilio), American lobster (Homarus americanus) and Atlantic cod (Gadus morhua) from cod pots. The evaluation includes fishing in trawls/fleets as well as single pot. Water depths investigated included 50m to 300m.

The project team assembled had significant expertise in the areas of marine institutional and field testing, use of flume tank, acoustic tank and pressure chamber operations. The team also was well versed in a variety of research and fishing vessel operations and various fishery operations as well as office operations, leadership, project and budget management.

Project team members included Keith Hutchings and Janet Kielly from CCFI, Mark Santos from MI's CSAR, Annette White from Dockridge Digital Inc., and Phil Walsh and other staff from WSS Inc. Professional Services. At various times over the course of the project, CCFI's Industrial Liaison Officers (ILO) Sean Macneill and Jason Card were engaged in the project.

The project team was engaged throughout the course of the project, meeting weekly to review status including accomplishments, upcoming activities present on the project plan, decisions required, discuss risk/issues and budget review.

CCFI engaged harvesters who they had worked with before on various projects and/or through industry engagement and others known to be engaged in adoptive technology and eager to participate in innovation in industry. Harvester selection focused on crab, lobster and cod fishers who fished inshore, mid shore and offshore with various vessel size and crew compliments. CCFI explored different geographical regions, as well as fishing zones in its selectivity.

There were seven (7) primary activities to be completed over the course of the contract period. These activities are highlighted below.

The project's testing methodology was planned to take place across three (3) phases and included:

- Pre-commercial testing
- Field testing
- Commercial testing with harvesters

Testing during the 3 phases led at times to engineering and other remediations and often resulted in repeat testing of a previous stage. System enhancements were undertaken or in response to a failure of some aspect of the ROC system. As a result, the methodology did not always follow a linear progression from pre-commercial to field testing to commercial testing with harvesters.

One of the projects' priorities was pre-commercial testing of the technology as presented to CCFI. This process was to assess the functionality of unit in current NL fisheries, related to water depth and pressure, rope and float types, battery and acoustic signal and to develop operating harvester testing procedures. This stage of testing was conducted in a controlled environment to learn information valuable to adequately plan for the field and harvester engagement phases of the project.

The Field testing phase supported the project team to gain on water/vessel experience in the operation of the technology in a controlled environment prior to engaging harvesters in testing. This phase also allowed continued remediation in partnership with technology partners and refining standard operating procedures.

The commercial testing phase with harvesters was to introduce harvesters to the new (ROC) technology and was the most important aspect of the project. It was this process which allowed direct feedback from commercial harvesters through fishing trials on their vessels and gain insight into the ability to adopt the technology in current practices and environment, and what enhancements are needed today and, in the future, to make it fully adaptable to the fisheries.

Through the product research, testing and engagement activities for the ROC project, CCFI and its project team identified a number of key findings, conclusions and recommendations to guide the refinement and future development of ROC systems as a key mitigation technology for the fishing industry in meeting the sustainability challenge of potential Right Whale entanglement. These findings are based on the potential application of the ROC system in all aspects of NL Fishery – inshore, mid-shore and offshore in deep water conditions found in the Newfoundland and Labrador's crab fishery. They are guided by the input of experienced fish harvesters who have an intuitive understanding of what can work and what cannot, and equally what might be feasible from an operational and financial perspective.

Key findings during the execution of the defined methodology during the project included:

- Cage (engineered new design for greater water depth)
- Water Penetration (improve design to reduce water affecting functionality at greater depth)
- Battery Functionality(non-reliable battery life proposed by manufacture – enhance battery dependability)
- Connectivity reliability between deckbox and MOBI on fishing vessels (software enhancements and upgrades)
- Deckbox instability
- Inaccurate reading of location of Unit
- Issue with cage cover release on acoustic release retrieval - (redesign of key and cover redesign)
- Increased depth - (required increased rope)
- Rope entanglement - (determination to use floating rope in unit – rather sinking rope)
- Rust on cage (non-eroding paint to avoid rust on unit)
- Stability of cage unit on ocean seabed (stability runners attached to units)

A key part of the engagement with harvesters was informal observations and exchanges during the harvester testing but also, formal interviews with harvesters following testing and trials. While harvesters were surprised by the reliability of the ROC system and expressed a desire to engage in further testing in a commercial fishery setting, there remained many concerns among harvesters that will help guide the next stage of ROC product development. These include:

- System identification on seabed after deployment due to tide and currents. Traditional high flyers/buoys on surface will be no longer be part of the fishing exercise.
- Size of cage unit holding rope and relevant space on deck of fishing vessel to stack and/or store units both to and from fishing grounds and as well at reset.

- Weight of cage units depending on rope type and water depth lead to excessive heavy units for deployment and retrieval
- On retrieval of units after acoustic release, the ability to identify buoy on surface at nighttime, in fog and other unfavorable conditions, can lead to excessive time and fuel to search.
- Ability of unit to surface in areas of high current - at times in these areas, current and related drag will submerge large 50-inch buoys.
- How do you know if other harvesters have already set in the area? Harvesters use sight to locate other harvester buoys on the surface. That will not be the case with the ROC system – this could cause many fleets to become tangled, and harvesters could set their gear over other harvesters' fleets causing major problems.
- The shape of the ROC system for the crab fishery does not fit well on the current vessels and will take up a lot of space. Also, the large cage for deep water is very heavy and cumbersome on deck. Harvesters suggested if the ROC system could be modified to attach to a current crab pot, then it would eliminate the extra space needed as the rope could be packed into the first crab pot in each fleet and that pot could be stacked with the other pots.
- The lobster fishery in Fortune Bay uses fleets of pots and the system works well with their setup. It would not work well with many current lobster fisheries in Newfoundland and Labrador where harvesters use single pots - having a ROC system on each pot would be cost-prohibitive.
- The cost of the system is always an important factor as most harvesters stated that to have at least two units on each fleet of pots, have the transducer mounted in the vessel, and buy the deck box and notepad/software, would run them between $20,000 and $50,000 depending on the fishery and the amount of gear each fishery uses.
- Harvesters also stated they do expect to be a little slower hauling the ROC system, but they said they would adjust quickly and were more concerned about packing the unit as the rope is being retrieved. If there is not a specific container to allow for 200+ FTM (365m) to be coiled into as it is coming off the hauler this would add a lot of time. The current fish pans that are on the vessel now are not large enough. Once the line is in the container, it can be dumped into the ROC quickly, and the system can be reset.

Product considerations were defined across three key areas including:

- Design
- Adaptation
- Financial

Specifically, these considerations included:

- Reset Process Considerations
- Cage Design/Shape and Weight
- Battery Life in Cold Water
- Technology Updates
- Rope Type
- Proven Reliability
- Resources needed
- Speed of locating the equipment
- Gear conflict - awareness of other gear
- Distance between drop and land
- Concern of Stability at seabed
- Space on vessel
- Redundant Equipment
- Fuel Increase
- Cost of unit

Fuller adaptation and use of the ROC system require further research and project development. Recommendations include:

- Battery life improvement
- Hydrophone/transducer
- Buoy work
- Beacons
- Cage development
- Reliability testing
- Product comparisons

Progress on Activities

Progress on Project Tasks

Year 1 – Acquisition and testing of prototype ROC fishing system executed at MI flume tank, Acoustic tank (MUN) and Holyrood (marine environment at Centre for Ocean Technology (CTec))

This activity began last reporting period and completed this reporting period.

Acquisition - Product Delivery

The MOBI unit from Ashored Inc. was first delivered to CCFI on April 18, 2022. Units were shipped from Nova Scotia at various intervals through year two of the project. As remediations took place and new versions were manufactured, they were delivered to CCFI. The final shipment of units and accessories concluded in March 2023.

Product Introduction - Hardware

Ashored's underwater buoy/rope units work with existing lobster and crab traps and trawl lines. The equipment is activated via acoustics (or a backup timer) to bring the lid to the surface. Once the buoy, lid and connecting rope rise to the surface, harvesters can use existing onboard equipment and processes to retrieve the gear and prepare it for redeployment. Ashored's cages (illustrated in Figure 1) rest on the seabed on deployment. MOBI's cage and related hardware can be seen in in the image below from the Ashored website. During the project, a modification was made to the equipment displayed in the drawing to add weighted runners to enable reliable settling on the seabed.

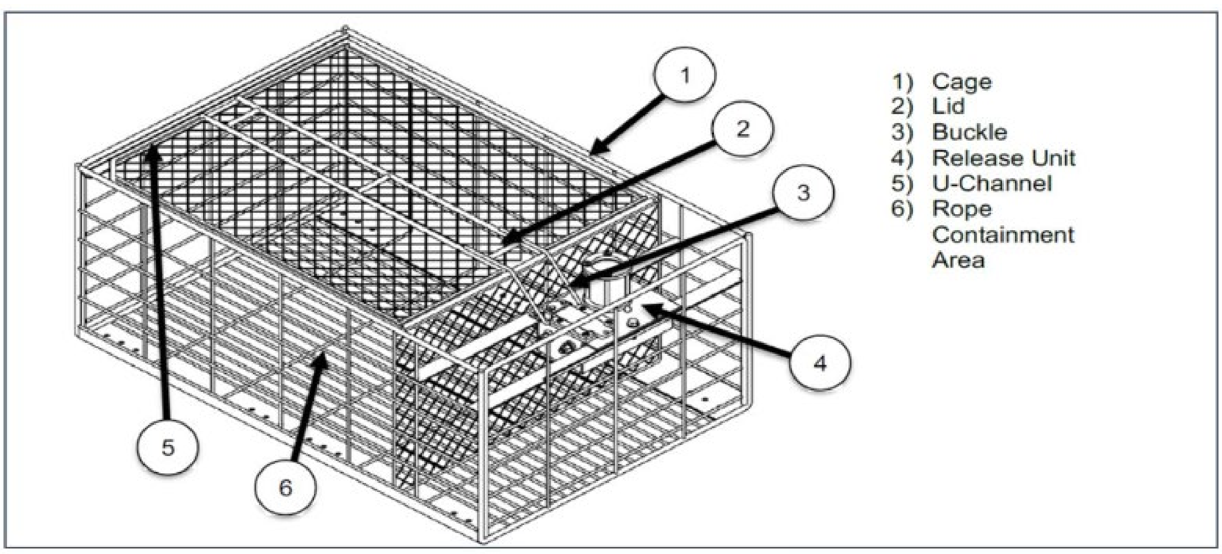


Figure 1 – Hardware

Product Introduction - Software

Figure 2 - Software

Ashored has developed ATLAS, an intuitive suite of software and hardware that tracks the location, inventory, connection, and ownership of a user's fishing gear. Super Tags, Smart Tags, and sensor arrays collect data and ATLAS+ software automates and displays this information in a convenient and actionable manner. MOBI's software and related system technology can be seen in the figure above.

Testing Summary

Testing began on April 19th on the version received. Through April and May institutional testing took place in the flume tank and pressure chamber of Marine Institute. Testing moved outside to trial the product in controlled conditions by the project team aboard the research Ludy Pudluk vessel in Conception Bay, NL. As the results described in this section will indicate, during spring and summer of 2023 the unit was tested and remediated iteratively. Extensive collaboration occurred between CCFI project team, Marine Institute Resources, and technology partners (Ashored and eSonar) toward the goal of reaching a stable solution to advance to the commercial testing stage with harvesters.

In early summer, an extensive examination of the results from the institutional testing was completed (which included, flume tank testing, pressure chamber testing, and testing onboard the R.V. Ludy Pudluk) As a result, Ashored and eSonar decided to conduct a complete review and remediation on the MOBI unit. Up until this time, a series of smaller remediations were taking place. Water penetration issues were persisting and to correct this, it was recognized a full review would be needed to ensure all issues were solved before further testing. Ashored and eSonar determined they would need a month to correct the issues; after which testing could continue again starting mid-August/early September.

Significant investment was made by Ashored and eSonar to bring the water penetration issue to the forefront and to find a resolution. Throughout this period, they utilized a two-pronged approach to solving the issue. While Ashored continued to investigate and work with the original MOBI design, eSonar undertook a further approach that would be engineered using a different MOBI design with a new encapsulated concept. This second approach undertaken by eSonar would have meant additional costs to manufacturing and was not the preferred long-term approach for the product. However, it was a back-pocket alternative should water penetration continue to be an issue after subsequent attempts to remediate. With the season closing in, it was imperative to the project that a resolution be found to the water penetration issue in a reasonable timeline to enable the project's activities per the original schedule. The approach taken to problem solving was clearly communicated in regular weekly and sometimes twice weekly status reports to CCFI. Having knowledge that the super-unit was prepared and available to continue the project's deep-water activities was a significant risk reducer for CCFI at the time.

Following significant development and enhancements (including encasement changes, cage and software updates), testing began with harvesters on September 7, 2022. Harvester testing continued through the fall and winter period with the support of additional remediations.

Since the fall progress report, the main institutional testing type conducted was the pressure chamber to test ability to function under measured water pressure and depth. As new/remediated units were delivered to the province, additional pressure testing at the Marine Institute chamber was necessary to determine reliability prior to undertaking activity at the harvester testing site. When this activity was first planned, it was envisioned that institutional testing would have been completed as a gate before advancing to other test phases. Due to the nature and magnitude of product development, the project plan required a level of flexibility to revisit and resume additional pressure chamber testing as the product was remediated and new versions were shipped.

It is recognized that commercial testing with Harvesters is instrumental to providing insight into the equipment's behaviour under various sea conditions experienced in traditional crab harvesting in depths ranging from 100 to 300 metres off the East coast of Newfoundland and Labrador. Institutional testing in the pressure chamber would serve to give assurance and confidence the remediated units would operate in the depths required for harvester testing.

During commercial testing, additional product enhancement requirements were identified with respect to other aspects of the equipment including cage/key design to accommodate the release in heavy sea conditions and firmware/ software updates required on both the MOBI units and deck boxes. The deck boxes were the interface between the notepad and software and the transducer. The deck boxes were attached to the transducer via a transducer cable and the notepad and software communicated with the deck box via Bluetooth. All systems together communicated to the MOBI units via acoustic transmission from the transducer. No major issues were experienced with the deck boxes. Since these remediations were performed, the unit has been working with very few failures and shows a high-performance rate in the harvester trials conducted on the project (though not measured for statistical significance). Institutional testing results in the form of pressure chamber testing also indicated progressively positive results once remediations concluded.

Constant collaboration between CCFI and the technology partners occurred to enact product improvements extending the end date of this activity.

By the end of the harvester testing trials stage, the product was observed with consistent deployment and responsive release and return to surface consistently from a depth of 300 metres.

Detailed Testing Results

Acoustic Tank Testing Results

Tests were carried out in the Acoustic Tank at MI with the objective of quantifying both the acoustic signal intensity and directional beam pattern of the Ashored ROC MOBI system units. The facility has a rectangular concrete water tank 4m deep, 4m wide, and 5.5m long containing 88,000 liters of water. The tank is used for transducer development, materials and flow noise studies, in addition to structural acoustics. These tests were conducted to a calibrated reference standard with a Reson TC4033 calibrated hydrophone (Serial No. 4309018).

The MOBI transducer was mounted in an articulated holder at an optimal location in the Acoustic Tank to allow a reasonable "free field" window of time to make the required measurements. For these tests, the MOBI transducer unit was driven at the frequencies and intensities generated by the MOBI transducer drive electronics, and the mounting arrangement allowed for rotation of the unit to fully describe its output level from all directional aspects. The calibrated hydrophone was mounted 1m from the MOBI transducer to directly receive the generated signals within the "free field" time window of approximately 1.33 msec. Measurements were taken at both azimuth and elevation covering a hemispherical surface describing all possible vessel approach angles to a MOBI unit when deployed.

The test results documented a source level consistent with a range in seawater in excess of a 1 km, and a variation of intensity over the hemispherical space of 3dB within +/- 45 degrees of vertical, and +/- 5dB within +/- 60 degrees of vertical. These results confirm the potential for the MOBI unit to perform its intended role with no deficits noted (See Figure 3 – Acoustic Tank Rotational Test). Figure 3 outlines the MOBI unit transducer output data. Zero degrees represents the water column, and the angles are elevations. Azimuth intensifies (not show for full rotation) are constant with 1dB over 360 degrees, as expected for a uniform cylindrical transducer element.

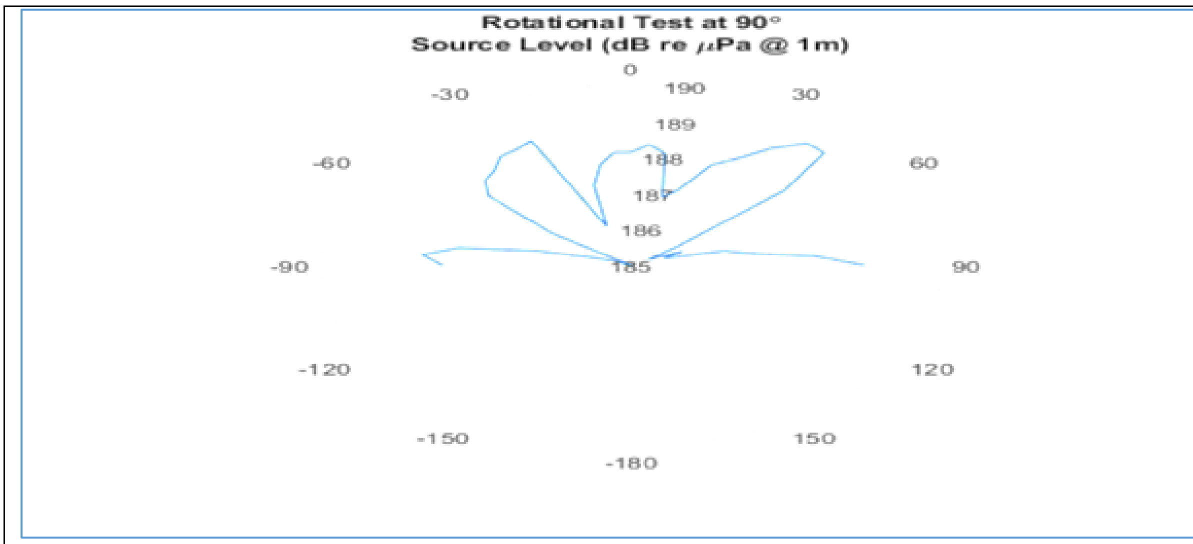


Figure 3 – Acoustic Tank Rotation Test Result

Flume Tank Testing Results

Tabletop Testing
Before any in-water testing took place, a tabletop test was performed on each of the four (4) MOBI units. The reason for this test is to ensure operability of all units before progressing on to more significant testing. One unit would not communicate with the deck box and atlas software and was removed from testing (to be returned to Ashored). The remaining three units proceeded to additional testing.

System Communication
Throughout testing in the flume tank, there were several occasions where issues arose with communication between the transducer and the MOBI unit, between Atlas software and the MOBI unit, and the deck box and the MOBI unit. Difficulties in communication between the transducer and MOBI unit could be attributed to several factors including issues with the signal in an enclosed area. After many tests in the flume tank and MI's Pressure Chamber, results indicated that water was getting inside the MOBI units. This was causing MOBI unit failures and communication issues that ended up being remediated extensively over the summer as further described in the report.

Rope size
During the flume tank tests, rope size and length was verified and tested in a release to the surface. After several tests, it was decided that 7/16 rope was optimal for small cages and exactly 200ftm (365.8m) could be placed inside the cage. The small cages (36"x24"x15") would not be able to hold enough rope for offshore crab fishery in Newfoundland. With this knowledge, CCFI explored a solution suitable for deeper water as would be required to operate the full breadth of the crab fishery in the waters off Newfoundland and Labrador. As a result, a larger cage (48"x24"x24') was designed by Ashored (and fabricated by Technical Services at MUN) to be able to hold more rope and larger rope for this offshore fishery.

The small cage weighed approximately 75 pounds (with rope) on the deck and has an interior volume of 7.5 square feet, while the large cage weighs approximately 175 pounds (with rope) on deck with an interior volume of 16 square feet. These weights were taken when each cage was full of rope and dry. The chart below (Figure 4) outlines the rope size and length applicable to the standard/small and the large cages tested.

Cage (Small/Large)	Rope size (inch/mm)	Amount (ftm/m)
Small	3/8 inch (10mm)	250ftm (457m)
Small	7/16 inch (11mm)	200ftm (366m)
Small	1/2 inch (13mm)	160ftm (293m)
Large	1/2 inch (13mm)	300ftm (548m)
Large	9/16 inch (14mm)	250ftm (457m)
Large	5/8 inch (16mm)	200ftm (366m)

Figure 4 – Rope Size and Length applicable to Cage

Sinking vs. Floating Line
Testing in the flume tank included testing both floating and sinking line interaction with the hardware retrieval of the MOBI unit during acoustic release and flotation to the surface with no water current. The purpose was to determine if the properties of both types of lines (e.g., thickness/buoyancy) reacted differently in preventing snags during ascent to the surface.

Results revealed that the floating line caused an issue with snagging once the unit roof and floats were released with the acoustic release mechanism. All the floating rope in the cage quickly floated out of the cage in a ball after release. The sinking line remained in the cage until the floats that were attached to the roof pulled the line out as it ascended to the surface (see **Figure 5** below). This figure demonstrates how the sinking rope (on the left) exits the cage after release compared to the floating rope (on the right).

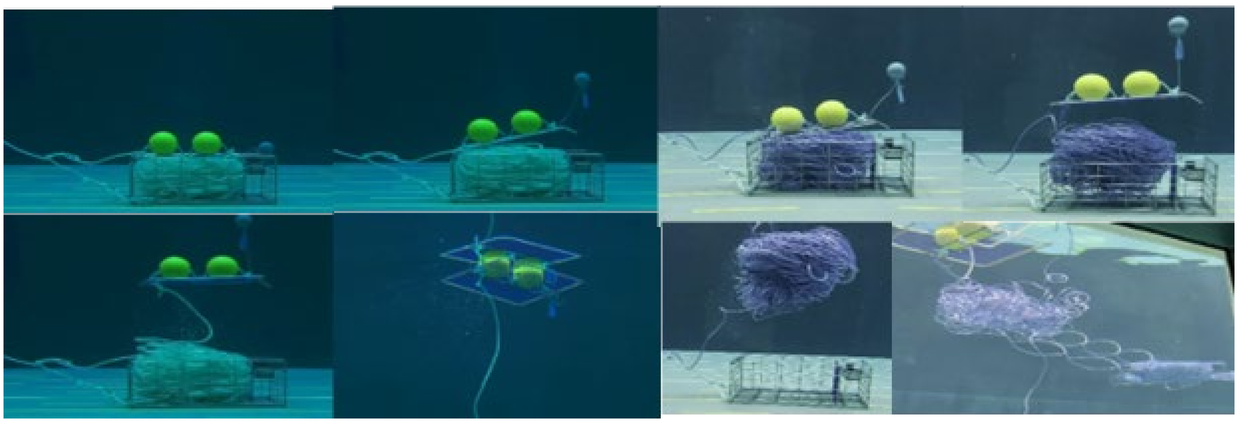


Figure 5 – Rope Behaviour upon Release

Using floating rope would increase the chance of rope tangles which would result in the MOBI unit not surfacing and having a large amount of tangled rope in the water column which could be hazardous to marine life. Also, the extra floating rope will be at the surface during slack tides, increasing the possibility of entanglements with other vessels and gear.

It was also determined through trials and in learning of the current fishing practices, that harvesters would need up to 40m of extra line than the required depth to prevent floats from submerging because of increased current and wave action.

Current and Effect on Surface Floatation

Testing was completed on the cage cover release process and amount of float surface drag after acoustic release from the MOBI unit and cage. The purpose was to visualize the effect of ocean current on the cage as well as the cage cover and floats coming to the surface. The test would determine if the floats and cover at the surface would sink at higher currents due to current drag. Even though it was impossible to add the amount of rope used in commercial fishing operations at depths of 400+m in a flume tank, this exercise was invaluable in understanding the effects of water current on seabed to surface reaction. The objective was to determine if the cover and floats would sink in the flume tank (controlled environment) and therefore conclude then it was likely that it would sink in the ocean environment with extra rope and drag created by longer rope and heavy tide. Testing indicated that floats did not sink. Field testing provided another opportunity to further check into the floatation. Figure 6 looks at the effect of the current on the surface floats and cage lid after release, as observed in the flume tank. Current speed from Left to Right ranged from 0.2m/s (0.4 knots) to 0.9 m/s (1.8 knots).

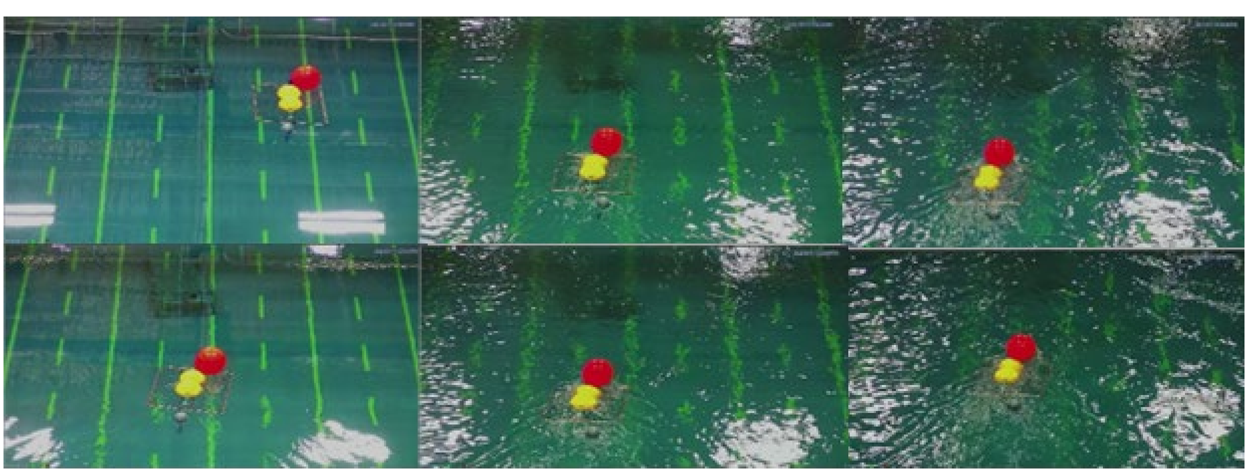


Figure 6 – Flume Tank Current Effect on Floatation

During flume tank testing, MOBI cage position/orientation to the current was videoed at various current speeds. Positions included MOBI release closest to the direction of flow, MOBI position perpendicular to the flow, MOBI unit facing down current, and with MOBI unit and cage on its side (See **Figure 7 below**). While in these positions and with various currents, the MOBI units were released to observe if there was issue with releasing in these orientations. All orientations released successfully except when cage was on its side, the key release mechanism would lodge. Once the cage was righted, the key would release.

Ashored has worked on new key designs to help prevent the lodging no matter what orientation the ROC system rests at after submerging to the bottom. During the flume tank testing with floatation and weighted runner bottoms on units, the ROC system never landed on its side during these tests (i.e. always landed right side up) and may only be an issue if it lands on a rock and tips during descent in seabed situation. All the units that are supplied by this project have included a set of weighted runner bottoms to ensure a positive result on the seabed. Figure 7 below shows different orientations to current flow for the MOBI unit. MOBI down, MOBI up current, MOBI perpendicular to current and MOBI unit and cage on its side.

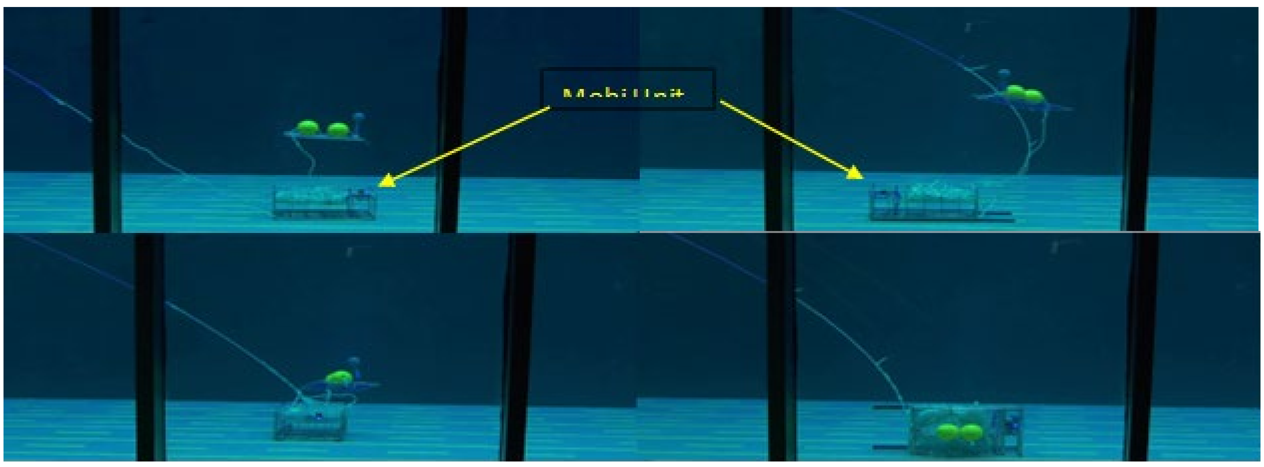


Figure 7 – Current Orientation to MOBI

At times during testing in the flume tank, the MOBI unit key, on release, would stay lodged between the cage roof and the MOBI release edge (see **Figure 8** below). After observing the occurrence, Ashored was informed, and work began on remediation of the key size and shape. During further testing at sea, this lodging of the key was also observed. This lodging would prevent the MOBI unit from surfacing resulting in test result recorded as a release failure. As noted above, Ashored and eSonar were fully engaged and when issues appeared they were quick to mobilize and work on a solution completing all remediations in a timely manner to ensure testing could be completed. The key lodging issue was remediated successfully prior to the end of the project. Figure 8 displays underwater pictures that show the key lodged after release both in the flume tank at MI and in Conception Bay during harvester trials.

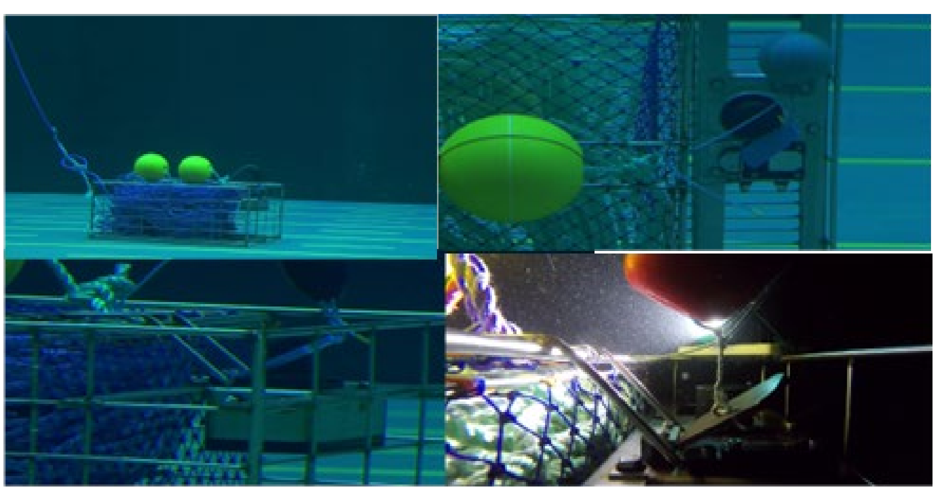


Figure 8 – Key Lodging on Release – Flume Tank and Conception Bay

Pressure Chamber Testing Results

MOBI Unit – Initial testing results

As testing was being performed in the MI's flume tank, pressure chamber testing was also taking place between April and June 2022. Initial testing was undertaken to establish a depth rating for the MOBI units. Prior Ashored testing took place in the Maritimes with trawl lobster fishery, this project was the first time its ROC system was tested in the Newfoundland and Labrador snow crab fishery. Fisheries in Newfoundland and Labrador for snow crab can take place at depths up to 260 fathoms (475m). Most of the prior testing that Ashored had completed was at water depths of 20m to 40m.

Ashored had indicated that the MOBI unit had never been tested at depths needed to fish snow crab. After initial testing it was quickly realized that water was penetrating the MOBI units, and the units were failing. The testing indicated changes in pressure inside the chamber and gains in the total weight of the MOBI units after testing. The penetration of water into the unit resulted in a pressure drop inside the pressure chamber. Aligned with the results seen in the pressure chamber testing, early results in the field and in the flume tank in May 2022 also saw water penetration at depths much shallower than needed for crab fisheries.

During field and flume tank testing, visual observations showed water escaping from around the transducer, charging lugs, and LED light. Failures in the MOBI units from the pressure chamber testing were not visually evident, however, the weight of the units changed with units weighing more after testing. The weight gain indicated water had penetrated the system and was causing significant issues with reliability and normal operations. As well, from the pressure sensor, it was easy to see the pressure drop, which also indicates the failure of the MOBI system and water penetration. Figure 9 below shows pressure chamber results (y axis outlines the pressure, while the x axis shows the time the unit was at depth). The graph on the left outlines a MOBI unit failure in less than 10 minutes at a depth of 400m (582psi). After the MOBI unit was removed from the pressure chamber, weight increased from 3915 grams to 3950 grams. This indicates that 35 grams of water had penetrated the MOBI unit during the test. The graph on the right shows interval testing where MOBI unit failed at 215 psi (150m) after cycling through shallower depths (50-100m) for half hour intervals. There was also a change in the weight of the MOBI unit, gaining 10 grams.

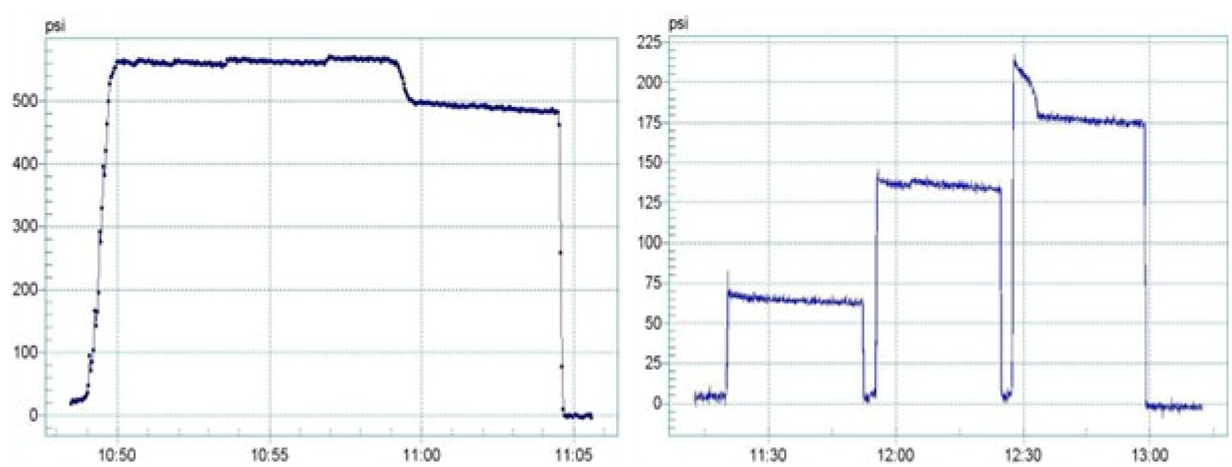


Figure 9 – Pressure Chamber results – water penetration

MOBI Unit Testing – Results after Remediation

September 2022

Once the unit had incorporated all the new parameters from remediation, further testing in the Pressure Chamber in September 2022 showed that the unit was now much more robust and could handle pressures up to 150m depth. This test looked at repeatability at 150m. Multiple units were tested to determine repeatability with respect to depth rating of each unit (see **Figure 10** below). The tests were successful which meant that Ashored could have confidence that the MOBI System could meet their ROC system specifications to be fished to a depth of 150m. This result was significant as 150m covers all American lobster fishing grounds in eastern Canada and in New England, US. Figure 10 illustrates the positive results for four MOBI units in the pressure chamber at 150m (230psi) with no visible change in pressure for a one hour time frame. These results were also verified with no change in the weight of the units after testing was complete

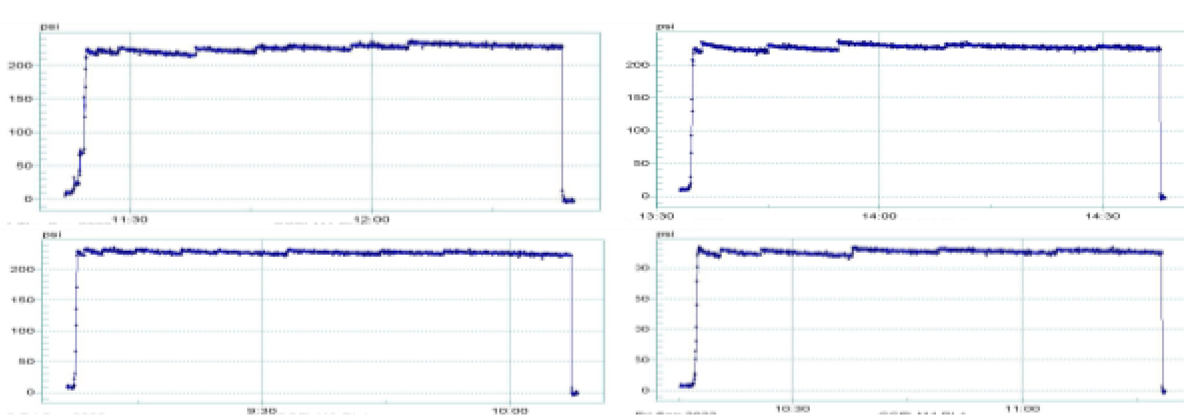


Figure 10 – Positive Pressure Chamber results post-remediation September 2022

October 2022
In early October 2022, Ashored supplied an additional four MOBI units (new numbering MOBI 1, 2, 3 and 4) that had gone through all remediations for preventing water incursion. A pressure test was conducted on two of the four units received and both units were found to be functioning well in the tests performed.

On October 26, 2022 testing was completed on the first unit (MOBI 3). After testing was completed, the unit was weighed. The weight did not change (4925 grams) and there was no change in pressure over the 60 minutes at all three depths. The connectivity of the unit after each depth was fine with the system powering up and connecting to the Atlas software and the deck box. MOBI 2 was tested on Oct 28, 2022, with the same procedures as MOBI 3.The unit weighed 4900 grams before testing and the weight did not change once testing was complete. Again, after each test the unit was connected to test communications with deck box and Atlas software and all connectivity had a positive result. Finally, there was no change in pressure over the 60 minutes for each depth tested**.** Both units passed the testing procedures for pressure chamber institutional testing and would proceed to be tested with harvesters in January and February 2023.

Key Float testing

During the pressure chamber studies, the key float was also tested to ensure they were able to function at depths up to 870 psi (600m). The key float is a float that lifts the key plate away from the magnet on the MOBI unit after acoustic release signal is sent. The testing on the key floats started in shallow water and then continuously increased in depth. Depth increased at 5-minute intervals to approximate depths of 100, 200, 250, 300, 350, 400, 450, 500, 550, and 600-meter Intervals. At 550 psi (377 meters) floats remained under pressure for 30 minutes to ensure failure would not happen over time. Once depths were increased the float failed at approximately 870 psi (600 meters). This would indicate the float performed successfully beyond the depths required by the fisheries examined by this project. Figure 11 shows the results of float testing at various depths with the float failing at 600m (870 psi). The graph on the left demonstrates a successful test of the float used by Ashored at depths needed to fish snow crab in NL waters. The graph on the right outlines a failure of a deepwater gillnet float at less than 600 psi (412m), which does not cover the deepest depths for the snow crab fishery. Ashored supplied the key floats for testing.

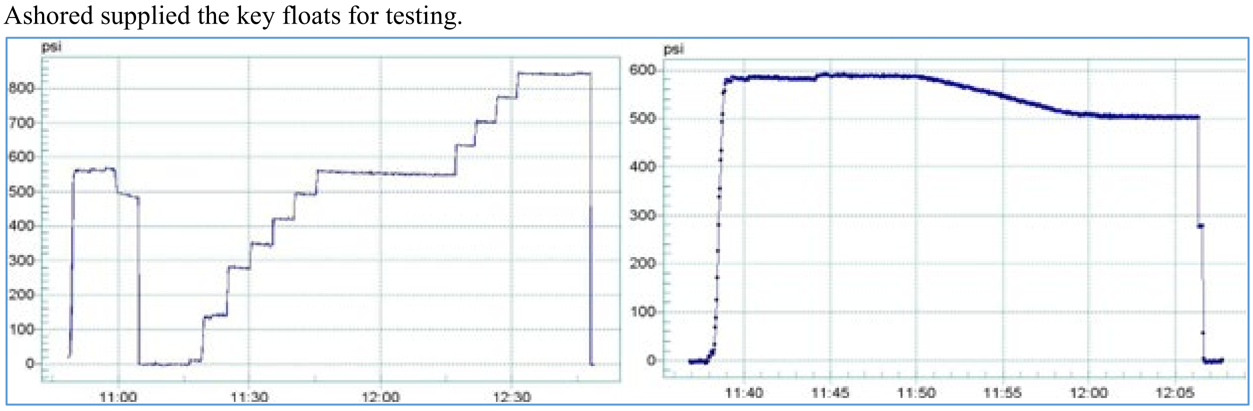


Figure 11 – Key Float testing results

The images below (Figure 12) show the floats that were tested either in the Marine Institute Pressure Chamber or by Ashored at their facility in Nova Scotia. The Red and Yellow oval-shaped floats in the picture and to the left are now being used with the Rope on Command System key. These floats are tested to 600 meters and have enough buoyancy to pull the key away from the magnet after release. The original blue float in the picture was tested in the Marine Institute pressure chamber and established that the buoyancy and depth rating met the level needed for the key float moving forward for depths of 300m. The blue float was not available in the marketplace however, but similar floats were found that had similar specs as the blue float. The gillnet float on the right failed during pressure chamber testing at depths required and therefore should not be used. The yellow and Red oval floats were sourced by Ashored and are the floats that are being used on the Rope on Command system as the key float, which lifts the key away from the magnet after release.

Figure 12 – Float Variations

Field Testing on R. V. Ludy Pudluk

The initial field testing of the MOBI units was carried out on the R.V. Ludy Pudluk in May and July 2022 to determine if: the system was communicating with the deck box and software; to establish a range that the system could communicate with the deck box and software (distance vessel was from ROC system), and once released, the time for the unit to leave seabed and rise to the ocean . Testing took place on May 31, 2022 and again on July 4 and 5, 2022. The primary goal of the field testing on the R. V. Ludy Pudluk was to ensure the MOBI units consistently performed.

On May 31, 2022, after initial remediations on Ashored's MOBI units from MI's Pressure Chamber and Flume Tank testing and trials, field testing on the R.V. Ludy Pudluk began. A statistical sampling method was developed to test the MOBI unit in 50m of water. The unit was set and all information on the date, time, water depth, latitude and longitude, water temperature, sea conditions and wind state was recorded. As well, information was gathered on:

- The time the signal was sent to the unit – Noting the time of day when the buttom was pressed to release the unit (start time)
- If the signal was detected by the unit - recorded as yes or no
- Number of signals before detection - Every time the release is sent to the MOBI unit the transducer will signal 5 times over before giving a release failure. These 5 signals happen over a 20 to 30 second interval.
- Range from the vessel –The product allows the user to 'range' from the system to MOBI unit before releasing. This is a great way to ensure transducer and MOBI unit are communicating before release. The response from ranging is a distance in meters.
- If there was a notification of release (Release Success) – After release during the five signals from the transducer, the system can indicate release success. It can happen on any of the five signals.
- When float was spotted on the surface - This is time from release success to seeing the float at the surface.
- When floats recovered - When harvester hooked the floats and brought on board this time was recorded as well.
- When the full system was aboard - The time to haul gear from when floats recovered to when last pot was onboard.

To complete statistical analysis on the unit it was important that the unit remained unchanged (i.e. not swapped out) for statistical consistency. The initial testing plan was developed to statistically measure release success and failure and measure time for the unit to reach the ocean surface.

The unit worked very well for 23 sets. After this, on occasion, the unit would not range or give detection of release. On set 34, the MOBI unit failed. After trying to complete a number of resets on the MOBI unit with no response, the testing was postponed.

Results on the system for 32 sets before failure included an average time to the surface of one (1) minute and 9 seconds for the system (cover and floats). The release mechanism encompassed two 8-inch floats with 2.54kg of buoyancy for each float and a 3/8-inch sinking line for the retrieval line on the release.

The poor performance indicated water penetration was still an issue resulting in system failures at shallow depths. On the unit, water could be seen inside the clear epoxy and this resulted in MOBI unit failure. It was clear that water was entering through areas such as the transducer head, the charging leads and the LED indicator and these areas would need to be redesigned. Ashored was involved in testing and in undertaking remediation to the MOBI unit.

On July 4 and 5, 2022, further testing was completed on the ROC system aboard the R.V. Ludy Pudluk. After remediations were completed, consistent with practices of May 31, 2022, information collected included, release time, release notification, time to the surface, the time to recover floats and the time to bring system onboard. After Ashored made remediations, it was decided these tests would be completed at 100m depths to see if remediations completed from earlier testing were sufficient. On July 4, 2022, a MOBI unit was added to the cage and testing started at 100m. After eight (8) sets were completed, water could be seen seeping out around the charging leads on the unit. At this point water had penetrated the unit and the unit had failed.

Ashored took back the units and performed remediations to the system. Remediations confirmed by Ashored included changing procedures for curing epoxy to ensure all air pockets were removed and added a sealing compound to areas where it was thought water had entered.

A new MOBI unit was provided. Forty-four sets were completed on the new MOBI unit with multiple issues. Over time, as water penetrated the system, release failures and communication issues persisted, and at set 37, the MOBI system failed. The system did not release on command and on many occasions the unit would only come to the surface when the timed release expired.

A timed release was used as a failsafe in case the command release did not work. The time release was used on all testing as a backup for acoustic release failures. In all of the testing, if the acoustic release failed for reasons other than water penetration then the timed release always worked. Insight into this feature was gained in harvester testing completed in Fogo Island and Grand Bank as well with success.

During this testing on July 4 and 5, 2022, the timed release was programmed for 20 minutes on every set. If the acoustic release failed, the time release usually worked resulting in the rope coming to the surface. When the timed release did not work (i.e. rope did not surface), it could be attributed to:

- key jammed preventing release
- water penetration shorting out the timer.

Also, on three (3) sets during the July 4 and 5th testing trip, the unit did not release on the time release and was pulled by the safety line at opposite end. Some of the failed releases could be attributed to release key issues. These tests were completed before all remediations were completed on the release key design that prevented the key from being jammed. The goal was to make changes to the key design and test it later in the fall with video on harvester vessels – discussed further into the report.

At this stage of the project, Ashored would continue remediations and the project remained focused on gaining a stable product that could be used in harvester testing. Harvester testing was and is extremely important to contribute to the discussion around the needs and requirements for successfully adoption of this technology into fishing operations.

The insights and recommendations related to the results of Acoustic, Flume, Pressure Chamber and controlled Field Testing will be combined with Harvester Trial testing results and provided in summary further into the report. This will provide DFO and the technology partners with information to contribute to ongoing conversations around adopting the technology for the crab, lobster and cod pot harvesting industries in Atlantic Canada and the Quebec region.

This activity is complete.

Results to provide to DFO for this activity:

- All required system components delivered to facility in Holyrood – Shipment summary attached
- All system components verified operational – Final pressure chamber results above indicate the water penetration issues were corrected
- Identified deficiencies corrected – Progressive results above outlines many of the remediations on the product were successful – results of testing in the next activity show further evidence of positive results following additional remediations
- SOP developed and reviewed by all project partners – Electronic copy of SOP attached

Year 1 - Activity 5: Video and Camera Work on ROC Demonstrations at Holyrood (Conception Bay, NL) (Carried over from year 1)

The technology testing activities that have occurred since April 18th when the initial equipment was delivered, have provided opportunities for video and camera work. Access to video and photos are provided to DFO with this year-end report via a USB data stick. (Contact CCFI for a copy of the video and camera work completed in accordance with Activity 5)

Video and camera work completed includes:

Flume tank and surrounding deck – initial exposure to the equipment

- Cage lid release
- Lid and rope rising to surface
- Project team and partners
- Buoyance performance related to size and type of buoys
- Analysis of rope size and buoyancy features and affect on unit performance

Ludy Pudluk, Holyrood/ Conception Bay

- Using ROV, in-water video and camera work from Ludy Pudluk off Holyrood
- Cage lid acoustic and mechanical release
- Lid and rope ascending to surface
- Camera work illustrating hauling and resetting gear on deck
- MOBI unit and cage entry into water, retrieval,
- Unit contacting seabed surface on deployment and viewing stability
- Unit attached to cod pot, crab pots and lobster pots.

Training – photos of harvesters, technology partners and project team

- Presentation style, interactive learning
- Equipment
- Project team, harvester community, Ashored Inc and eSonar partners

Commercial Testing – from Harvester vessel

- Photos and videos of harvesters, project team and partners interacting with gear – learning, hauling and resetting gear, comparison with traditional and new MOBI technology and work practices differences in operations.
    - Camera work illustrating the interaction of the harvesters with the equipment
    - Shows equipment attached to crab pots, released underwater, and drone footage of above water process.
- The team mounted a go-pro camera and lights to a unit during a harvester vessel trial. This approach was instrumental in troubleshooting a mechanical issue with the cage design related to a deficiency in the cage key plate release. With the underwater footage, the cause of the issue was identified and the resolution was immediate as a result. The key shape was altered slightly to allow for successful release. Subsequent testing has indicated the issue to be resolved.
    - Video and sound were both produced by this test which enables a clear indication of the actions of the unit and the sound of the transducer signal.
    - Footage includes:
    - Release of the key mechanism on cage, buoyancy of floats, effect of currents, release of the cage lid and the rise of rope to surface, and observation of sea life at each ocean depth
    - Acoustic signal interacting with the key release
- Drone footage capturing additional perspectives of all aspects of the work processes and equipment operation

Gear Disbursement

- Images of harvesters receiving their Rope on Command systems.

This activity is completed.

Results to provide to DFO:

- Video and/or photos of underwater testing, deployment and retrieval. Provided to DFO via USB datastick
- Summary of artifacts:
    - April 19th, 2022: videos from the flume tank testing: 9 videos
    - May 10th, 2022: video from more flume tank testing: 25 videos
    - May 11th, 2022: Video from flume tank testing: 8 videos
    - Oct 18th, 2022: video from on old key fail and new key success release and other
    - releases at depth: 8 videos
    - Oct 24th, 2022: video of MOBI system sinking to the bottom: 1 video
    - Dec 02nd, 2022: Surface video of MOBI units and pots entering the water from the vessel: 11 videos
    - ROV and underwater videos from May 13th and from December 02nd: 17 videos.
    - Video from testing Fogo Island Jan/Feb 2023
    - Video from Testing Grand Bank Feb 2023
    - Drone Video Late Feb 2023

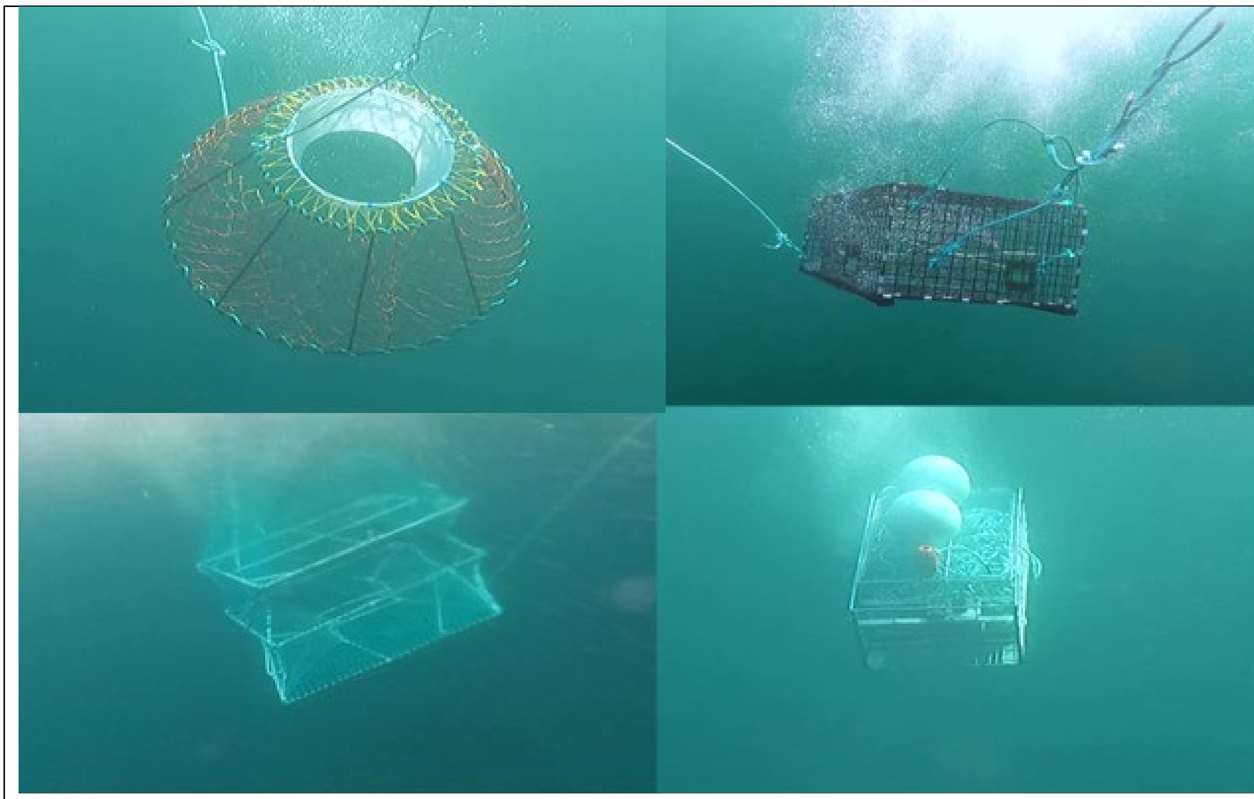


Figure 13 – Various Types of Pots with ROC system

Figure 13 above illustrates fleets of different pots (Snow Crab, American Lobster, and Atlantic Cod) being set with ROC system during video collection on December 2, 2022.

Year 2 – Activity : Commercial Field Testing in lobster and crab fisheries in both inshore and offshore ocean environments.

Activity Summary

The scope of fisheries for this project includes inshore and offshore snow crab (Chionoecetes opilio), American lobster (Homarus americanus) and Atlantic cod (Gadus morhua) from cod pots. The evaluation includes fishing in trawls/fleets as well as single pot. Primary depths investigated included 50m to 300m with the harvester testing stages ending with high performance. In addition to these depths, preliminary testing completed by the project at greater 300m indicated the unit functions as designed. However, the results are cautiously optimistic and additional testing is needed below 300m to provide insight into product reliability and consistency and to gain information on any adaptation needs specific to the extreme depths of the offshore crab fishing.

For this activity, a Commercial testing plan/approach was developed that included four components as illustrated below – training, familiarity, timed trials and feedback.

- The goal of the Commercial testing was to collect both quantitative and qualitative data for analysis.

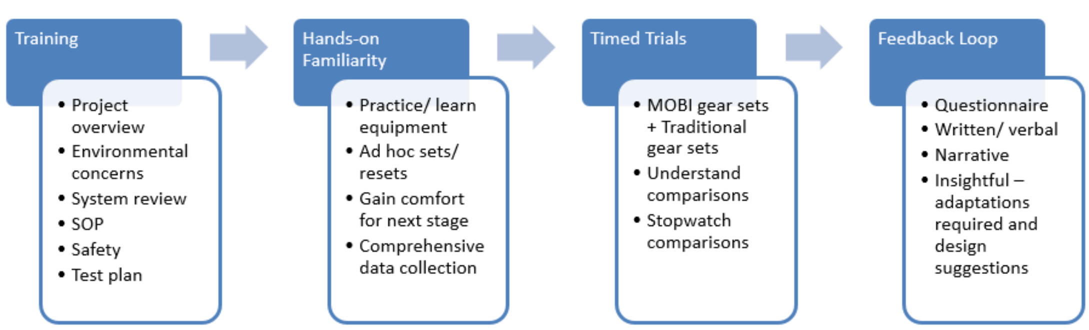


Figure 14 – Commercial testing plan steps

- Commercial testing with Harvesters was instrumental to providing insight into other aspects of the equipment's behaviour under the sea conditions experienced in traditional crab harvesting depths off the coast of Newfoundland and Labrador.
- Commercial harvester field-testing began in September and continued through to March 2023. Seven harvester vessels were chartered in areas of Petty Harbour, Grand Bank, Fogo, and Conception Bay South, NL.
- The harvester trials included lobster, crab (inshore and deep sea) and cod pot fisheries. The trials encompassed various conditions and variables, as summarized in the graphic below as well as elaborated on in the detailed results below.

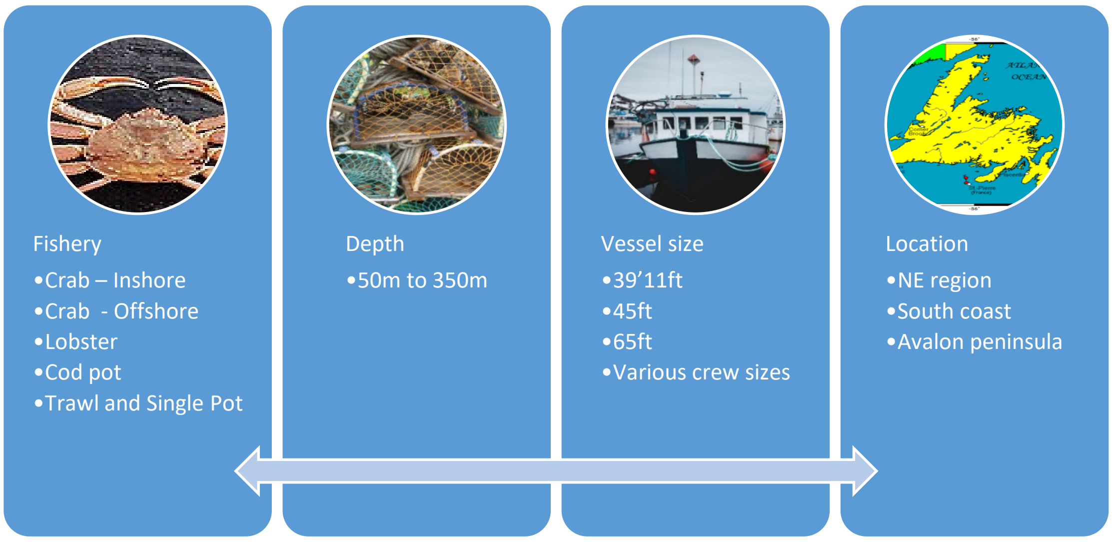


Figure 15 – Summary of Testing Variables

- As testing progressed, significant collaboration with Ashored and eSonar continued to take place. Remediations to the product (cage stability on seabed, cage size, battery functionality, connectivity enhancements, buoy sizes, key design), were necessary to achieve the harvester testing stage objectives.
- Significant product upgrades/fixes were made including resolutions to water penetration, key shape, and firmware/ software maintenance. In addition, the standard operating procedures were being refined to learn the appropriate release of the cage into the water to prevent the lid from early release.
- Harvester testing provided valuable insight for both the technology development as well as adoption considerations to enable successful change to fishing operations.

Participating Harvesters

Harvester	Home Port	Vessel Name	Vessel Length	Vessel Registration Number (VRN)
Doug Trainor	Petty Harbour	DRA Enterprise	39'11"	139394
Damien Stratton	Calvert	Kitty Phonse	35"	136621
Patrick O'Leary	Conception Bay	Jennifer Joanne	35"	155798
Jerry Best Glen Best	Fogo Island	Teresa T	64'	802290
Jason Matthews	Grand Bank	Jake's Pride II	45'	139858
Doug Howlett	Petty Harbour	Finest Kind	35'	138495
Bernard Chafe	Petty Harbour	Phoenix	35'	142294

Detailed Chronology and Results of Harvester Testing

Petty Harbour - September 2022

On September 7, 2022, the vessel DRA Enterprise registration 139394 owned by Doug Trainer a harvester from Petty Harbour, NL, was used to test the newly remediated MOBI unit Rope on Command System. The unit had arrived the previous week following positive testing in Nova Scotia conducted by Ashored.

Ocean conditions were 2 to 4-meter seas. As a result of the conditions, it took some time to set up the system and get the right amount of line inside the cage for the depth needed. When completed, the system was tested at a 50-meter depth and was successfully activated and returned to the surface. The system was then tested at a 150-metre depth. Weather conditions and not having the system set up with a fleet of crab pots (3 pots) caused the system to drift and settle at depths greater than the amount of safety line on the system. This caused the safety line to sink and the buoy was below the surface. The unit could not be retrieved in the sea conditions present at that time as the unit had been taken under and location was impossible to achieve on September 7th.

On September 9th, the vessel returned to the fishing grounds to continue harvester trials to test a different MOBI system with a fleet of pots at 150m. MOBI units were attached to both ends of the fleet of pots. When the transducer was placed in the water the system was released and both units returned to the surface. The system was hauled at 10:48 am with everything onboard at 11:15 am. There were still communications errors with the system but there were no issues with water penetration at 150 meters. Following this round of trials, Ashored would complete firmware updates and ensure all units have the latest software.

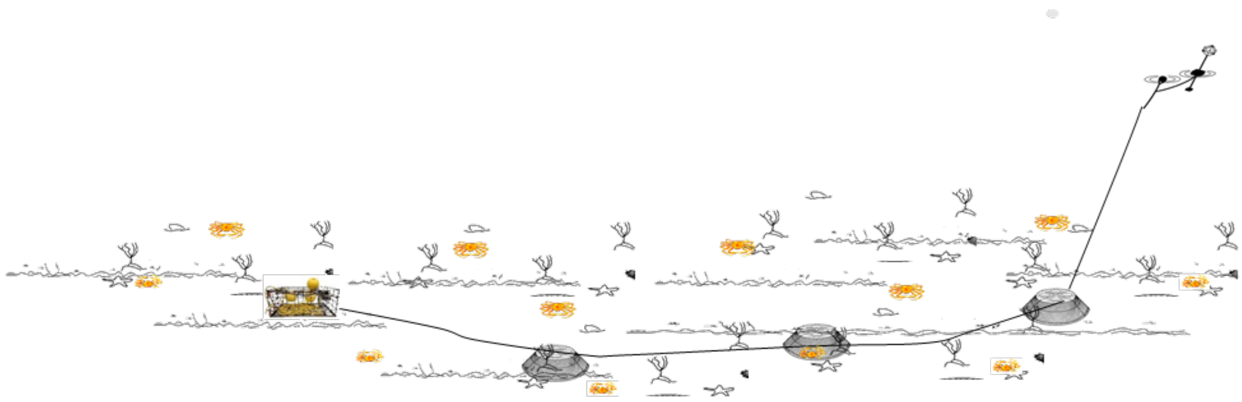


Figure 16: *Showing how testing of the Rope on Command system was set up during harvester trials. This includes a safety line on one end with three crab or Lobster pots and the rope on Command system on the other end. This set up will be compared to traditional gear using just three crab or lobster pots.*

After the September 9th trials concluded, the Harvester returned to the site of the lost unit. When the vessel arrived, it was between tides with no current. The floats from the trials on September 7th were on the surface and visible for retrieval.

Once hauled in, there was an issue identified with the battery display; it read the battery life was at 40%. This percentage was concerning as it was only in the water for two days and was supposed to have a battery life of months to enable harvester for the season. From this observation, it was concluded that either the battery display was reading the battery life wrong, or the batteries were not lasting as the specs indicate. Ashored is further investigating battery performance and the accuracy of the indicator. As well, Ashored have identified a new battery supplier for their batteries, as the current supplier's batteries are not performing up to their indicated specifications. This project did not test the new batteries. Further battery performance testing is needed prior to gear adoption.

During these early harvester trials, an issue was identified with the MOBI lid prematurely releasing when deployed. When the rope on command system was thrown into the water at times the roof would release prematurely. The Marine Institute under the direction of Ashored, who provided drawings, made changes to the roof section of the cage to prevent premature release when setting the rope on Command system.

Testing later in the year also identified that it is important to ensure the key is firmly in place before setting the rope on command system or there is increased risk of premature lid release as well.

It was determined that the way the gear was set made a difference to whether an issue was experienced with the cover. When setting there were no issues when the MOBI unit side of the Rope on Command system was pushed into the water first. This method created water pressure that kept the key locked in place. When setting in other directions there was a slight possibility that the key would release.

Finally, the harvester also identified that there may be issues with the amount of floatation on the release and larger floats should be tested. It was felt that the current 8-inch floats did not have enough buoyancy to keep the release on the surface in any current. This was discussed with stakeholders and new 11-inch floats were identified for future testing.

During testing in September and early October, with Doug Howlett's vessel, the Finest Kind; Bernard Chafe's vessel, Phoenix, and Damion Stratton's vessel the Kitty Phonse, there were issues with the deck box in that it stopped working during the execution of the trials. Changes had been made, due to the previous trials, to the transducer signal to allow for better communication at depth. As a result, the electronic board inside the deck box was having problems processing the increased signal information and the deck box stopped working after two sets. Also during trials with Damien Stratton, it was suspected that the key was jamming on times preventing the cover from coming to the surface. Further investigation would be required into the key shape.

Ashored and eSonar were notified and the synchronization problems between the unit and the transducer were corrected. After further investigation, it was discovered that the deck box output transformer also failed, and it was also replaced.

Conception Bay - October 2022

On October 18, 2022, Paddy O'Leary, a harvester based in Portugal Cove South tested two remediated MOBI units in Conception Bay, NL. Mr. O'Leary's vessel is named the Jennifer Joanne, with VRN 155798 and the vessel length was

34' 11". The goal of these tests was to observe changes to the release key to see if it corrected the jamming issue that was observed with previous key designs.

Also, this testing would compare larger floats (11-inch) to see if this made a difference in the amount of time to reach the surface after release. The new floats being tested were 11-inch center-hole floats with 6920 grams of buoyancy per float. There would be two 11 floats on the standard cage. These would be compared to three 8-inch floats (8-inch floats with 2540 grams of buoyancy). Information was collected on the amount and different types of floats and the time it took the unit to surface after release, while, also allowing the cage to sink when setting the gear. Testing was carried out at 150m. Results showed that the 11-inch floats were much better at reducing the amount of time for the unit to surface after release. Two 11-inch floats averaged 2.08 minutes to surface from 150m, while three 8-inch floats averaged 4.10 minutes from the same depth.

During this testing, there was a Go Pro mounted to the ROC system looking at the MOBI unit. Having this video verified when the system did not surface after release with the standard key, it was caused by the key jamming. The standard key was modified from the original key in late summer 2022 as that key was also jamming as was verified from flume tank testing. Three key design remediations took place during the trials. The first changed the size and shape (late Summer 2022) and the second modified the edge of the key that locks the floats and roof in place from non-tapered to a tapered edge (Fall 2022), the third looked at painting the key to prevent rust. This jamming may have played a significant role in the system not surfacing in earlier testing. During earlier testing, when there was full communication between MOBI unit and deck box and Atlas software, but the unit did not surface after releasing, it may have been because of the key being jammed. **Figure 17** below shows the different key designs used during the testing.

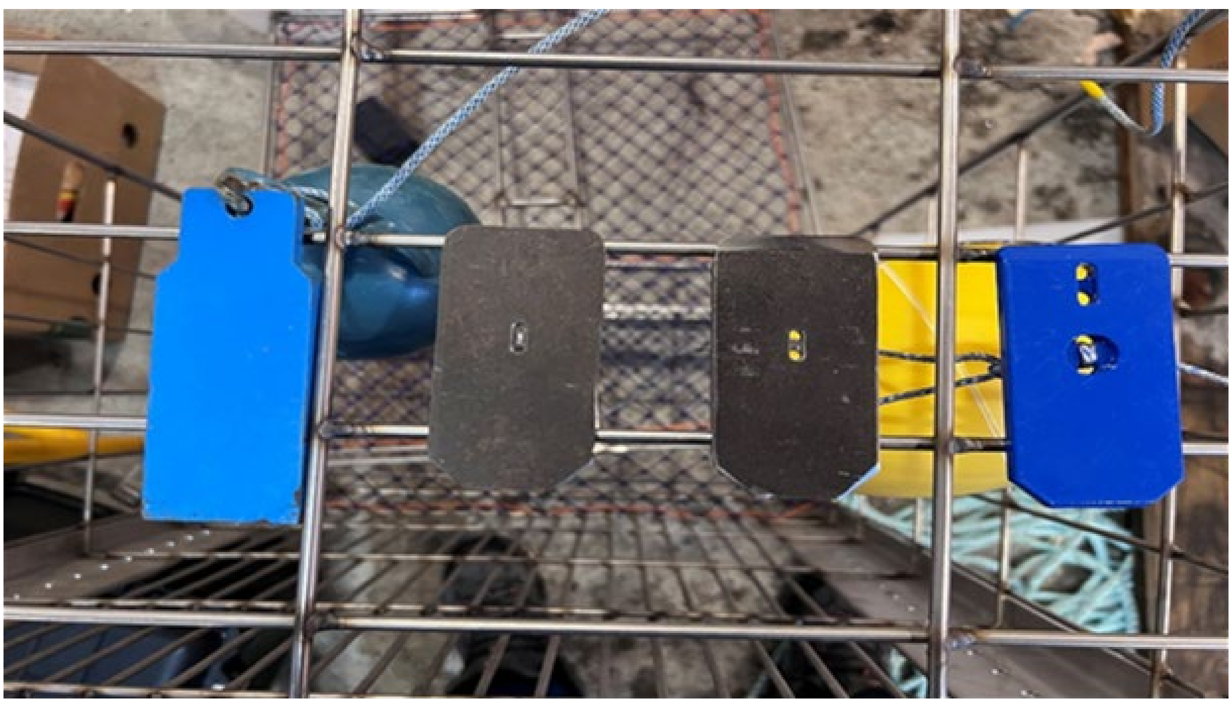


Figure 17 – Key Designs used during project

Testing on the vessel, Jennifer Joanne, also investigated ranging the system to see how far the system would range and release at 150m depth. This refers to how far away from the unit can the harvester send an acoustic signal to the unit successfully having the unit respond. The system performed well ranging and releasing at 2151m. The cover floats had already surfaced when the vessel arrived back on site therefore an accurate time to the surface was not recorded for this test.

On January 30 and 31, 2023, Jerry Best, a harvester based on Fogo Island, NL, tested MOBI units. Best's vessel, the Teresa T, has a length of 65'. Weather on both days ranged from snow to sunny with temperatures ranging from -3 to -8. The winds ranged from 10 to 25 knots and swells ranged from 1m to 3m. Testing took place in the crab grounds approximately 15 to 20 nautical miles northeast of the town of Fogo. The weather description for this trial is provided to illustrate the testing was being conducted in cold temperatures in winter. The purpose of this test was to establish MOBI unit reliability at depths between 200m and 300m on harvester vessels on traditional Snow Crab fishing grounds. For this work, two 11-inch floats were attached to the standard cage and three 11-inch floats were attached to the large cage. The 11-inch floats had a buoyancy of 7250 grams per float. As well, these floats were yellow in color, harvesters had indicated white would be hard to see and if possible, orange would be the best color to use. Orange floats were not available for purchase at the time, therefore yellow was chosen; the buoyancy of both the yellow and orange floats are the same. The rope size used in the standard ROC cage was 7/16 (11mm), while the rope used in the large cage was 1/2 inch (13mm). Rope length inside the ROC systems was 365m for the standard cage and 430m for the large cage.

Two fleets of gear were set, one had the ROC system and the second fleet represented traditional practices without the MOBI unit. Both fleets had three crab pots. Times were taken for setting the gear when mooring went into the water until ROC system entered the water and when the last pot entered the water on the traditional gear. Times for hauling were also recorded when ROC system was hooked with the boat hook until the last pot was onboard. The traditional gear times started when mooring rope was hooked with the boat hook until the last crab pot was onboard. Twenty sets were completed using the ROC and traditional fleets. The traditional fleets used floating lines, while the ROC system used sinking lines. Ten sets were completed on the ROC system with zero failures in deployment and retrieval.

When the release command was sent to the system, it responded and always replied with release success. Eight (8) of the ten (10) sets were compared to gather information on time differences between MOBI gear and traditional for setting and hauling. As well, data was collected on time to the surface including time to spot floats. Results from the testing showed that the time to set the ROC system was 30 seconds longer than the traditional gear. The time to haul the ROC system was on average 2.14 minutes longer, providing the ropes on the ROC system were coiled back into a pan as it was coming out of the hauler. Once the rope was in the pan the rope could be dumped back into the cage and the system reset efficiently by one crewmember.

On average it took 9.03 minutes for the floats to surface after release. This time was influenced by how long it took to spot the floats after they surfaced. The quickest time to spot the floats was 3.30 minutes, with the longest time being over 31.34 minutes. From most of the sets it took between 3 minutes and 30 seconds to 4 minutes and 30 seconds for the floats to surface at depths between 200 and 300m. From these results, it is clear that visibility plays an important role in being able to spot the float released by the ROC system.

From an adaptation perspective, eleven-inch floats are small compared to 40 to 60-inch buoys that are used on traditional gear. The smaller floats could present a major issue at night, when it is foggy, when it is a lot of wind and swell in the water, and in areas where there is a strong current. More work is needed on this system with respect to seeing the floats in different weather conditions as well as during different times of the day and night.

During this trip, a test was conducted on an overnight set of the ROC system. During the true fishing season, the unit will be set in the water for extended periods. The large cage was used in this trial. The system was set in the evening of January 30, 2023 at 17:30 PM with a timed release of 15 hours, at a depth of 245m. When the vessel arrived on January 31, 2023 at 9:37 AM the floats were on the surface. The system was hauled and placed on deck for a couple of hours until needed. When the crew was preparing the system for a second set the MOBI unit would not operate. The unit was not responding and all attempts to get it working failed. It was returned to Ashored once the trip concluded and continues to undergo analysis.

One set was also completed at 354m with the large cage – this is the deepest trial conducted on the project. The system responded when the signal was sent which indicates the acoustic technology operated successfully and unit replied as designed. However, the floats did not surface. When the cage was retrieved manually, the cover was snagged in the cage. This test illustrates that the electronic portion of the system worked at the 354m depth while further investigation would be needed at this depth to determine the reason for the cover not operating as expected. Additional testing is required to determine performance and consistency/ reliability at this depth.

Grand Bank - February 2023

On February 10 and 24, 2023, Jason Matthews, a harvester based in Grand Bank, NL tested MOBI units. Matthew's vessel is named Jake's Pride II, vessel length 45ft. Harvester testing involved testing fleets of crab pots with ROC system against fleets of snow crab pots and fleets of lobster pots. The fleets were set up with three crab pots and ROC system compared to three crab pots. The lobster fleets were fished the same way, with three lobster pots and ROC system compared to three lobster pots. Fleets of traditional pots used floating rope for the mooring rope (1/2 inch - 13mm) for crab, (7/16-inch - 11mm) for lobster), while the ROC system used sinking rope (7/16-inch - 11mm). The ROC system used 365m for the crab testing and 65m of rope for the lobster fishing. The ROC system had two 11-inch floats with 7250 grams of buoyancy for each float. Testing on Feb 10 included recording timing for setting and hauling the pots as well as more information was collected on time from release to spotting the floats at the surface. This was done for both snow crab and partially for lobster. The remainder of the lobster testing took place on February 24, 2023, and drone video was taken of the ROC system setting and hauling.

Results from the crab testing on Feb 10 showed very little difference in setting and hauling times for the fleets of pots with ROC versus the traditional gear. The average time to set the gear with the ROC was 2.97 minutes while the traditional fleets averaged 2.29 minutes. The time to haul was 7.49 minutes for the ROC system, while the traditional gear was 7.62 minutes. The vessel owned by Jason Matthews was different from most vessels fishing in NL. The stern of the vessel was level with the deck which made for easily setting the fleets of gear and the hauler was not the traditional hanging hauler. The hauler was mounted inboard on the superstructure with a block that guided the ropes when hauling and made it easy to remove pots quickly when hauling. This setup is similar to what is used in the Maritime Provinces for fishing. The average time to spot the floats after release was 4.70 minutes. Information collected in Grand Bank on February 10, 2023, recorded the time to set and haul fleets of crab pots at depths between 235m and 318m. As well, time for the floats to surface and be identified was recorded. There were no issues with the ROC in deep water. All releases were successful and happened with the first ping from the transducer.

During these tests we did not have a major issue with finding the floats; however, finding these small floats in bad weather is predicted to be an issue according to feedback received from harvester. Jason Matthews stated they conduct a lot of fishing at night and the current setup would be problematic since these floats would be difficult to spot. As well, Mr. Matthews stated that on St. Pierre Bank where they also fish for crab, there is heavy current and they use two 50-inch buoys; the ROC system uses 11-inch floats, which may not be enough floatation in this area.

The testing for the lobster pots took place on February 10 and 24, 2023. Results from the testing show a small difference in the time to set and haul the fleets with the ROC system versus the traditional fleets with the ROC system taking 0.80 minutes to set and 2.30 minutes to haul, while the traditional gear took 0.51 minutes to set and 1.84 minutes to haul.

The overall difference in time can be extrapolated to include two ROC systems (one on each end) with the fleet. Extra time to set and haul with ROC systems on both ends is approximately 2 minutes and 30 seconds. To simulate a harvester scenario with 12 fleets of gear with two MOBI units each, the extra time to haul the full fleet in the lobster fishery would be estimated to be 30 minutes.

The unit released in all but one attempt. The one failure was because of the Atlas software not resetting. Once the software was reset, the unit worked fine. In the deep water the unit was always releasing on the 1st ping, but in shallow water this varied with releases sometimes on the first ping as planned but there were occasions where the 2nd, 3rd and 4th pings were needed. There also seems to be a little more noise in the system in the shallower depths and adjustments to the transducer for shallow water applications may correct this.

This harvester testing chronology portrays a progressively positive journey of the product performance and its ability to operate effectively. There is a significant different in the number of issues and results experienced in initial harvester trials to the performance experienced in the end. Product enhancements and getting to the know the system and refine procedures has enabled this activity to end on a positive path.

Harvester Interviews

Supplementing quantitative data collection, a questionnaire was developed to obtain significant feedback from each harvester. This data facilitated the analysis of operational performance of traditional gear vs. the Ashored technology used in the tests. It also highlighted any factors/ variables that create challenge or opportunity for successful gear adoption in the future. A series of questions (sample attached with this report) provide a narrative/ description useful for gear adoption and equipment enhancements.

There were many ideas that came from the harvester interviews. These interviews took place after each harvester testing session. Some of the concerns early in testing were related to the issues with float not surfacing and focused on the potential for lost gear. After many remediations by Ashored and eSonar during interviews from October 2022 to late March 2023, harvesters stated that they were very surprised at how well the system worked, with some harvesters stating they thought the system would never work. After seeing the system work during the winter months in very cold weather they stated that the reliability of the system to surface after release was a surprise and they looked forward to doing further testing in the commercial fishery.

The themes that evolved from this activity included the following:

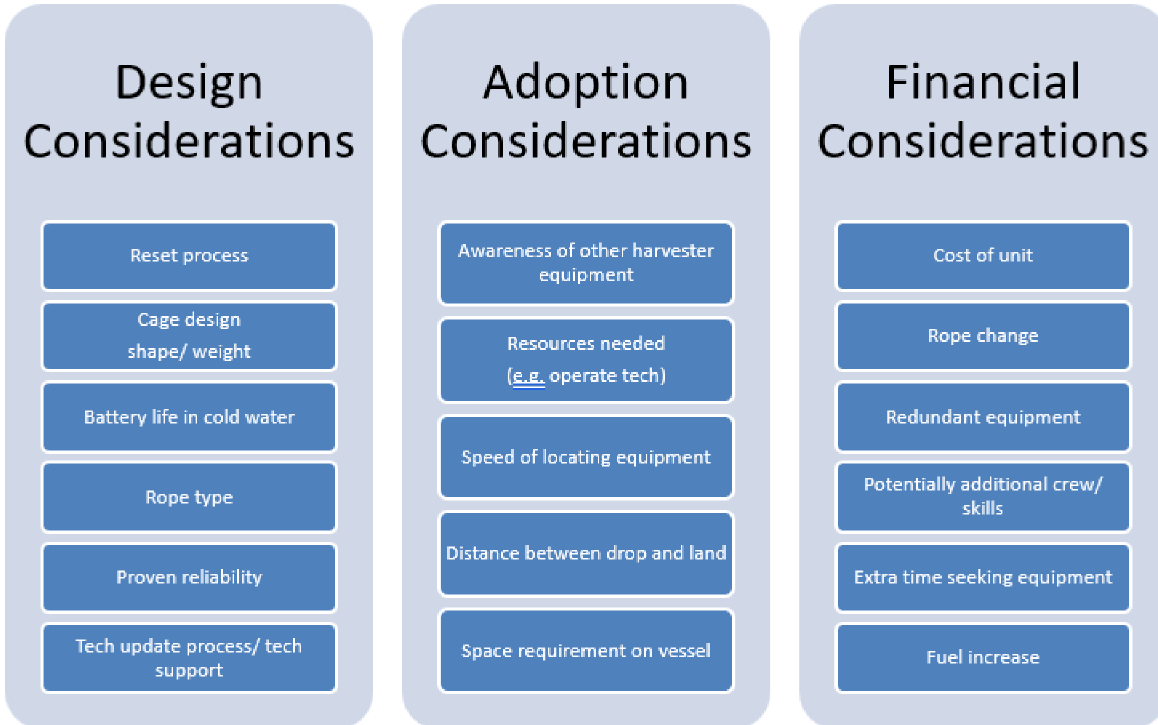


Figure 18 – Consideration Themes

Design Considerations

Reset Process

- Harvesters have some concern over the time it takes to complete the reset. The reset is characterized as returning rope to the cage, reapplying the cover, and returning to water. As with the adoption of many new processes, as familiarity increases the time required may decrease. However, it is unknown if familiarity alone would fully mitigate this consideration and allow for a process considered practical for the fishing operation. A cumbersome step in the reset is having somewhere to put the rope as the cage is hauling in. A fish box or barrel may be necessary to add the rope into it and then flip it out into the cage once the cage is on deck.
- From an electronic standpoint, the reset seemed to work more reliably if it was powered down and back up. This step created extra time; feedback was provided to Ashored on this aspect to allow them to determine whether remediation / product enhancement would be pursued.

Cage Design/ Shape and Weight

- Two cage sizes were tested by the activities associated with this project. The standard cage as sold on the Ashored website was not deemed suitable to hold the rope that is required for deep crab fishery. The strong current found in many of the fishing grounds off NL waters has created a need to increase the rope required for the vertical line to account for the current. Due to the preferred rope strength and length required, a larger cage was fabricated for specific trials. The larger cage was manufactured by Technical Services, Memorial University using specifications engineered by Ashored.
- While the large cage met the rope need, the harvester experience with the large cage is that it is extremely heavy (greater than 100 lbs) and large. The size poses issues on deck and the weight of it poses issues from a human resources and transportation perspective.
- Harvesters offered opinions on the cage shape; options require exploration. Crab harvesters prefer a cage design that stacks well with their crab pots. The current shape takes up a lot of space on deck. They suggest an investment into a design that uses a crab pot cage; the concept is to retrofit the pot to hold the rope and the unit. This shape would enable effective stacking on the deck and cause the least adaptation concerns. Rope could be packed into the first crab pot in each fleet and that pot could be stacked with the other pots.
- The design specification varies by fishery and the needs of that fishery. The shape proposed for the crab fishery would not work for lobster and cod pot fishery. Feedback from harvesters fishing lobster is that the current rectangular cage shape works well for that fishery.

Battery Life and in Cold Water

- The MOBI unit displays a gauge that shows the percentage of charge. Fluctuation was noticed upon initially removing from the charger. Through testing, it was discovered that the battery gauge was not operating well.

A fully charged unit showing 100% immediately dropped to 85% when removed from charge. There were jumps in the battery percentage that were unexpected. Ashored is aware of the battery and gauge performance feedback. At time of this report, while the details of future enhancements are unknown, the battery is an item Ashored is investigating further.

- Further testing is required to determine the reliability of the battery over longer periods of time. The duration of this project did not enable a significant battery reliability test that would mimic the use during a typical fishing season. While reliability was not measured scientifically, there are some measurements taken during the trials that indicated an area of concern and an area that would be benefit from further dedicated testing.
- There were two trial failures that may have been related to battery performance. One of the trials was an overnight soak.
- Temperature conditions have been known to affect battery performance in a variety of products. Deeper water related to the crab fishery in Newfoundland and Labrador as well as the time of year will challenge the standard battery design due to the more extreme temperatures. Further testing and research are required to understand temperature effects on battery life.
- Ashored design, consistent with several other products on the market, has a feature that automatically brings the unit to the surface when the battery reaches 15%. This feature provides comfort to harvesters regarding reducing gear loss however it also means if the battery is unreliable and surfaces earlier as a result, rope will be suspended in the vertical and environment risk created. As a result, battery performance has a role to play in reducing the instances of vertical line in the water column.
- Battery life is increasingly important in areas where the gear moves and cannot be hauled up with a grapnel. In shallow water where the gear is not expected to move, should the battery run low and the product not return to the surface, the risks are less. The gear location would have been marked and can be hauled manually via grapnel in the case of very shallow fisheries. This is not an option for all waters off Newfoundland and Labrador. Equipment reliability and battery use are critical in all instances in this province.

Rope Type

- Harvesters have a concern that they need to use a rope type that is inconsistent with the rope they currently use in order to fit into the cage. Floating rope cannot be used - neutrally buoyant or weighted only.
- With the larger cage, some of the rope concern is reduced.
- For the offshore crab fishery, the large cage would also not provide the space needed for the typical rope used.

Proven Reliability

- Harvesters question whether the product is reliable for the conditions, season length, depth, etc. of the fishing operations conducted in the waters off Newfoundland and Labrador. Future use and a potential research project with a goal of achieving statistical significance is needed to allay the concern.

  The scope of this project was not intended to provide scientific reliability conclusions to enable product reliability guarantees. That said, the initial trial strategy was designed with input from a statistician at MI. Based on the variables presented, a trial set of 38 iterations in the same conditions was determined to be the required number to draw statistically significant conclusions. If the product had performed as expected when testing started in spring 2022, the trial plan would have been achieved allowing for a stronger set of data points. However, due to issues experienced with initial trials that led to lengthy product remediation time, the project was prevented from reaching the # of drops required for statistical significance on the product reliability. The results presented in this report explain a narrative that indicates the product was in development when the project started. With the remediations conducted during the life of the project, the product is showing improved performance in latter trials in comparison to earlier versions.

Technology Update Process and Technical Support

- Harvesters and project team members express concern over the maintenance required on the technology over time. Software upgrades are expected to be delivered as a part of typical software development lifecycles. The time and technical skills required by the crew to ensure the product is maintained is a concern.
- The time and steps to initially set up the electronics associated with the product is extensive for the average individual.
- The support model at Ashored and the expected cycle of software updates while the product is in early-commercialization stages need to be reviewed to understand whether the harvester technology skill concern is sufficiently addressed or is manageable.
- The composition of crews and their technology skillsets vary widely in the industry.
- Overall support for harvesters during the fishing season and at times when they require the contact with a support resource is a significant consideration. The support structure provided by an organization from an

initial training perspective through to technical maintenance when a harvester requires it is an area that requires considerable discussion to adopt and support harvesters in the new processes.

Adoption Considerations

Awareness of Other Harvester Gear

- There is significant concern over the changes in the awareness of another harvester's gear in the technology ecosystem on a fishing ground. The possibilities for gear conflict significantly increase without the visual of the buoy on the surface.
- Currently harvesters use sight and GPS, they see other harvester buoys on the surface. That will not be the case with the ROC system and could cause many fleets to become tangled; harvesters could set their gear over other fleets causing major problems. Knowing where other harvester gear sits in relation to where you are dropping is critical. Fishing in trawls creates the risk that another harvester could be running through another's line without knowing it. The strain on the rope during gear conflict can also lead to breakage and the risk of lost gear.
- The industry and technology suppliers are aware of this concern and in response is working to develop software to enable insight into the gear of others. The Ropeless Gear Consortium is one known organization working toward a resolution. It is recognized that this concept remains under development. Any software developed will need to include the capability of the software to recognize and work with gear from multiple ropeless gear vendors.
- Harvester feedback on the use of an industry wide software approach also included the importance of keeping data controlled; providing only the information needed to resolve the issue of gear identification.

Resources needed

- The composition of crew members is a factor in managing activities and steps needed for successful reset. One of the harvesters involved in this project have a crew of only two people including the captain. The size of the cage for mobilizing (especially the large cage) and the steps required on the electronic equipment pose a need for this harvester to expand the crew size. This adds extra cost to the harvester's operations.

Speed of locating the equipment

- Feedback from harvesters indicate concern with visibility of the buoy. In today's world, harvesters use larger, brighter buoys, highflyers well above the surface. Suggestions are that the color of the buoy should change to orange. With the size and color, they presently are, harvesters are reporting they would have trouble seeing the buoys on the surface to locate gear quickly. Harvesting in the nighttime would be especially concerning. A suggestion was made to add a beacon or flasher to the buoy. Further exploration into this area would be a benefit to adoption and part of a future project.
- Finding the system in bad weather, at night and in areas where currents are high are cited as concerns. It was even stated that the unit may not even surface in areas where there is a lot of current. In these areas at times, current and related drag will submerge large 50-inch buoys.
- The time spent locating the gear is a concern for cost as well – additional fuel and productivity during the time at sea are considerable factors.

Distance between Drop and Land

- The distance between drop and land is a factor of concern as well. There is concern over the movement/ drag distance from the drop to where it finally rests. Currently, gear is marked as it leaves the vessel and hit the water but not directly on the seabed. The software can range to the unit however, the location remains not exact. Further exploration into improving this capability is important for fishing with confidence in the extreme conditions and depths seen in Newfoundland and Labrador.

Space on vessel

- If the shape of the equipment is not able to stack well such as the case with the cage unit design and the crab pots, the space requirements on the vessel is a concern.
- Deck layouts vary widely and the amount of gear currently on the deck of vessels creates limited space for new equipment.

Financial Considerations

Cost of Unit

- The initial equipment cost is a significant investment for harvesters as is the cost of maintenance.
- There is a per unit equipment cost as well as software and tablets required.
- Should the product require a hull-mounted hydrophone, there is additional costs to installing that.
- Whether performance assessments show that there is a need for redundant equipment or not is also a factor affecting cost.
- There are several different products on the market. Some of the product designs require an investment of another piece of equipment attached to the deck of the vessel such as a spooler.
- The lobster fishery in Fortune Bay uses fleets of pots and the system works well with their setup and cost would be lower in the case of a fleet. The cost structure would not work well with many current lobster and cod pot fisheries in Newfoundland and Labrador that use single pots and having a ROC system on each pot would be cost-prohibitive.
- Cost of the system is always an important factor as most harvesters stated that to have at least two units on each fleet of pots, have the transducer mounted in the vessel, and buy the deck box and notepad/software, would run them between $20,000 and $50,000 depending on the fishery and the amount of gear each fishery uses.

Rope Change

- If the product requires more rope or a difference in the current roped owned by the harvester, additional costs will be required.

Redundant Equipment

- Reliability concern may spark the need for redundant equipment on deck. Feedback was received regarding the battery reliability performance as potentially creating a need for redundant/ extra equipment on deck. Should a unit be hauled onto the deck showing a low battery, the time required to charge the battery would significantly impede operations. Available sources and multiple charging connectors may also be useful.
- Further comments related to reliability and needing to charge more frequently, centered around the other apparatuses requiring charge to operate as well besides the MOBI units. The atlas tablet and the deck boxes both require charge as well. Depending on the weather and the vessel set up, there may be only one suitable area for charging these items and it may not be on the deck. Reliability of the equipment to operate in varied conditions through the fishing season would need to be proven to have confidence.

Additional Crew

- Aligned with previous stated above concerns, the weight of the gear and tasks associated with operating new gear will require a minimum number of crew and a varied skillset to troubleshoot issues and maintain the gear properly.
- This may lead harvesters to have additional resources and therefore increase costs.

Extra Time

- Extra time spent locating equipment, maintaining software, swapping out gear when battery runs low, etc. are all areas requiring time and resources.
- Harvesters also stated they do expect to be a little slower hauling the ROC system, but they said they would adjust quickly and were more concerned about packing the unit as the rope is being retrieved. If there is not a specific container to allow for 200+ FTM (365m) to be coiled into as it is coming off the hauler this would add a lot of time. The current fish pans that are on the vessel now are not large enough. Once the line is in the container, it can be dumped into the ROC quickly, and the system can be reset.

Fuel

- Concerns previous stated above may lead to the need for additional fuel. Potential for increase in fuel related to additional weight on board the vessel as well as the additional time spent locating units.

Remediation/Issues April 2022 to March 2023

Over the past 12 months, there have been many remediations to the ROC system by Ashored and eSonar. Many of the modifications were done on the MOBI unit. These changes were in response to water penetration issues that arose during testing. Issues with water penetration around charging leads, the traducer head, and through exposed wires for LEDs led to a complete rethink on how to assemble all electronics inside the epoxy mold. To Ashored's credit, they have been able to keep the design but have made sure all areas are now fully sealed and parts such as the LEDs are encased in the epoxy to eliminate the possibility of water penetration.

Communication between MOBI units, the deck box and the software were an issue at the earlier stages of testing. Firmware updates were completed on all units, and it was understood that many of these communications issues may have been caused by the water penetration issues and could not be fully dealt with until the water intrusion was solved. After remediations on the unit were complete communication between MOBI unit, deck box and software improved significantly. There are still some software concerns related to initializing MOBI units and having to reset between deployments. Ashored is aware the team experienced the need to reset during field testing.

A larger cage was constructed to allow for more rope when fishing for snow crab in deep water. The standard cage can only handle 365m of 7/16 rope. Snow crab fisheries in NL fish much deeper (500m) and use larger rope to help with this a larger cage was constructed that could hold up to 365m of 5/8-inch rope and 548m of ½ inch rope.

There were changes made to the release key to eliminate jamming during release. Issues earlier in testing contributed to failures and after completing flume tank testing and during testing in Conception Bay it was confirmed that the key would jam causing the ROC to fail. The new Key design has eliminated this issue.

Weighted rubber runners were also added to the ROC cages to give it a more stability on the seabed and to ensure it remains in contact with the seabed while deployed. The main reason for adding runners was that larger floats were added to the release roof section to ensure it stayed on the surface after release. This caused the cage system to be light when being set as the larger floats has significantly more buoyancy (three 8inch floats had 7.5 kg of buoyancy, while two 11inch floats had 14 kg of buoyancy). To counter this buoyancy weighted runners were added to the cage. These runners are used in current lobster fisheries.

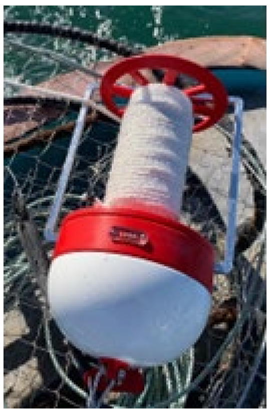
During the project changes were made to the key float. Issues with not having enough buoyancy to lift the key after release and with the float imploding at certain depths caused Ashored to look at additional options for a better key float. The final key float used has a buoyancy of 450 grams and has a depth rating of 600m.

After testing in late 2022 and early 2023 the MOBI units where the key attaches to the acoustic release developed rust. It was determined to be surface rust and may be coming off the key Ashored is aware and working on key remediations. Research completed during project identified a difference in magnet strength when the key is attached to the MOBI unit. Ashored supplied both unpainted and painted keys during testing. It was observed that if the key is not painted, it seemed to have a stronger hold than a painted key. This may be important in ensuring the cage does not prematurely release when setting the ROC system.

Additional Product Alternatives

In addition to our work with the technology provided by Ashored Inc., CCFI engaged several other companies involved in pursuing technology production in Whale Safe Gear Technology in North America. Meetings were held and presentations received on the technology of Devocean, Jasco and Guardian/Sub Sea Sonics. In addition, an in-person demonstration session at the Marine Institute Flume was held with Puget Buoy (based out of Seattle, Washington). The additional sessions provided significant insight to the CCFI project team of alternate Whale Safe Gear products currently on the North American market or still being commercialized. The outreach to these other suppliers helped build the body of knowledge with CCFI and our expertise in this field.

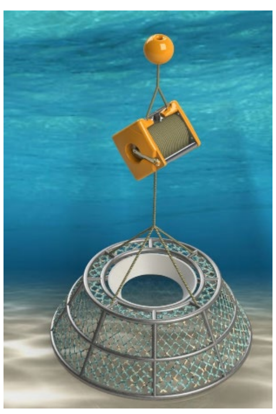
Puget Buoy



Puget Buoy is a US-based company with a product in the development and testing stages. Puget Buoy has developed a new type of pop-up buoy; one that prioritizes speed, durability, and space efficiency at a low economical price for commercial fishermen. A session was held with Puget Buoy at the Marine Institute. The product was trialed and observed in the flume tank and a productive discussion was held with respect to the conditions that the product would be required to operate in to meet the needs of the crab fishery in the water of Newfoundland and Labrador.

Puget Buoy's goal is to provide a product to the industry that is based around a spooler varying in size depending on the depth of the operation to encompass the rope type and length required. This product requires the harvester to acquire a custom spooling unit to be applied to the deck.

Devocean



Devocean is a Quebec based company in the beta stages of a ROC product. The system features a large spool design that floats above a regular crab pot. The use of the unit requires a custom spooler on the vessel deck to reset the rope before returning to the ocean. Devocean is undertaking an extensive testing effort this season, however, not targeted for Newfoundland and Labrador. Devocean expressed interested in furthering their work and discussions related to this province with CCFI.

Guardian Ropeless – Sub Sea Sonics Trawl Sled

Guardian and Sub Sea Sonics have partnered to bring a unit to market to benefit the whale safe gear issue. Their product, Guardian Sled, is a high-capacity line and buoy retention system that doubles as an end anchor for multi-trap trawls or groundlines. It has been successful in shallow water fisheries and starting to gain positive data in deeper water as well. The unique capability of this unit raises CCFI interest with respect to the snow crab industry as the shape is adaptable to the size/ shape that works best for the fishery it is being used in. The round version responds to the suggestions of snow crab harvesters in this project who suggested such a model would be more adoptive and integrate into current practices easier.

The reset process also appeared simplified. It is facilitated by having an empty cage ready to spool the rope into as it comes off the hauler. The float and netting are then secured on top, and the cam arm is reset again. The netting design and reset procedure aligns well to the skills and products that the fishers currently use/ have typical experience with. From that perspective, troubleshooting issues with the mechanical design and innovatively resolving those issues seemed reasonable using the tools, skills, and equipment fishers would typically have today.

Newfoundland and Labrador - unique set of conditions

The scope of activities under this project provided a unique perspective since prior to this project, extensive testing of ROC technology off the coast of Newfoundland and Labrador had not been initiated. Being the first of its kind in Newfoundland and Labrador waters provided an opportunity to test the ROC system in a wider range of conditions than companies and products had been familiar with. The breadth of testing and analysis conducted has resulted in the advancement of product development and recommendations for future applied research and testing.

Much of the existing body of knowledge relating to ROC technology has targeted the inshore lobster fishery in the Maritime Region of Atlantic Canada, with its shallow water depths. When analyzing current ROC technologies and applications, the attributes of the lobster fishery are vastly different from the crab and cod pot fisheries in Newfoundland and Labrador. As a result of the project's planning and research, it was apparent that there had been limited research conducted using ROC technology in deep water fisheries, and only a limited body of knowledge involving trawls the size that are typically used in Newfoundland and Labrador waters.

The diversity of the province's crab industry requires consideration to adapt the technology effectively. The Newfoundland and Labrador crab fishery involves multiple sized vessels, multiple zones, and multiple water depths, leading to a range of distances from shore, and varied environmental factors.

Future Research

The main objective of this project was to trial a single product line from Ashored Innovations Inc. and to gain insight into the critical success factors around adopting the gear into the harvester's fishing operation. The results of this project have led the project team to propose additional research and development into the following areas. Investment in learning more about product capabilities and exploring adaptations further with harvesters will be critical to the successful adoption of rope on command technology in the commercial fishery and protection of the Right Whale and other marine mammals endangered by the vertical line fishery.

Further research and investment consideration are proposed for the following areas:

- **Battery life improvement / research** – An increased understanding of battery reliability in the existing products in the marketplace as it relates to all parts of the equipment and accessories required. This research should be conducted in extreme conditions including severely cold-water temperatures as well as increased depths over extended period fishing and repeated use during fishing season. As well as research into improved battery designs and capabilities would be advantageous to reliability and confidence goals.

- **Hydrophone/ transducer** – the current approach to transducer use is not conducive to a long-term sustainable strategy for ROC use by the harvester. As a temporary basis, the Ashored solution uses a hydrophone attached to the cable that is placed into the water when approaching the harvesting area. It can be strengthened by attaching it to a pole, however the robustness of the current hydrophone provides a risk to the operation and is an area that requires future exploration of options. As was experienced in testing, manually maneuvering the hydrophone can create an environment that is unsuitable to protect the unit and does not fit well with the fishing operations placing it at risk of breaking. The type of cable used and the encasement it is contained in requires some care taken in handling. Further research into options available for harvesters would create a benefit and reduce a barrier to adoption. While a long-term solution is a hull-mounted hydrophone, it requires an investment on the part of the harvester to build that into their vessel for permanent use or a temporary attachment process. A harvester may benefit from being able to trial the gear from a particular vendor for a period / a season or two before making that decision. The hydrophone used is product specific. Having insight into options that enable the harvester to trial gear of different types successfully without risk would be an advantage to the harvester technology adoption process.

- **Buoy and Beacon work** – Research into options to increase visibility on the surface (during daytime, swells and night-based operations) is crucial to adoption of technology. Further exploration of the variable density buoy is proposed and how that may be an option to assist in the relationship between cage weight required to keep unit on seabed and the buoyancy required to bring the unit to the surface. Beacons attached to units that indicate the exact resting point of the cage and improve visibility would be an essential area to research to alleviate the concerns of harvesters of the identification of gear in the nighttime and various other environmental conditions.

- **Cage design / development** – Working with vendors to develop an ROC cage design that replicates a crab pot that facilitates greater integration of the technology in the crab fishery. This would reduce space on the vessel and has the potential to drive costs down.

- **Reliability testing on this product and others on the market** - Adoption efforts will be smoother if the product is proven by being supported with scientific and statistically significant evidence. Additional durability and reliability testing over a longer time span in season is required to provide confidence in functionality and adaption over a season of harvesting. Product reliability testing involves determining and executing on several repetitions as required to obtain evidence that is considered statistically significant by scientific calculation. The number of repetitions that occurred during this project would not be concluded as statistically significant in scientific terms. Additional testing needed to obtain this level of results for analysis. More repetitions at these depths would provide further insight for decision making.

- **Products Comparisons** – In-depth product comparisons with harvesters on the options available in the market would drive the understanding and technical knowledge forward significantly. Due to the uniqueness of the NL waters and deep-water crab fishery, a project that provides comparison data is important to enable decisions to be made. There have not been any significant body of knowledge in deep waters in the conditions experienced off the coast of this province. As the project team was able to research other products, there are some attributes of other products and companies that peak the interest and speak to some of the concern raised as well. The purchase decisions facing the industry and harvesters is significant investment and they need a resource that know the pros/ cons of these products for the conditions in which they specifically operate. The harvesters and DFO need reliable information to make effective decisions. Awareness of the various products as well as how they interact with the ropeless gear consortium software as it develops will also be crucial to reducing the risks of gear conflict.

- **Support Structure** – It is recognized that new processes and equipment requires support for those who are adopting it. Investigation into the appropriate and effective support structure to help with equipment adoption, training, troubleshooting is necessary for ease of adoption. As seen in Nova Scotia, there are benefits to having an independent organization that harvesters can approach for assistance in learning which gear to use/ purchase for their operation, how to obtain it, and how to maintain it. The support organizations of the companies providing this equipment in the marketplace vary. CCFI with its experience now in ROC and relationships built with industry would look to play this role in NL and int Atlantic Canada if required.

- CCFI would propose an additional project with identified harvesters involving a pilot project of a small number of harvesters in both the inshore and offshore crab fishery in NL. The pilot would test a limited number of ROC technologies, including Ashored, during the annual crab fishing season. Technology would only we used on limited number of fleets of crab pots aboard harvester vessel but would be incorporated into a normal fishing trip with the deployment and retrieval enshrined in the normal operations of the season. This project would provide invaluable feedback from harvesters as well as educating those involved in the technology and the adoption of that technology in future fishing seasons.

This activity is complete.

Year 2 – Activity – Final Report Preparation

The project team documented the results and outcomes of the project. The intention of the report as specified in the contribution agreement is to collect feedback and observe harvesters use of the new ROC fishing system operated in different vessel size in both an inshore and offshore marine environment. The report documents the results from both a product development stage to a harvester and vessel operations stage. The feedback from harvester trials and experience with systems, further supported with operational feedback and implementation realities supports the projects intent of direct engagement with industry in creating and sustaining dialogue on the important technology adoption discussion. Pre-harvester trials were greatly supported with the pre-trial sessions within the Marine Institute & Holyrood CTec facilities. Observations on ease of use, functionality, benefits and limitation encountered were documented. The report also accounts limitations encountered and provides recommendations for future work, and advice for further adoption across Newfoundland and Labrador and Atlantic Canada.

Key areas included in the report are as follows:

- Link with the objectives of the Whalesafe Gear Adoption Program, alignment with the DFO contribution agreement and environmental considerations
- Product overview - types of products available in the market, structure of the equipment, operating considerations with respect to the equipment
- Review of Technology partners, Institutional partners, Project team and other Stakeholders engaged
- Fisheries targeted including the significance of Newfoundland and Labrador conditions and unique aspects
- Planning process and trial methodology
- Video and camera work inventory
- Trial testing results and analysis related institutional, pre-commercial field testing, commercial (harvester) testing results – including data compilation, narrative and graphical presentation
- Harvester qualitative feedback process and results
- Product remediations
- Recommendations
- Partnerships

Tasks carried out as outlined in the contribution agreement for this activity included:

- Analysis conducted on the data collected
- Preparation of the final report
- Meetings held with technology partners and the harvesters involved in the project
    - Main topics at the partners final meeting included a review of the methodology used for project, testing and trial processes, results, feedback from harvesters, planned product enhancements and recommendations for future exploration/projects
- Consultation with DFO to provide updates

This activity is complete.

Project benefits

Results for the Fiscal Year

In the original Contribution Agreement: Section 1.3 of Schedule 5, it was stated:

"….anticipated that the results of this project would determine that by using acoustic telemetry technology, it will be possible to fish for crab and lobster using traps without having a tethered surface float during trap soak times, thus reducing significantly the risk of whale entanglement".

CCFI worked with the primary technology partners (Ashored Inc/eSonar) to develop, enhance and support a Canadian manufactured technology that was tested at a repetitive level of performance in water depth up to 300 metres in the Atlantic Ocean Fishery. As Project Manager CCFI with its partners and harvesters in both the crab and lobster fisheries, established that under an experimental licence testing project, the final performance and reliability of the ROC tested does support the likelihood that with continued development and engagement with harvesters, a system can be developed to meet the needs of industry and regulators to protect the marine environment and support successful commercial fisheries.

The project supported a stable testing product and executed significant institutional testing, pre-commercial testing, and commercial harvester testing to meet the project outcomes. The results of the project activities indicate that there are viable products entering the marketplace that, with adaptations and remediations based on each fishery, could with continuous development make it possible to perform fish harvesting without having a tethered rope to the surface. It is recognized that comprehensive and continued efforts are required to gain a system and process that works well for all the fisheries conducted within the province of Newfoundland and Labrador, on the east coast, and in the gulf region and specifically in water depth exceeding 300 metres and up to 500 metre depth.

This project was instrumental in bringing to the forefront the significance of the different variables and uniqueness in the snow crab fishery in Newfoundland and Labrador how current technology to date has not functioned at the maximum depths needed. The offshore snow crab operation requires unique product features and adaptations that are distinct from the requirements of shallow water lobster fisheries often seen in the Maritime region of Canada. The depth or water and the environmental conditions in which harvesters operate provide a new set of conditions for DFO and product developers to address. It is hoped that with this knowledge, DFO, product developers and harvesters will be assisted in bringing an effective solution to the industry.

Also as stated in section 1.3, the project was intent on:

"…introducing the technology to numerous NL harvesters before a commercial trial will familiarize harvesters with the gear and provide a chance for feedback, allow for modifications (gear and/or deployment/handing methods) based on that feedback that will make easier the adoption of the technology into existing fishing activities on a commercial scale."

This goal was achieved through effective collaboration with more the 30 harvesters, in a variety of fisheries and locations, throughout the project period.

Commercial fish harvesters in the crab, lobster and cod fishery:

- Interacted with technology developers and CCFI project team
- Educated and informed of gear intent and operations in a stress free and supportive training environment
- Provided initial feed back at project start on why technology as presented may or may not work with technology developers. This was invaluable information for Ashored/eSonar
- Understand and discuss the intent of technology, why important and ask questions
- Secured an open, frank, open relationship with developers
- To be trained on the product with the innovators and fabricators and influence further development in real time
- Ability to operate the Ashored/ESonar technology on their own vessels, on familiar fishing grounds, with their own gear, and supported by project team and technicians from both technology companies
- Ability to gather the group together for feedback sessions and to ensure each enterprise owner and crewmember had the opportunity to participate in an individual feedback session as well as in a group atmosphere
- Ability to bring fish harvester and technology innovators together
- Each harvester enterprise received a complete MOBI – Unit at completion of project to allow continued familiarity with technology and continue dialogue with manufacturer Ashored Inc. and eSonar in future product development

CCFI also understood the benefit of ensuring a cross section of harvesters were involved (i.e. representing crab, cod, lobster fisheries, various vessel and crew sizes, inshore and offshore operations in a number of areas of province). CCFI brokered the feedback from harvesters to the primary technology suppliers to strengthen the product. Engagements between vendors and suppliers directly were facilitated by CCFI. These activities produced positive results evident in the product remediations made during the project timeline as well as in the planned research and development of the product in the future. There is now a strong base of working relationships with CCFI, technology developers, FFAW and harvesters, that bodes well for future activity and working together.

Final reporting on methodology and partnerships

Methodology
Considering the methodology used to achieve the project Activities, provide details on the challenges with, and successes of the key methods and techniques implemented during your project (complete only if the project involves on-the-ground work).

The project methodology involved cultivating significant partnerships with a variety of stakeholders across the industry. Facilitating conversations and collaborating with organizations and individuals led to the project successes described in the final report and furthered the objectives of the Whale Safe Gear Program.

Relationships have been built with harvesters, multiple vendors, FFAW, suppliers, skilled resources, and other research organizations and institutions. The project has excelled by all stakeholders coming together. CCFI received a positive reception and high level of interest from harvesters showing interest in the project. It is expected the key messages of the project shared with all team members and the team's complete understanding of the value of relationships was helpful to harvester engagement.

Secondly, project methodology that could react to change was a success factor. Having a project team that can adapt and respond to altered timelines and strategies was key to this project due to the challenges posed by Ashored's product development and remediation schedule. Though a planning exercise was completed in the initial phase of the project, the plan was regularly altered.

Thirdly, the project recognized the value of information. The project was guided by the goal of building a comprehensive body of knowledge which is evident in the depth of information provided in the final report. The team went outside the original scope of technology and explored other technology type to heighten understanding on what was on the market and share that knowledge with all project team and harvesters. This proved to be in valuable as well.

Fourthly, meeting regularly with DFO provided feedback that enabled the team to confirm the project was on the expected path.

Initial challenge of project was the reluctance for the harvester's union organization to be engaged in the research. While this never inhibited CCFI ability to recruit harvesters there was some initial negativity which today has fully dissipated due to the CCFI project team and harvesters who participated.

Ongoing challenges felt by the project team included the high degree of remediations required in the first year of the project and an extended development period to gain a dependable product for testing that we could confidently place in front of harvesters with a degree of predictability.

Institutional testing capability proved essential with the extended development as we could carry on land testing before having to engage harvesters for trials, allowing a comfort level for successful trials with harvesters.

CCFI had to refine original methodology to meet some of the challenges related to early units that had failed in various testing streams.

Due to the remediation cycle, there was risk to gaining a sufficient body of knowledge in a limited amount of time. Given factors such as weather and resourcing, it was recognized that a higher amount of time would be spent in planning discissions, coordinating, and reaching decisions than originally expected.

Table 6.2: Project partnerships
Provide details on the creation of new/existing collaborations and partnerships with external groups.

Partnerships

This project has pulled together the collective expertise and resources of a significant set of stakeholders in producing the body of knowledge and intelligence gained. All stakeholders consulted with have been positive, eager to share knowledge and are highly engaged in finding resolutions to the challenges being faced. The increased awareness has been valuable to the community and industry. CCFI recognizes the attitude, insight, and significant contribution of the following partners:

Project Team	Partnerships	Technology Partners	Harvesters and Harvester Groups	Suppliers	Consultation
Keith Hutchings Janet Kielly Sean MacNeil Jason Card - Dockridge Digital Inc: Annette White WSS Inc Professional Services: Philip Walsh Philip Walsh Jr. Eamonn Casey - Kevin O'Brien CTec CSAR - Mark Santos	Barry Peters, Regional Manager, Resource Management, DFO Jackie Kean, Resource Manager, Resource Management, DFO Connie-Dobbin Vincent, Resource Management Officer, Resource Management and Indigenous Fisheries, DFO Andrea Morden, Acting Manager, Gear modifications and Whale-safe Gear Adoption Fund, DFO Edward A. Trippel, National Programs, Fisheries Resource Management, DFO Hillary Wainwright and Catherine Merriman of the Whalesafe Gear Adoption Fund – Fisheries Resource Management Paul Winger - CSAR Kevin O'Brien - CTec - MI Craig Hollett - CSAR - MI QiKiqtaaluk Corporation	Ashored Aaron Stevenson Ross Arsenault Stephen Jones Guillaume Demers eSonar Gary Dinn Corey Parsons Matthew Dinn Technology Consultation: Jasco Puget-Buoy Devocean Guardian Sub Sea Sonics	Harvesters and Crew: Patrick O'Leary Doug Howlett Glen Best Jerry Best Doug Trainor Bernard Chafe Damien Stratton Jason Matthews Related crew Fisheries Food and Allied Workers (FFAW) Petty Harbour Fishermen's Co-op	Hampidjan Limited Enterprise Metro Self Storage Vonin	Canadian Wildlife Federation (CWF) Whale Consortium Sustainable Seas

There were numerous new collaborations and partnerships developed on the project.

Identified new resource partners to staff the project with the required skillsets including Dockridge Digital and WSS Services Inc. The inclusion of WSS services Inc. in the resourcing plan enabled CCFI to distribute resource reliance across MI and private industry to maintain an acceptable risk level.

DFO - CCFI became exposed to new resources and divisions with DFO as well both locally and nationally expertise and knowledge that exists.

New collaborations included relationship with new technology vendors in Canada and the US as well as other not for profit and NGO'S, research and academic, other organizations with similar goal including World Wildlife Federation and Ropeless Gear Consortium.

Built on Memorial/Marine Institute with increased engagement related to: MI based (CTec, CSAR, Technical Services), FFAW, Petty Harbour co-op, Ashored and eSonar, and other technology companies developing products in this area.

From a community outreach perspective, CCFI procured supplies through a number of existing and new supplier relationships. Seeking products using the three-quote method provided suppliers in the province with an opportunity to participate in the project.

The partnership with harvesters continues through the gear distributed by the project. The project team has supplied participating harvesters with gear and contact information to Ashored for support, questions and maintenance. Ashored also has information on the harvesters to keep account of potential use of their systems. Images of gear distribution activities are below with Jason Matthews with CCFI project team representative Phil Walsh; Doug Howlett and Doug Trainor.