

Atlantic Large Whale Take Reduction Team Ropeless Subgroup Feasibility Matrix:
Questions and Answers to be considered in rulemaking effort

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Author’s Note

In the interest of hastening the continued progress of ropeless fishing, in November of 2018, eight companies that have either a mature product or are actively developing ropeless technologies formed an informal working group after the Ropeless Consortium meeting through which they collaborate and share data through a central researcher. The author and Fulbright student, affiliated with the University of Connecticut, the University of St. Andrews, and the Marine Institute, has functioned as a liaison for information gathering to answer many of the questions posed by the Atlantic Large Whale Take Reduction team. That data can be viewed in the full version of this document, available online [here](#).

The opinions, calculations, and summary points are those of the author, only, but were the result of conversations, data sharing, and collaboration with many of the above listed parties. Several of the above mentioned parties were directly quoted in this report and are being listed as coauthors or collaborators.

Request

My request to the ALWTRT would be to ensure that the continued development and support of the following named ropeless technologies be included in the rulemaking process.

¹ This document was updated 12 DEC 2020 with additional input from David Capotosto and Dr. Harold “ Bud” Vincent, Ropeless Systems, Inc. (abbreviated as RSI in our responses to questions).

Ropeless gear use has a long history, primarily for use as scientific device recovery tool prior to being modified for potential use in fisheries applications. (Baumgartner et al., 2018.; Werner, 2015; Lent, 2017; Moore, 2018) These innovative approaches to endline management allow for the lowered risk of bycatch and entanglements of critically endangered species. Due the innate differences of individual fisheries, *it is well accepted that there will likely not exist one perfect ropeless technology that will address all of the individual needs of all fisheries.* It is imperative that a better understanding of the benefits and potential gains be shared if technology such as this is to be affordable and accepted for widespread use for pot/trap fisheries, thus making adoption a more timely and feasible goal.

As with any proposed change to fishing technique or technology, there has historically been a period of resistance, research, and adjustment. This period has been unusually long for ropeless gear, and thus far, much of the discourse between management and industry partners has been laden with unanswered hypothetical queries regarding functionality and implementation. (NOAA, 2018) Valid concerns provided by fishers with decades of harvesting experience have not been reasonably resolved with the limited testing, funding, and reporting that has been completed by environmental non-government organizations or regulatory fisheries partners. To ensure the continued success of a co-management approach to fisheries practices, priority needs to be given to further this testing.

Additionally, the expectation of objective data, which can only be gathered through true proficiency with equipment and preparation for gear testing has not been realized with these past efforts, nor with the multitude of various public demonstrations. As these concerns have stymied the forward progress of further advancement and support, it seems imperative to move forward with these systems in a supported, immersive, and timely fashion. With the population of several endangered marine species prone to entanglement continuing to struggle, this data will serve to provide the vital information management leaders need to determine the future course of these technologies, and the laws and regulations that govern current fisheries practices.

Q and A Feasibility Matrix

This document serves as a response to the Large Whale Take Reduction Committee's questions regarding Ropeless Fishing systems. Subgroup members were asked to articulate feasibility concerns and to identify further research needed. They were also asked to identify whether the feasibility consideration represents a big, medium, or small challenge.

Directions to respondents:

Please enter any comments you have below each description of concern if it applies to your technology:

1. Target Catch Retention

The current baseline fishing method percent of the small concern to take reduction team members with regard to target catch retention. The lift bag and acoustic release system was of great concern as they felt it may cause trap movement and lobsters to shy away. The bottom stowed bag presented a small amount of concern; as long as the system is balanced anything tied to the trap is a problem for fisherman.

There is no evidence that exists to date that supports these concerns. Lobsters have tremendously poor vision and navigate primarily by scent. With all the gears being stored and transported with the same gear currently used, and in the same environment, it seems unlikely that these innovative gears would "smell" any different to a lobster. This is an area where more research can be completed.

EdgeTech- The target catch retention will not be affected in any way as the Release system acts just as if it was just the last trap in a trawl. The weight of the release cage can be adjusted by the fisher based on the currents he anticipates without affecting the release systems functionality.

LobsterLift- Would have to see data showing to verify anything like that. The lift bag system like LobsterLift would be similar in size overall to the bottom stowed bag.

Fiomarine- The Fiobuoy can have the attachment line adjusted to limit visual influence on the target species. In a longline operation the first trap is the only trap with the pop-up buoy. Once the Fiobuoy has surfaced recovery operations are the same as traditional gear, reloading is accomplished by a rapid spooling winch located under the power block.

Longsoaker- The Longsoaker innovation is a retrofit for regular traps. Traditional buoy line is coiled in a standard fashion then placed on top of the trap with the buoy securely placed at the center of the coil. The buoy acts to keep the coil orderly until deployment to prevent fouling. While the trap falls to the bottom, the buoy ensures the trap lands bottom side down. While the line and buoy await deployment to the surface, it is contained within the net apparatus and seafloor entanglement extremely unlikely or impossible. Line and buoy are held tightly so there

is no movement in the current that may cause lobsters to shy away. Required buoy size would be variable based on the required flotation in a given area.

Desert Star- Desert Star's ARC Ropeless Fishing System relies on a stowed release bag containing the fisher's standard (and in many cases extended) rope length. This bag may float slightly above the trap or be stowed on the sea-floor (depending on local area fishing regulations). The release mechanism is a patented fusible link which works in the matter of fractions of a second. Given these conditions, catch retention is not in any way affected by Desert Star's system.

Ashored – The rope containment cage floats a few feet (depending on regulation and fisher discretion) above the last trap (or anchor in some trawl setups). It has no effect on the appearance or functional aspects of the trap in use. Visual or turbulent interference is not perceived to be an issue at this time.

RSI - We do not expect any change in catch retention. In deep water, our system sits in a separate anchor-type configuration and will be many feet for the first pot. In shallower waters, our system is mounted beside the trap and should not interfere in the catch process.

2. Large Whale Entanglement (Short and Long Term)

When asked about large whale entanglement, on both a short and long term basis, the current fishing method was stated to possess a lack of information on location, source and cause of entanglements. Further understanding on distribution, habitat use of right whales and how this overlaps with fisheries would be necessary. Short term whale entanglement with the use of Lift Bag was said to be of medium concern, while long term large whale entanglement was said to be of large concern. With use of the Bottom stowed Bag method, large whale entanglement on a short term basis was of big concern due to the following reasons: inability to locate and retrieve gear, lack of implementation, unavailable technology, and the method not being scalable for commercial fisheries.

LobsterLift- The use of LobsterLift with regards to potential future entanglement is yet to be seen but given the information we know about our system and other ropeless systems, there should be a large reduction in entanglements, as this is what our devices are targeted at reducing.

Ashored – Our MOBI release system removes the rope from the vertical water column until arrival and command from the vessel. Allowing whales to pass freely. Range testing is currently being measured given various depths (cone coverage), tides (angle changes), etc. Initial results are consistent with existing acoustic communication systems (i.e. kilometers).

Fiomarine- The Fiobuoy is readily locatable through an acoustic link at a range of up to 1km, this range can be adjusted. There are no entanglement issues as the vertical line is no longer in the water column. The technology is mature, fully implemented, and in numerous marine sector; defense, oceanographic research, and offshore oil and gas. The Fiobuoy is scalable for commercial fisheries and can be configured for different operational requirements.

Desert Star- The ARC Ropeless Fishing System provides a lack of vertical rope in the water column unless a fisher is physically present. Therefore, whale entanglement is next to

impossible.

EdgeTech- The 5112 ropeless fishing system will not entangle whales. The rope will stay stored on the bottom until released by the fisher after the fisher has confirmed there are no whales in the area. Initially the gear is located, and the position recorded in a data base and on a chart. If the gear is moved by currents or mobile gear fishers it can be relocated using the release range transponder. Ranges of over 2000 meters are expected. This technology has been in use and commercially available for over 30 years with tens of thousands of units sold. The 5112 ropeless fishing system is scalable whereas the acoustic technology is the heart of the system that can be integrated into any size bottom equipment.

Longsoaker- Our innovation uses traditional buoy lines and coiling techniques. When the line is coiled in a reasonably orderly fashion, the chance of the buoy not reaching the surface is minimal. The trap would land on the sea floor at the same point it was deployed from the vessel with adjustments for current drift. Using vessel GPS, locating the gear for recovery should be easy when current is figured in. The trap does not float to the surface using a lift bag. Instead it is hauled by normal deck gear in a traditional fashion. The Galvanic Timed Release (GTR) method of buoy trigger is a readily available technology. Both the GTRs and the retrofit innovation are highly scalable for commercial fisheries with a price point that maintains the viability of commercial fisheries.

RSI - In terms of the solutions available, the lift bag system we propose has the least amount of potential risk. There are no vertical lines even during the recovery process, except ground lines between traps in a trawl.

3. Operational Feasibility with Regard to Relative Safety

There was small concern to relative safety of operational feasibility using the current fishing method. With the Lift Bag method, there was large concern over the use of Single Lift Bag using a lifting trap. There was small concern over the use of the Trawl Lift Bag using the lift buoy and line. There was medium concern with consideration to the Bottom stowed Bag due to the number of unknown factors it could present, such as bag stowage and if it requires a more careful process to deploy, thought it would likely be no more dangerous to haul than the current method. There was also big concern about this method and the possibility of gear being set over each other, as well as deploying in rough weather.

EdgeTech- The EdgeTech RFS is deployed and recovered like any other trap and buoy marker. Gear location is recorded and displayed for anyone using the Trap Tracker app. The EdgeTech RFS does not use a bag, the rope is stored in a modified lobster trap, so it is no more dangerous than if it was a standard lobster trap being deployed and recovered. Re-arming of the system can be accomplished using one hand and no tools. Gear location for both single traps and trawls is recorded in the EdgeTech Trap Tracker application and saved real-time (cell device required for real-time) so that anyone with the Traptracker app can see where other fishers traps are located with just as much accuracy if not more than a buoy at the surface that would have some positional inaccuracy based on the scope of the buoy line and depth of water

Fiomarine- There is no change to current operations for setting or recovering gear, no weather

restrictions. The digital marking of gear through a shared application will provide location information on all deployed gear to fishers and enforcement.

LobsterLift- Inflatable bag systems that bring traps to the surface would reduce the usage of power winch systems, which would make the deck environment safer. Acoustic triangulation can be used to determine the location of already laid ropeless traps, to prevent gear being set over each other.

Desert Star- The ARC Ropeless System has a 6-year field history of use in a commercial setting, plus four pilot projects with real gear deployments. No additional safety hazard has ever been noted. In fact, future versions of the ARC plan to incorporate a safety switch in the case of a crew member becoming tangled in gear which is being deployed. This switch will allow the release bag to open, preventing the fisher from being pulled under with the gear. Additionally, no special deployment or caution steps are needed when deploying the release bag, it simply slides off the boat with the rest of the standard operating gear.

Longsoaker- The Longsoaker retrofit uses standard buoy line and hard floats. Both of which are securely stored on top of the trap until deployment. Upon deployment, the buoy pulls the line to the surface for retrieval. The GTR triggers are extremely reliable and not prone to failure. Once buoy surfaces, the trap is hauled in the traditional manner using standard deck gear. Tests of the innovation at 200 ft depths resulted in deployment as expected. Since the buoy is not visible on the surface until triggered, chances of setting on top of another does exist however the risk of entanglement with another would be mitigated by the fact the buoy lines and floats may not be deployed at the same time.

Ashored – The notion that all gear being deployed is now going directly to bottom is an issue Ashored has been concerned about since we began development of MOBI. If a crew member becomes tangled in a line during deployment (i.e. mid-way through launching a trawl), it would now be much more difficult to grab the buoy or the end of the line and throw it into the hauler before it sinks to bottom (previously they would always have something floating). We have had fishers reach out citing instances where this previously possible method of retrieval (although tough to implement at the time) has actually been used successfully to recover an entangled crew member. In ropeless fishing with trawl (the more financially viable method) we believe safety protocol must be in place. An emergency release trigger (incorporated into MOBI) to tell the buoy to pop immediately could save some time but may not release fast enough or could already have to be in the water to hear the command. Therefore, we are in development of a simple anti-launch system that the end of the trawl clips into when launching. If no issues arise, it launches normally, however, in the event of an emergency it can retain the end of the trawl onboard the vessel.

RSI - Relatively speaking there should be no greater change in safety hauling our lift bag system. There may be some improvement due to less line being handled in the process. On deck there will be some additional safety measures related to handling compressed gas cylinders. Additionally, the lifting methods and technology we employ are similar to that used by military divers to retrieve explosive ordnance safely to the surface without use of lifting lines.

4. Operational Feasibility with Regard to Gear Conflict

There was small to medium concern about the current method, which requires regional knowledge and history work between fixed gear and mobile fishermen. There was medium concern about the Single Lift Bag Method, as there is no way to locate gear without location technology. There was large concern about the Trawl Lift Bag for the same reason. There was big concern over use of the Bottom stowed Bag Method due to the large differences between many types of fishers, and dependence on gear density.

The current methods used in community-based fisheries consist of utilization of local informal “agreements” between fishermen, setting of gear strings in densely fished areas in similar directional configurations to avoid overlayment (i.e. North to South, or East to West), and cooperation between mobile and fixed-gear fishers on the regional level. While the use of visible surface buoys is helpful for identifying potential trawls for avoidance purposes, they are also used for local self-policing by fishermen and present a real threat to propellers and must be avoided at all costs. This becomes incredibly difficult to do in densely fished areas. They can certainly be replaced by virtual gear marking, which is generally how set traps are marked now on a multifunction display or chart plotter. (Greenlaw, 2002; Ludwig *et al.*, 2012)

LobsterLift- Deployed ropeless traps can be entered in a database, updated daily, allowing fishers and regulators to know where traps are to minimize the chances of gear conflict.

EdgeTech- Our RFS uses a bottom stowed rope and floats. It makes no difference to anyone what differences there are between fishers any more than in matters now. All fishers Fixed and Mobile can see the location of single traps and trawls marked on the Trap Tracker app just as they would a buoy marker on the surface. I think that the possibility of setting over other fisher’s gear is less that when using ropes and buoys at the surface.

Fiomarine- All fishers in a region regardless of the fishery will need to use a cloud-based gear location database. This is not difficult.

Longsoaker- Conflict between ropeless gear and other fisheries is likely to be an issue in some areas due to the fact there is no surface buoy most of the time. Fishery managers and fishers will likely need to work together amongst themselves to find a solution no matter which solution is selected.

Desert Star- Desert Star currently offers a free smart phone app called ‘Ropeless Fisher’. This app allows any and all fishers to view gear locations within pre-set visibility radii. Regulators may also view any trap from any distance. The app’s capabilities will also be expanded in a future update called ‘Ropeless Control’, which incorporates nearly all software needed to operate the ARC. This version will also hook into a widely used location marking system called VMS through the Iridium satellite constellation. This capability will allow all fishers and regulators (mobile gear fishers as well) to view trap locations no matter the distance from shore. VMS has also proven to be robust in the sense that fishers cannot use location spoofing tricks or other work arounds for false reporting under VMS. Finally, gear conflict therefore more remains in the hands of fishers and their willingness to incorporate new technology, rather than a lack of a solution.

Ashored – We have created a piece of software called ATLAS that automatically (totally hands free) records when traps and trawls are onboard and not-onboard the vessel. This data is synced with GPS info and time stamped, uploaded to a cloud server, processed live, and our dynamic

map automatically reports where gear is set at all times. Fishers can view traps and trawl strings around them either through a mobile platform or point-plotting right into existing onboard equipment (OLEX, MAXSEA, etc). This info is only obtainable by ping request when on location and can be connected via cell phone or Iridium.

RSI - Resolution of gear conflict is one of the major benefits of our solution in that we allow for real time, in situ gear *location*, as opposed to a historical estimate by *reporting* of last known surface position. As such, fishers will be able to “see” gear on their chartplotter in real time at the fishing location. The real time continuous locating and chartplotter display is performed automatically, hands free, much like a depth sounder automatically measures and displays depth information. Visibility might actually be improved over existing methods especially where long trawls are involved and during inclement weather.

5. Operational Feasibility with Regard to Gear Loss

There was small concern over the current fishing method. There was large concern over the use of Single Lift Bag method and the buoyancy of the flotation bag, and only medium concern over the Trawl Lift Bag as the weight of the trawl helps with the buoyancy issue. There was medium to big concern over the Bottom stowed Bag method as there is existing loss, and no resolution to modern and mobile gear loss. If the system fails, storm loss would be a major factor, with the potential to foul the system and render it inoperable.

EdgeTech- Our RFS acoustic technology uses a transponding release which means it can be relocated using the deck control unit. The range of the transponder is more than 2000 meters slant range. If the system was fouled in some way such as being dragged by currents or a mobile gear fisher, the RFS release can be relocated and if necessary grappled for.

Longsoaker- Storm fouling of the Longsoaker retrofit would be fairly unlikely due to the line and buoy being protected on top of the trap with nothing to become snagged or snarled while it awaits trigger. In some cases, the lack of surface buoy may make storm damage less likely. Like traditional gear, should the gear become completely buried there would be a problem.

LobsterLift- If gear is lost, a boat that is equipped with an acoustic triangulation device can go to its last known location and pinpoint its location for retrieval.

Desert Star- Fishers using trawls may opt to cover both ends with an ARC and release bag system. This provides a fail-safe in the case of one end not working. If a fisher chooses to use one system, or is fishing singles, gear locations are also recorded in the Ropeless Fisher App. Further, a future update will incorporate setting drift, or the drift in gear as it settles onto the sea floor. This will further help fishers identify where gear ought to be and may include cases of extreme weather. Next, the ARC-1XD comes with a reply capability and may be used to find ranging information. For instance, a fisher may send out a message asking ARC XX to identify where it is. This results in a distance from the boat to the ARC and will allow the fisher to navigate closer. Finally, in a future firmware update, ARC's will have a public code which allows other passing boats to ping and record locations of another fisher's gear. This code cannot release gear but will better inform the community if gear has drifted.

Fiomarine- Fiobuoy will reduce gear loss since the gear is located acoustically at a range of up to

1 kilometer. There is no bag to fail and the line is cleanly managed on the spool.

RSI - Gear loss is addressed in a number of ways. As mentioned above, gear can be found with the technology without the vessel having to perform maneuvers for surveying. And if the gear has moved, within a reasonable distance, it can be found as the ship is travelling. The lost gear could also be reported to authorities or other fishermen and the location reported if found. Once found, it can be recovered by initiating the inflation sequence or by grappling. Secondly, the proposed system for trawling has a recovery unit at either end, allowing for some redundancy. Thirdly, an integrated timer can be set to initiate recovery at a particular day/time.

6. Operational Feasibility with Regard to Limitations in Spatial Positioning Technology and Variability between Boats

There was small concern over the Current Method. There was big concern over the Lift Bag Method, as gear cannot be located without acoustics. There was medium to big concern over the Bottom stowed Bag Method due to the inherent differences in GPS and varying ability to execute technology among fleets. If doing singles, this would reduce the problem, but could still be an issue in high-density areas.

EdgeTech- The EdgeTech RFS Trap Tracker app stores trap and trawl positions real-time in a Cloud data base. Any fisher or enforcement with the Trap Tracer app can virtually see all traps in a 5 mile radius while on site. Modern GPS systems use WAS GPS at a minimum which is accurate to within 3 meters. The current method of relying on buoys to mark gear assumes that the lobster pots are directly below the buoy which will not be the case considering the scope of the buoy line and the wind or currents affecting where the buoy is positioned.

LobsterLift- To mitigate this issue, ropeless gear manufacturers can work together on a consistent communication interface, that allows for needing only one device to communicate with and locate deployed traps from all ropeless gear manufacturers.

Fiomarine- The Fiobuoy is an acoustic system with two failsafe release backups; a programmable time/date trigger and a low battery trigger. GPS is accurate, not sure what the inherent differences are.

Longsoaker- Location of the gear would be done by using GPS marks when the gear is set. The gear would be in the same spot, with current drift on the way to bottom considered.

Desert Star- This refers back to #2, and #3. With the Ropeless Fisher app and future updates, boat positioning is not a problem. Fishers can see where other trap locations are at, as well as other vessels given the standard onboard VMS system, which already identifies where other boats are located.

Ashored – It's difficult to predict the total extent of storm damage on the device. However, we have taken every step possible to avoid snagging within our coiling approach (around a center cone). As well, with acoustic devices, ranging and finding the device on bottom could be possible if release is not operational.

RSI - Unlike the alternatives that require either reporting by GPS location of surface deployment position, or actual location by surveying areas, we propose a real time approach. By using our

acoustic technology, we can evaluate all gear on the seafloor within a certain distance from the vessel. We identify if it is “mine” or “not mine” and we distinguish individual traps from trawls, so the fisher can quickly decide how to deploy gear without risk of setting over someone else. Again, performed hands free based on a graphical display on a chartplotter.

7. Operational Feasibility with Regard to Portability between Fishing & Management Areas to Accommodate Fishing Practices

There was small concern with use of the current method. There was also small concern over use of the Single Lift and Trawl Bag Methods as there are no lines on singles and normal fishing practices with use of trawls. There was medium to big concern over use of Bottom stowed Bag, for every bag losing space of a trap would be dependent on scale of the fishery and density of gear.

Fiomarine- All fishers in a region regardless of the fishery will need to use a cloud-based gear location database. Fisheries management practices will be improved, and efficiencies will be realized by the fleet.

Desert Star- The ARC-1XD system has been used and/or tested in six separate fisheries from Australia, New Zealand (DSS not involved), the USA, and Canada. The release bag itself is not a Desert Star product and can therefore be easily adapted to any fishing boat in any area. A variety of release bag configurations were designed and manufactured by fishers and associations for their ropeless sea trials.

LobsterLift- As noted above, the ropeless gear manufacturers can agree on a single acoustic communication interface that allows fishers and regulators to locate existing traps. The ropeless traps may record their GPS location before submersion, and report that location in an acoustic communication message back to a regulator or fisher.

EdgeTech- The EdgeTech ropeless fishing system uses a release cage that is roughly the same size and material as a standard lobster trap for New England waters so that it can be stacked and transported like a lobster trap. The release cage can be scaled up or down to meet the requirements of each fishery.

Longsoaker- The Longsoaker retrofit does not take up space inside the trap.

Ashored – As with other acoustic tech, underwater ranging and drift prediction are possible.

RSI - The air bag technology and our “configuration approach” to systems will allow for customizing solutions for different fisheries and fishing practices. The design approach allows variation of buoyancy for differing payloads. The system can be configured as a stand alone device (anchor style) or mounted to a trap or pot (trap-attached). Acoustic approach would be the same for all areas.

8. Operational Feasibility with Regard to the Ability to Accommodate Different Rules in Different Areas or Seasons

There was small concern using the current method. There was also small concern over law enforcement with use of the Lift Bag Method. With use of the Bottom stowed Bag, there was

small to medium concern over the use of small vs. hard rope for each bag. This would present only a small challenge if the same end line in bag could be used. However, if different endlines are used, there would be a medium challenge, as they cannot be stowed on a boat, or changed on a moment's notice. This could be done in a discreet closed area but not on a commercial scale.

Longsoaker- The Longsoaker retrofit uses standard buoy line that can be swapped out and stored for transportation using current techniques.

EdgeTech- The EdgeTech RFS can accommodate any type of rope in the cage but for this type of ropeless fishing, rope that is strong enough, and easiest to pack should be used. The same type of rope used for fishing should not necessarily be used in the release system. Regulations should be changed as to not dictate what type of rope should be used in the release cage as this rope will only be in the water column for minutes during the recovery of traps.

Desert Star- The ARC system is extremely robust and works with a series of gear configurations. The incorporation of Ropeless Fisher also means gear reporting is more streamlined and efficient over current systems.

LobsterLift- The LobsterLift device does not have endlines, so this would not be a major issue.

Fiomarine- The Fiobuoy can accommodate most types of line currently in use in commercial fishing operations. As long as the line can be loaded on the spool it can be used, different spool sizes are available.

Ashored – The MOBI cage is modular and can handle practically all different rope lengths and thicknesses for trap fishing.

RSI - No comment here as the lift bag does not use rope.

9. Operational Feasibility with Regard to Effects of Storms on Trawl Line

There is medium concern with use of the current method. There is big concern over use of Lift Bag method as the bag's durability is uncertain. There was medium to big concern over use of Bottom stowed Bag which poses a similar issue to end line and gear loss; the method would need to be tested first and depends on water depth and wave height.

EdgeTech- The Edgetech RFS uses a bottom stowed rope with buoys attached to the rope. If there is a concern that the buoys cannot be seen due to waves or currents more buoys could be added to the standard amount used or trailing buoys could be added. In fact, with the EdgeTech RFS it was designed so that it could be modified and even fabricated or repaired by fishers to meet whatever operational requirements they may have for their unique fishing application.

LobsterLift- The LobsterLift device utilizes buoys that are in widespread use in the marine industry and are not expected to have any serious impact on the functionality due to storms. The main concern would be with the travel of the device due to the storm, but the use of long range underwater acoustic may be implemented in those few occasions to accommodate the event.

Longsoaker- For trawls, a Longsoaker retrofit would only be required on each end. The

innovation has a very low failure rate to date. Reliable GTRs are used to trigger the end buoys to the surface at a pre-determined time.

Fiomarine- Fiobuoy units that were procured over two decades ago are still in use.

Desert Star- The ARC Ropeless System and corresponding Ropeless Fisher will provide better gear location finding/marketing and will therefore not have any negative affect on drifting gear.

Ashored – The MOBI system is built to be only very slightly positively buoyant and low drag when not released and would therefore have practically no effect on trawl lines in storms.

RSI – Our lift bag solution offers the best protection from gear loss or movement due to storms. It sits completely at the seafloor and is ballast quite heavy. No buoyancy is generated until recovery is required and then various amounts of buoyancy (tens to hundreds of pounds) can be generated. The lift bags utilized are quite rugged and are often used to lift vehicles and airplanes on land, and are the same as we use for ocean science and military applications. Sea state and storm conditions could be taken into account when choosing lift bag capacity. Increasing the buoyancy will increase the ability of the system to withstand currents and waves. There is no tradeoff in the in water weight when doing this unlike stowed buoyancy and bag solutions.

10. Operational Feasibility with Regard to Turbidity Effects on Acoustic Release & Effects of Ocean Conditions (Storms, Currents)

This was not of concern with use of the current method and is yet to be determined with use of the Lift Bag Method. Concern over use of Bottom stowed Bag is also to be determined pending ongoing input and manufacturer specifications.

EdgeTech- For the EdgeTech RFS there is no problem using the system in turbid conditions.

Communication distances of over 2000 meters have been regularly achieved.

LobsterLift- During times of high ocean turbidity, the onboard transceiver can be configured to transmit at a higher volume. The onboard transceiver can then transmit a message instructing the deployed trap to send response messages at a higher volume as well. A higher transmission volume should be sufficient to allow continued operation of ropeless gear acoustic communications during most types of turbulent weather conditions.

Fiomarine- The Fiobuoy is sized so the weight of the trap meets the requirement to maintain position on the seafloor.

Longsoaker- Turbidity and ocean conditions do not affect GTR corrosion rates. With GTRs, the only significant variable that affects trigger time is water temperature. Tests have been done to ensure desired release time at a given bottom temperature.

Desert Star- In the case of extreme water turbidity, fishers may simply move closer to the trap location. The issue of water turbidity has never been noted as a problem or concern in any fisher pilots.

Ashored – Tides can pull on the floating release system, but the low drag buoy designs help keep it vertical.

RSI – Turbidity has no effect on the use of acoustic signaling. See answer to #9 regarding storms.

11. Operational Feasibility with Regard to Tangling Gear

There was no concern over the use of the current or Lift Bag Methods, however there was medium to big concern over use of Bottom stowed Bag method, though those without endlines may be less of a problem for singles and doubles (this is a similar issue to gear conflict.)

Ashored – We have built the MOBI cage to coil rope in a fashion that encourages smooth unspooling (around a cone). Testing to date has shown positively for this design.

Desert Star- The ARC external housing is comprised entirely of Delrin and Titanium parts. Thus, the ARC is extremely robust, while the release bag is made from a hard oyster mesh and will survive repeated abuse. Should a large storm move gear, it is however possible that traps may tumble and tangle release bags. In this case, a bottom stowed cage such as the CMFA method may be used.

LobsterLift-The LobsterLift team agrees with the lack of concern, as the lift bags have very little line length that would make it difficult to get tangled.

EdgeTech- There have been no issues with tangling of the system to this date. The system has been deployed and recovered by EdgeTech during testing and fishing.

Fiomarine- The Fiobuoy deployed on a single or longline string does not have gear entanglement problems, the line is neatly wound on the spool.

Longsoaker- One benefit of the Longsoaker innovation is that it allows fishers to use existing buoy line and does not require costly upgrades. As long as the buoy line is coiled in a reasonably orderly manner, tangles are minimal. The risk of gear is further mitigated where more than one trap is placed on a common ground line. In this case the common line can be dragged up using a grapnel should the buoys not deploy properly for whatever reason.

RSI - No concern for tangling of gear in that there are no additional lines with lift bags. Lift bags also allow for greater lifting capacity in the event that the trawl gear is tangled in any way.

12. Operational Feasibility with Regard to Effects of Ocean Conditions (Storms, Currents) & Technology's Functionality

There was small concern over use of current method. Concerns over use of Lift Bag Method and to be determined pending durability of lift bag and buoyancy issues. There was medium to big concern over use of Bottom stowed Bag as it requires a certain amount of positive buoyancy to get gear up, but not too much as to mess up the balance. This is a big problem in high current and deep water areas and requires more research.

EdgeTech-The EdgeTech RFS only requires enough floatation underwater to float the rope and buoys to the surface. In high current areas where the RFS and or trawl or single trap may be moved by bottom currents, more weight added to the release cage which stays on the bottom to secure it while the floatation and rope float to the surface.

Fiomarine- The Fiobuoy is sized so the weight of the trap meets the requirement to maintain position on the seafloor.

LobsterLift- The buoyancy of the LobsterLift system is low and has the ability to automatically

change based on the ambient conditions.

Longsoaker- Longsoaker's innovation allows fishermen to use as many or as few buoys as they like to achieve the necessary flotation. Obviously, extra weight may need to be added to deep water traps to compensate for the buoy flotation. This would likely not be an issue with end-anchored ground lines. Locating buoys on the surface during bad weather would be done using traditional methods.

Desert Star- Currents; Testing in up to 3 knots (with CWLA) indicates the ARC method of gear retrieval actually increases surface buoy time on the surface due to extra slack provided by additional rope in the release bag (always recommended).

Ashored – Tides can of course pull on the floating release system, but the low drag buoy designs help keep it vertical.

RSI - See answer to question 9. The acoustic technology will function in all sea conditions. The technology will be controlled from the bridge.

13. Operational Feasibility with Regard to Fishing Density

There was small concern with use of the current method. There was big concern over use of Lift Bag Method due to acoustic dependability. There was big concern over use of Bottom stowed Bag, unless it was addressed with effort reduction, in which it could be managed. There are also concerns over problems with resolution and positioning information.

EdgeTech- The EdgeTech RFS use GPS at the surface to position the 1st trap and last release cage in a trawl. The positional accuracy of a buoy (as commented earlier) is not much better if at all depending on water depth wind and currents. The position of the Buoy IS NOT directly over the trap. The EdgeTech Trap Tracker marks the position on the bottom so that all fishers and enforcement can see the position no matter the time of day or weather conditions. This should reduce oversets, not increase them.

LobsterLift- The acoustic communication protocol will be designed in a way that each message is encoded to communicate with an underwater transceiver specified by a unique ID. There is ongoing research in enabling increased communication bandwidth in high density areas. Acoustic locating technology can be used to prevent gear conflict in high density trap areas. Fiomarine- The Fiomarine acoustic location equipment is mature and robust, there are no problems with location resolution.

Desert Star- Have operated and tested in areas with high density.

Longsoaker- Conflict between any type of ropeless gear and other fisheries is likely to be an issue in some areas due to the fact there is no surface buoy most of the time. Fishery managers and fishers will likely need to work together amongst themselves to find a solution no matter which solution is selected.

Ashored – Testing and education on how to effectively use and correlate plotter points will have to be given in high density areas.

RSI - Our real time approach to locating gear will allow increased fishing density as the fishermen will be able to see where gear is on the seafloor in real time. There is no system limit to density.

Density will more likely be limited by fishing practices. Individual systems are identified and recovered by touchscreen chartplotter interface.

14. Operational Feasibility with Regard to Water Depth (Shallow)

There was small concern over use of the current and Lift Bag methods. There was medium to big concern over use of Bottom stowed Bag method, because when using sound waves, the harder the cone is, the harder it is to find the gear.

LobsterLift- We do not see an issue with regards to using LobsterLift in shallow depth, as it will be easier.

EdgeTech- We have been manufacturing acoustic technology and releases for over 50 years. We have had successful communications in water less than 3 meters to over 10,000 meters deep. The EdgeTech ropeless fishing system uses an omni directional Hydrophone. There are NO concerns using EdgeTech acoustic technology in shallow water. Furthermore, the RFS deck unit power and sensitivity can be adjusted if needed depending on environments factors.

Desert Star- Shallow water does not impede the ARC system from working. Due to the directional nature of the current thru-hull (hull mounted) transducers, beam pattern will narrow as depth decreases. This simply means fishers at shallow depths will need to get closer to traps or use omni-directional equipment. Fishers simply use larger bags with greater rope length and recommended scope of 3:1 (already pretty standard in many fisheries such as CWLA). The thru-hull transducer can signal releases from up-to 300m due to a less narrow beam pattern.

Additionally, packing a large bag is easy due to the random feed style repacking which every fisher with a standard winch can do. This method of repacking has worked in all fishery trials while adding minimal additional time.

Longsoaker- This is not a problem because the innovation uses a GTR release instead of a mechanical and/or electronic release. Upon trigger, the buoy pops up where the fisher left it.

Fiomarine- The Fiobuoy has been used in all water depths with no degradation of performance.

Ashored – We use omni-directional hydrophones for both transmission and receiving. Shallow water fishing is definitely doable.

RSI - There is no concern in locating and recovering gear in shallow water.

15. Operational Feasibility with Regard to Water Depth (Beyond 300m)

*There was small concern over the use of the current method. There was big concern over use of Lift Bag method, because if it is set off in a current, it could float for a distance surface surfacing. There was small to big concern over use of Bottom stowed Bag method because of the potential to lose accuracy and is very difficult with a tight set. If scope is 2:1 or 3:1 it would be hard to pack the bag. Acoustic detection was said to be better, as well as the need to float a 60lb amount of rope. **** (More accuracy but lose signal. Size of bag to get to) ****

Fiomarine- The Fiobuoy unspools line to the surface and is still attached to the trap or string of traps, there will be no drifting off in the current. The amount of line loaded on the spool can be optimized for the area being fished.

LobsterLift- There is a valid concern and will need to be tested to answer whether it is a large or small limitation.

EdgeTech- This concern isn't clear. The Edgetech RFS does not use a bag, it is not hard to pack nor is it hard to re-arm. The rope is stored in a basket that can then be inserted into the release cage. Accuracy has nothing to do with the amount of floatation or the distance away.

Desert Star- Fishers simply use larger bags with greater rope length and recommended scope of 3:1 (already pretty standard in many fisheries such as CWLA). The thru-hull transducer can signal releases from up-to 300m due to a less narrow beam pattern. Additionally, packing a large bag is easy due to the random feed style repacking which every fisher with a standard winch can do. This method of repacking has worked in all fishery trials while adding minimal additional time.

Longsoaker- The Longsoaker retrofit can be used in deep water. That being said, there comes a point where a trap would not be heavy enough to be secure on the bottom with a large quantity of line and the necessary buoys to provide sufficient flotation to the surface. The solution for trawls is to create heavily weighted end anchors connected to the common line that are designed only to carry the line and buoys that are retained by a modified Longsoaker retrofit.

Ashored – In areas where tides are strong and depths are 300m+, fishers are already use to 3:1 (or similar) ratios. They understand which side to see the buoy if the tide is running up or down at the time. Our system can handle 3:1 situations and our currently-in-development high-visibility (not talking about just colour) buoys coupled with a kilometer or two release range will minimize effects of this concern.

RSI - The deeper the water, the greater the need for the lift bag solution. Where the popup buoys will be fighting physics (more depth = more line = more buoyancy = more weight needed), the air bag/cylinder size can be adjusted for the additional depth. Additionally, fishing activity in deeper water employs larger, stronger lines and buoys and are more lethal to whales. The lift bag solution is not depth limited for trap fishing.

16. Operational Feasibility with Regard to Sediment type.

There was small concern over use of the current method as well as with the Lift Bag method. There was big concern over use of Bottom stowed Bag method as it could become wedged in rocky areas. There was small to big concern over use of Bottom stowed Bag method as it could become muddled up or caught in rocks, but still have rope. It could also hang down on a hard bottom or get stuck in mud.

LobsterLift- The LobsterLift has a minimal amount of buoyancy designed in to reduce the effects of different sediment types, as well as keeping the gear as clean as possible.

Desert Star- Large underwater hills or other obstructions may impede acoustic signaling efforts. It is recommended fishers use their standard depth sounder and avoid potentially problematic areas as they already do. In the case of an obstruction causing failure to trigger a release, fishers may simply re-position their vessel and try again.

EdgeTech- The EdgeTech RFS has been tested extensively using Pitch roll and acceleration sensors to track the stability when deploying the system, no matter how it deploys will descend level to within 5 degrees. There is always a chance it could become wedged in rocks

just as with standard fishing methods.

Fiomarine- The Fiobuoy floats above the trap and cannot get muddled up or caught in the rocks.
Longsoaker- In theory, a trap rigged with a Longsoaker retrofit would be no more likely to foul on the bottom than tradition gear.

Ashored – The MOBI unit floats a few feet above the seafloor.

RSI - Air bag systems are designed to have additional lift capacity beyond the primary payload to allow them to dislodge from rocks or separate from mud. Airbag systems are also immune to orientation. Even if the system is on its side or upside down, it will still activate and lift. The only instance where this would be a concern is if silt or mud covered the transponder, prohibiting it from receiving the signal. However, even in these cases the backup timer would allow the recovery to initiate without receiving a command.

17. Operational Feasibility with Regard to Gear Releasing too Early

There was no concern over the use of the current method. There was big concern over use of Lift Bag method using Singles as a fisherman may be unable to find gear or drift. There was small to medium concern over use of Bottom stowed Bag method due to the risk of gear to whales and vessels. It would require testing and manufacturer specifications.

Ashored – Early releases would be extremely rare given the unique acoustic command structure required. Time based backups are available on MOBI but would be known when deployed.

EdgeTech- The EdgeTech RFS has over 1 billion unique commands available to control the releases. There is zero chance that anyone other than the fisher who owns the ET RFS (or enforcement) of the system releasing early. There is also zero chance of any other manmade or naturally occurring sound affecting the ET RFS in any way.

Longsoaker- Because Galvanic Timed Releases (GTRs) are used, the risk of premature deployment is slim. As long as proper GTR is selected for the desired trigger time the system will be highly predictable.

LobsterLift- To mitigate this concern, the LobsterLift device could be programmed to deflate its buoy if it is not retrieved within a set period of time, bringing it back to the seafloor, and be retrieved again at a later time.

Desert Star- In the case of Dave Casoni in Massachusetts this problem was noted due to modifications needed in his custom release bag design. In no other instance has this been a noted problem. Fishers and their associations should always test release bag designs (as recommended by Desert Star) before deploying real gear in fishing grounds. Additionally, Ropeless Fisher may incorporate an activity log in a future update which will notify fishers if/when gear is released.

Fiomarine- The gear will not release early unless the Fiobuoy is deployed and the batteries were low, at a low voltage threshold the mechanical release will trigger. The system can be configured with a telemetry system to notify the fisher the trap is on the surface. As the vertical line and

surface float have been eliminated the risk to whale and vessels is mitigated. The only time there is a line in the water is upon release of the Fiobuoy for recovery.

RSI - Early release would only occur due to operator error (and only if using the timer feature in addition to the acoustic release). A very specific set of acoustic commands is required to initiate the sequence. Our systems have been designed for year long deployments without having a false alarm create an unintended release.

18. Operational Feasibility with Regard to Gear that Doesn't Release

There was no concern with use of the current method. There was big concern over use of Lift Bag method with Singles which would not be found, and medium use of this method with trawls (due to grapple) There was small to medium concern over use of Bottom stowed Bag due to (status quo, needs testing)

EdgeTech- Edgetech's history of producing acoustic technology is well-known in the oceanographic field. The same technology we use in the RFS was adapted from existing proven technology.

Ashored – Time based backups are in place. Trawl setups could have redundancy.

Fiomarine- The Fiobuoy has a primary acoustic release and two failsafe release backups; a programmable time/date trigger and a low battery trigger.

LobsterLift- Gear will be designed to be highly reliable. However, if in the rare instance gear does not release, it can still be retrieved using a boat equipped with an acoustic triangulation device, and manually retrieved.

Desert Star- This may be the cause of several factors, in which case fishers should be trained how to trouble shoot. Potential problems may include snags in the fisher designed release bag.

Australian fishers generally experience a snag rate of one in every 30 to 50 release attempts. In 2018, one of the CWLA fishers managed to achieve a snag rate right around the one in every 30 release attempts (in case of a snag, either the other end of a trawl is released or if needed the gear will be grappled). Other problems may include strong currents in which case the acoustic signal is lost or degraded and never reaches the ARC. In this case, fishers may simply boat with the direction of the current at a slow speed which will then reach the ARC (insight from NSW).

Longsoaker- GTRs are very dependable. If line is coiled in an orderly fashion and the device is properly rigged, the risk of gear loss due to failure is minimal.

RSI - If the transponder is active an accurate location can be established for grappling. The system will also be equipped with a timer that will initiate recovery without commands. In the case of trawls, there would be redundancy since there will be a system at either end.

19. Operational Feasibility with Regard to Ease of Use for Fishermen

There was small concern over the use of the current method. There was big concern over the use of the Lift Bag method as it is difficult to fill the canisters, needs to be times with deflation, and the need for line to get the trap in the boat. There was big concern over the use of Bottom stowed Bag method as it is labor intensive and different from existing method. High precision is required which is difficult in rough conditions.

Fiomarine- The Fiobuoy will be managed just like existing fishing gear with the addition of a high-speed spooling winch. This device has been designed to operate at the same speed as the pot hauler with limited user impact.

LobsterLift- The LobsterLift device is designed to be quickly rechargeable with an onboard recharge station and will also feature automatic deflation of the lift buoy. The recharge and deflation period should take one minute or less and would be an automatic process.

Desert Star- The ARC system integrates well into many aspects of current fishing practices. For instance, the use of the release bag and re-filling process does not require any additional equipment not already found on every crab/lobster fishing vessel. Virtual gear marking with Ropeless Fisher does not cost anything and incorporates into current fishing practices (and will incorporate into VMS in the future). The ARC system also does not change any trawl, single or other gear setting. When fishers have become accustomed to the ARC, only minimal time is added between each servicing period. Finally, with any system some accommodation time is required. In a specific example, fishers in the CWLA fishery went from no knowledge to fishing with the ARC system in a real-world scenario (actual fishing grounds with real gear) in the matter of weeks. Further, with branched learning, entire fisheries may incorporate the ARC system within months.

EdgeTech- This is not the case with the EdgeTech RFS. We use a release cage with a rope basket that can be removed and replaced. The scenario for gear retrieval using the ET RFS is to have one extra rope basket on board that can be placed under the pot hauler so that it is filled up as the RFS line is hauled in. Once on board the fisher simply removes the now empty rope basket from the release cage and replaces it with the basket that was just filled. The release is re-armed by screwing on the same release link and inserting a link lynch pin.

Longsoaker- The Longsoaker innovation uses standard traps and line. Re-rigging only requires that the line be coiled in a reasonably orderly fashion. A one-use GTR trigger would be required for each application.

Ashored – All Ashored’s products must be able to be used with heavy gloves on. Resetting the MOBI device can be done using our automated re-spooler and arming is automatic once the fisher slams the lid on (takes only a second or two of interaction). Rough conditions have practically no effect on the ease of use of this product.

RSI - A lot of effort has been expended in the design process to consider deck operations. While it is true that bags will need to be deflated and compressed air cylinders changed, these operations can be executed while steaming between locations. Our system has the option for a leading line and buoy for recovering/hauling the system. Once aboard, the systems are swapped with units that are prepared to go. No precision operations will be required. All deck operations will be performed without tools and with gloved hands.

20. R and D- Cost Feasibility with Regard to Responsibility for R&D Costs

There was no concern over use of the current and Lift Bag methods. There was big concern over use of Bottom stowed Bag method they are not on the fishermen, rather the challenge depends on the scale of testing area.

Ashored – Research grants and environmental initiatives have helped us develop our products. Fiomarine- Fiomarine has developed its technology with no external support, the company has been in business since 1996 and has delivered thousands of Fiobuoys.

Desert Star- Desert Star has already invested a lot of time, resources, and capital into the ARC ropeless fishing system since 2005. Further R&D costs are covered by government research grants and opportunities such as programs like SBIR and BREP. Additionally, R&D efforts are funded by revenue made from commercial sales of the ARC system.

LobsterLift- R&D costs are a requirement for any new technology, and ropeless systems desperately need funding to be considered as a viable option.

Longsoaker- no answer

EdgeTech- We are a commercial manufacturing company with more than 50 years in the underwater technology field. We have done all of the R&D and testing in house without any funds from any other sources. Equipment is currently on loan at no charge to fishers in Massachusetts for NOAA DMFS approval.

RSI - Much of the R&D has been done at the company's expense over the past 6 years. Additional investment is now being made at the company's expense to take the technology to the next level. Field testing and trial fishing are areas where outside investment would be beneficial.

21. Cost Feasibility with Regard to Number of Fixed Gear Fishermen Affected

There was small concern over use of the current method. There is big concern over use of Lift Bag method as there is a large amount of fixed gear. The concern over use of Bottom stowed Bag method is to be determined as it depends on scale.

Ashored – Funding, leasing, and pricing models can be adapted to different areas and needs. MOBI units have been developed to be the lowest cost possible to produce and were developed solely as a solution for ropeless fishing.

EdgeTech- I don't see how I can comment on this as it depends on fishing regulations. I do think that there will need to be some cooperation between fishers to accomplish this ropeless fishing goal.

Fiomarine- Fiobuoy is a scalable technology.

LobsterLift- The LobsterLift system is designed from the start to be as cost effective as possible with utilization of as many off the shelf components to reduce cost due to low volume production parts.

Desert Star- Should Ropeless Fishing become legal and a norm in US and Canadian waters, some 22,884 license holders stand to be affected, not including crew, regulators and others.

Longsoaker- The Longsoaker retrofit and GTR supplies scale quickly. Due to the innovation's simplicity and reliance on GTR triggers, the cost per trap would be economically feasible for widespread deployment.

RSI - Efforts are being made to minimize all costs to the fishermen. Also, as volume increases, costs will decrease. Our designs are being developed with automated larger

volume processes in mind. That being said, the solutions will require capital investment for anyone fishing in the restricted areas. We do expect that some of the cost for our ropeless technology will be offset by no need to buy buoys and lines, lost gear prevention, and time/fuel savings not having to search and grapple for lost gear.

22. Cost Feasibility with Regard to Number of Mobile Gear Fishermen Affected

There was small concern over use of the current method. There is big concern over use of Lift Bag method as acoustic technology may be a problem. The concern over use of Bottom stowed Bag method is to be determined as it depends on scale.

Fiomarine- Broad-scale deployment will lower capital costs for equipment.

Desert Star- no answer

LobsterLift- The cost of the unit affixed to the boat will be a larger single purchase item that will work with all of the devices for each trap or trawl that will have lower cost acoustic receivers built into them.

Longsoaker- The Longsoaker retrofit and GTR supplies scale quickly. Due to the innovation's simplicity and reliance on GTR triggers, the cost per trap would be economically feasible for widespread deployment.

Ashored – Software and hardware for mobile gear fishers to have gear tracking capabilities is financially possible but of course will have to depend on regulations and area specific needs.

EdgeTech- I don't see how I can comment on this as it depends on fishing regulations. I do think that there will need to be some cooperation between fishers to accomplish this ropeless fishing goal. Using the Trap Tracker app will allow both mobile and fixed gear fishers to know where the ropeless systems are set.

RSI - Mobile fishermen fishing in the affected areas will have to have the hull mounted transceiver. This will allow them to see seafloor gear on their chart plotter software. There will be a capital expense. Again, in volume we expect these costs to decrease.

23. Cost Feasibility with Regard to Cost of System in Short Term

There was small concern over use of the current method. There is big concern over use of Lift Bag method due to R&D, testing and mobility into all fisheries. There is big concern over use of Bottom stowed Bag method due to prototype development.

EdgeTech- The EdgeTech RFS is not a prototype. We are currently in a production run of 25 units.

Ashored – Pricing models can be adapted to work with different regions and needs.

Fiomarine- Fiomarine has completed all R&D for the Fiobuoy, it is a mature operational product.

Desert Star- ARC implementation cost should be examined in terms of annual price over life-time of an average ARC. Viewing from an initial up-front cost is not realistic in the sense that cost applies over the entire period of time of use, not upon single purchase, and must also be examined in relation to average annual revenue per fisher.

LobsterLift- With any new technology, there is a cost hurdle to overcome up front. Given the

current situation, there may be a cost effective way to roll out testing in closure areas. Longsoaker- The Longsoaker retrofit could be quickly modified for lobster trap use. R&D time would be minimized by the simplicity of the system.

RSI - Our systems are not technically prototypes. We have been manufacturing them for 6 years. That being said, the cost for the systems will be higher due to the manufacturing run sizes.

24. Cost Feasibility with Regard to Cost of System in Long Term

There was small concern over use of the current method. There is big concern over use of Lift Bag method. There is medium concern over use of Bottom stowed Bag method, as broader implementation occurs, costs will go down, but the cost will increase for new entrants who bear the cost.

Longsoaker- The Longsoaker retrofit and GTR supplies scale quickly. Due to the innovation's simplicity and reliance on GTR triggers, the cost per trap would be economically feasible for widespread deployment.

EdgeTech- The EdgeTech RFS cost may be higher than other systems but the design life of our system is more than 20 years so averaged out per trap per year the cost become reasonable.

The maintenance of the system can all be done by the fisher with parts that can be purchased at local marine and box stores like CVS or Walmart.

LobsterLift- The cost of a LobsterLift system long term will decrease as the system is enclosed from the harsh environment, aside from the buoy itself which has been tested and verified throughout the years by Polyform.

Fiomarine- Broad-scale deployment will lower capital costs for equipment. The Fiobuoy is a robust system that is designed with a 20-year life cycle, there are systems still in operation beyond 20 years currently. Discussions have been held to explore assorted business models to finance capital outlay.

Desert Star- As with any business decision, fisher's investment in ropeless fishing will depend on the benefits of the fishery outweighing the additional costs. Approximate costs of ropeless fishing, expressed as a percentage of a fisher's annual revenue can be estimated. For example, [according to a study by WHOI](#), each vertical line yields a Maine offshore trawl fisher about \$5000-\$8000 of revenue. (This is similar to anecdotal numbers of US \$8,000 per crab pod in Gulf of St. Lawrence or \$17,000 per lobster trawl / \$8,500 per vertical line in LFA34, Nova Scotia).

The cost of the ranging model of a current ARC-1 release is \$1,600 at anticipated typical fisher first buy of about 50 releases. Assuming a service life of ten years (conservative based on experience with ARC-1XD), and averaged annual maintenance and supplies costs of \$30 per unit, annual ownership cost is around \$190 or about 2.4%- 3.8% of the revenue created per vertical line. This calculation does not account for savings such as engine hour reductions seen in NSW, prevention of lost gear and fishing even in the presence of time-area closures.

Ashored – Pricing models can be adapted to work with different regions and needs.

RSI - As mentioned above, these systems are being developed to be "fit for purpose" and designed for high volume manufacturing techniques. In the long term, this will make the systems more cost effective. We are also looking at ways for the fishermen to be able to directly make or buy some

of the components to remove middlemen markups on components. The primary components are designed for many years of use thus spreading out the capital investment.

25. Cost Feasibility with Regard to Cost per Fishermen Upon Implementation

There was small concern over use of the current method. There was big concern over use of Lift Bag method as it requires a subsidy. There was also big concern with use of the Bottom stowed Bag method as it presents a higher cost for new entrants.

Longsoaker- The Longsoaker retrofit and GTR supplies scale quickly. Due to the innovation's simplicity and reliance on GTR triggers, the cost per trap would be economically feasible for widespread deployment.

LobsterLift- The LobsterLift will be as cost effective as possible to create a return on investment by way of fishing in closure areas, as well as reduction in time at sea due to efficiency gains. The system will also be offered as a subscription to reduce the upfront cost of implementing the system. Ultimately, we are looking to make it as easy as possible for a fisherman to implement our system.

Ashored – Pricing models can be adapted to work with different regions and needs.

EdgeTech- I do think that the only way for fishers to afford any ropeless technology is by some form of subsidies.

Fiomarine- The Fiobuoy is a robust system that is designed with a 20-year life cycle, there are systems still in operation beyond 20 years currently. Discussions have been held to explore assorted business models to finance capital outlay.

Desert Star- Off-shore fishers tend to use trawls consisting of 15 traps, or very large singles, whereas near-shore fishers tend to use 8-10 traps per trawl and in-shore fishers tends to use small singles. In the targeted case of off-shore fishers (most likely first implementation case) \$85,000 will cover a full implementation cost of the ARC for fishers in the US, and \$32,000 in Canada. For further implantation costs, the quantity purchased and amount of trap per vertical line should be analyzed.

RSI - Initial investment in these systems is unavoidable as with any new technologies.

26. Cost Feasibility with Regard to Opportunities for Cost Savings vs Traditional Gear

There was no concern over the use of the current method or the Lift Bag method, as the R&D isn't fully developed. There was medium concern over the use of Bottom stowed Bag, with question of reduction in gear loss.

Fiomarine- The Fiobuoy will improve gear loss percentages since the equipment can be located acoustically.

LobsterLift- Cost saving opportunities with regards to gear loss, as well as fishing in areas of closure will be opportunities available to fishermen looking to use ropeless systems.

Desert Star- Fisher Steve Rosskelly in NSW Australia noted an engine hour reduction from 1000 to 600 hours in the face of a rising quota when using the ARC. Another fisher, Scott Wesley said in 2018 he didn't lose a single trap because of the ARC, meanwhile other fishers around him

continue to struggle with lost traps. If legalized in the US and Canada, ropeless fishing can also mean year-round fishing and fishing regardless of time-area closures or whale presence for those using Ropeless systems. Opportunities to defray costs: Local fishery associations, government grants, and privately acquired funding do offer fishers a legitimate chance to acquire additional funding for the implementation of Ropeless systems.

Longsoaker- When used carefully, the Longsoaker retrofit is expected to lead to minimal gear loss as a result of malfunction or incomplete line deployment.

EdgeTech- With the ET RFS the R&D has already been done by EdgeTech. Because the acoustic technology has ranging capability gear loss should be less than traditional methods.

Ashored – Propeller cutting could be minimized and potentially improve gear loss numbers.

RSI - There are no capital investment cost savings to be realized. However, there are several scenarios in which there will be operational cost savings related to lost gear from storm, ship strike, sabotage, or theft. This includes the cost of the lost gear itself as well as the cost associated with the time required to search and grapple for lost gear.

27. Regulatory Feasibility -- Requires Modification to ALWTRP Regulations

There was small concern over the use of the current method. There was big concern over the use of Lift Bag method as changes require time. There was big concern over the use of Bottom stowed Bag method.

Longsoaker- It appears that any ropeless technology will required regulatory changes or other flexibility.

LobsterLift- Change is required and should be implemented if given validated testing data as a solution to the current situation.

EdgeTech- Yes, regulations will need to be changed.

The ET RFS Trap Tracker allows for real-time gear marking which can be viewed by anyone with the Trap Tracker app. Enforcement will have permission to see all deployed systems and will have the master list from the cloud data base of IDs and release codes so that they can check traps just as they do now.

Fiomarine- There will be modifications required for fisheries regulations.

Desert Star- Yes, this would require the legalization of Ropeless Fishing, modification of time-area closures in relation to those fishing with Ropeless gear, and a framework for virtual gear marking, regulation and standardization.

Ashored – Regulations need to shift to allow ropeless gear. The MOBI unit features talkback to enforcement personnel to send up (acoustically) license and registration info (previously available on the buoy) that can be synced to the ATLAS server to view specific details about the fisher's deployments. As well, regulatory concerns have been raised about illegal fishing and hiding gear with ropeless systems. MOBI has checks in place to only work when allowed to do so given a unique communication and intelligence program in place in our systems.

RSI - All ropeless gear will be affected by regulatory changes. Our technology allows for some of the regulations to be minimized compared to other approaches. In particular, our real time gear location scheme doe not require satellite communications or reporting to a central database.

This will simplify the regulation writing and compliance issues.

28. Regulatory Feasibility ****COMBINED**** -- Requires Modification to State and Federal Lobster Regulations Related to Surface Markings / Specifications that Define Performance Characteristics / Specifications to Describe Allowed Gear

There was small concern over the use of the current method. There was big concern over the use the Lift Bag method as it requires changes among State and Federal Regulations. The same concern applied to the Bottom stowed Bag method.

Longsoaker- It appears that any ropeless technology will required regulatory changes or other flexibility.

Fiomarine- There will be modifications required for fisheries regulations.

Desert Star- There will be modifications required for fisheries regulations. Enforceable from surface- Regulators will have access to all gear locations at all times including location checking with VMS incorporation. This will actually make enforcement easier and more efficient. Can be hauled from enforcement: Regulators will be given specially privileged gear which may release any gear, this will also entail automatic event loggers (in the software) that record this activity. Enforceable from dockside-Regulators will be given very specific and real-time views of the entire fisheries gear. This will make regulation fair more efficient.

EdgeTech- Regulations will need to be changed. I see a problem now where the state and fed are not allowing for gear modifications for testing even on a small scale.

LobsterLift- Industry stakeholders are needed at the table during regulation changes, and the changes are needed in order to facilitate the uptake of a new technology. The involvement of stakeholders is a key component in the effort being successful.

Ashored – Regulations need to shift to allow ropeless gear. The MOBI unit features talkback to enforcement personnel to send up (acoustically) license and registration info (previously available on the buoy) that can be synced to the ATLAS server to view specific details about the fisher's deployments. As well, regulatory concerns have been raised about illegal fishing and hiding gear with ropeless systems. MOBI has checks in place to only work when allowed to do so given a unique communication and intelligence program in place in our systems.

RSI - All ropeless gear will be affected by regulatory changes. We would be glad to assist in the process of writing descriptions.

Appendix 2

Acoustic Concerns

Subgroup Committee members on feasibility for ropeless fishing were asked to articulate concerns and to identify if they felt further research was needed. They were also asked to identify whether the feasibility consideration represents a big, medium, or small challenge. ALWTRT Ropeless Subgroup members in 2018 felt that the ARC-1 “bottom-stowed rope” design was “a concern” and stated that they “needed more information” on the SMELTS Lobster Raft “lift bag” system. At the time of the meeting, the Lobster Raft “lift bag” system was utilizing the WHOI designed acoustic signaling unit. This document serves as a response to the Large Whale Take Reduction Committee’s questions regarding ropeless fishing with acoustic devices and is for public use.

Will ropeless fishing systems cause “acoustic problems for whales”?

Hearing is an important sense of marine mammals. Acoustic systems operating around marine mammals may cause harm to animals by either causing temporary (TTS) or permanent (PTS) 'threshold shifts' i.e. hearing loss. It is imperative that ropeless devices that may operate acoustically at or near the hearing threshold of marine mammals be sensitive to those species and reviewed by independent third-parties who are considered subject-matter experts.

In July 2016, NOAA Technical Memorandum NMFS-OPR-55 established Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing. The memorandum uses the following approach:

- Marine mammals are divided into hearing groups. This is table ES1 in the memorandum, which can be found reproduced in table 1 below.
- For each hearing group, PTS onset acoustic thresholds are stated in the memorandum table ES3. These thresholds are cumulative exposure of the animal to the sound, not intensity levels. Thus, higher intensity sounds with shorter exposure time may be equivalent to a lower intensity sound but with longer exposure time. Overall, some animals such as baleen whales in the LF hearing group are very noise tolerant and are thus assigned high thresholds. Others, such as harbor porpoises in the HF hearing group are found to have a much lower noise tolerance and are thus assigned a low threshold.
- Sound that is emitted from a device is weighted per table ES2 depending on the frequency of transmission as compared to the assumed audiogram of an animal in one of the hearing groups.

Here were our third party reviewer’s questions regarding the acoustics of ropeless fishing devices:

1. What are the frequencies and bandwidth of the release signal (s)?
2. What is the signal amplitude (in dB re: 1uPa)?
3. Signal type or form factor?
4. What is the signal duration or required repetition for an assured release?

5. If each trap has a unique release code, what is the typical time between individual trap retrievals on a close-packed trap-line?
6. If a set of traps is on a specific release code, how long would the signal be broadcast to release all of the traps in that area?
7. Do the fishers operate in close proximity to other fishing boats?

Here are the responses from the following manufacturers:

*Lobster Raft is currently partnering with WHOI, and FioMarine for acoustics release devices.

*LobsterLift is currently partnering with both FioMarine and DesertStar for acoustic release devices.

EdgeTech 5112 Acoustic release source level information

1. Frequencies and bandwidth of the release signal (s). We use three set frequencies, 17.5 Khz, 18.0 Khz & 19.0 Khz.
2. Signal amplitude (in dB re: 1uPa) 179dB.
3. Signal type or form factor: Bit encoded, FSK, 40 bits total (5 bytes) with a 5 second pre-amble.
4. Signal duration or required repetition for an assured release: Total command duration is 14 seconds with an average duty cycle of 18:1 (pulse off time / pulse on time)
5. If each trap has a unique release code, the typical time between individual trap retrievals on a close-packed trap-line. Command can be sent every 30 seconds.
6. If a set of traps is on a specific release code, how long would the signal be broadcast to release all of the traps in that area. Do not use a universal command or Broadcast Mode.
7. Do the fishers operate in close proximity to other lobster boats? If so, how close? Depends on region.

Desert Star ARC-1

1. What are the frequencies and bandwidth of the release signal (s)? 34kHz-42kHz
2. What is the signal amplitude (in dB re: 1uPa)? 192-197dB
3. Signal type or form factor? Frequency hopping pulse position coding
4. What is the signal duration or required repetition for an assured release? 0.004-1.2 sec
5. If each trap has a unique release code, what is the typical time between individual trap retrievals on a close-packed trap-line? N/A
6. If a set of traps is on a specific release code, how long would the signal be broadcast to release all of the traps in that area? 1.2 seconds
7. Do the fishers operate in close proximity to other fishing boats? If so, how close? Depends on region.

Ashored-MOBI

1. Frequencies and bandwidth of the release signal (s). Working between 20 and 25 KHz currently.
2. Signal amplitude (in dB re: 1uPa) 198 dB re uPa.
3. Signal type or form factor: Pulse Width Modulated Signal
4. Signal duration or required repetition for an assured release: Still underdetermined exactly for best approach.

5. If each trap has a unique release code, the typical time between individual trap retrievals on a close-packed trap-line. Still underdetermined exactly for best approach.
6. If a set of traps is on a specific release code, how long would the signal be broadcast to release all of the traps in that area. Still underdetermined exactly for best approach.
7. Do the fishers operate in close proximity to other boats? Yes, in densest areas within 20-30 meters of each other.

FioMarine- Fiobuoy®

1. Frequencies and bandwidth of the release signal (s). 16-30kHz
2. Signal amplitude (in dB re: 1uPa) 165-170dB however due to the complexity of the signaling used, there's debate about whether this is the best way to define things in terms of its effects and how they're even perceived by marine life.
3. Signal type or form factor- Broad band spread spectrum; 2 way packet confirmed data transfer
4. Signal duration or required repetition for an assured release-
Wake from sleep ~11 sec duration (with 2 sec acknowledge)
Subsequent commands and acknowledgements, 2 sec each.
5. If each trap has a unique release code, the typical time between individual trap retrievals on a close-packed trap-line: With the current model, you could wake then send an activate release command, and receive the confirmation to be ready to start on the second one, about 30 seconds. In practice you wait for the jaw to open (25sec) then for the Fiobuoy® to unwind its way to the surface, (dependent on depth), then retrieve it on deck.
With the new system, that will all be automatic.
The system will know it's coming up to the location of previously deployed unit number xxxx, send out the correct wake signal, and by the time you get to the spot the Fiobuoy® is already up.
6. If a set of traps is on a specific release code, how long would the signal be broadcast to release all of the traps in that area. We've made the decision not to allow this (with the exception that we may give that capability to the authorities) The other way, is a work-around: We program multiple Fiobuoy®s to have the same address.
While possible in theory, it gets messy and all would be trying to acknowledge at the same time.
7. Do the fishers operate in close proximity to other boats? They can, yes.

Ropeless Systems Inc.

1. What are the frequencies and bandwidth of the release signal (s)?

Our signals operate at 24 kHz with 8 kHz of bandwidth.

2. What is the signal amplitude (in dB re: 1uPa)?

188 dB (+/- 2 dB). Note that is less than typical Source Level transmitted by odontocetes (e.g. bottlenose dolphin, beluga whale and false killer whale).²

3. Signal type or form factor? [Direct Sequence Spread Spectrum](#)

4. What is the signal duration or required repetition for an assured release?

We use four sequential pulse signals each of duration 8 msec. Total time to transmit a release signal is less than 1 second.

5. If each trap has a unique release code, what is the typical time between individual trap retrievals on a close-packed trap-line?

About one second delay between sending a new release code. However, in typical operations, there will be a delay required to maneuver the vessel into position to start the next recovery.

6. If a set of traps is on a specific release code, how long would the signal be broadcast to release all of the traps in that area?

We do not anticipate offering a universal release code to allow release of all traps at the same time. They must be performed sequentially after selection by the operator on the chartplotter.

7. Do the fishers operate in close proximity to other fishing boats?

This appears to be a question best answered by the fishers. From our perspective as system designers, our technology allows operation with gear placed in close proximity to one another as presently practiced using buoys and lines.

² *Principles of Marine Bioacoustics*, Au and Hastings, Springer 2008, pp. 512-513

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