Overcoming Development, Regulatory and Funding Challenges for Ropeless Fishing to Reduce Whale Entanglement in the U.S. and Canada

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Funded by a Woods Hole Oceanographic Institution Research Opportunity Initiative. **Workshop Summary**

The workshop was motivated by a recent assessment of the North Atlantic right whale species (NARW), which indicated that it is in its 7th consecutive year of decline with only about 450 whales left in 2016 (Pace et al. 2017, Pettis et al. 2017). Only about 100 breeding females are left in the population. Given the current mortality rate, the species has about 20 years left before these 100 females are gone, at which point the species will be functionally extinct (i.e., unable to recover). Fishing gear entanglements cause the majority of right whale deaths today, and also contribute to declining calving rates through the prolonged health effects of non-lethal entanglements. Pressure to mitigate entanglements will grow quickly as the right whale population continues to decline; this pressure will come from the public as they inevitably learn about the extent of the problem and the drawn-out suffering of entangled whales. With no other options at hand, governments will ultimately close fisheries to mitigate entanglements (as has already happened in Massachusetts and Canada). We believe such closures will devastate fixed fisheries and the communities that rely on them. This is everyone's problem – the fishing industry, wholesalers, retailers, consumers, government regulators, scientists, and conservationists. We must work together to find science-based solutions that will allow the fishing industry to coexist profitably with right whales. The development and operational use of ropeless fishing (marking and retrieving traps without buoys or end lines) has the promise to eliminate the majority of trap/pot gear entanglements, the cause of most right whale entanglement deaths.

The objectives of the workshop were to (1) discuss the need for and approaches to implementing ropeless fishing to reduce entanglements of large whales in trap/pot fisheries, (2) discuss how to develop regulatory pathways to make ropeless fishing legal in the United States and Canada and (3) discuss strategies to fund two phases of development: demonstration/ evaluation and experimental fisheries. The workshop format consisted of presentations followed by discussions on the urgent need for ropeless fishing techniques, the current state of development of ropeless fishing, technical development plans, regulatory and practical challenges and solutions, and the funding landscape. This report summarizes the presentations and ensuing discussions. Key illustrations from the workshop talks are included in the report. For a detailed interpretation of the report, we encourage the reader to examine each presentation while reading the relevant section of the report. Workshop presentations and other background material can be found at <u>https://ropeless.org/</u>. Direct links to each presentation are also given in the report text.

The challenge of developing ropeless fishing is to provide a safe, legal, practical and affordable alternative system to: (1) mark the location of traps on the sea floor, and (2) retrieve traps without a surface buoy or end line. Technological advances now make this option more feasible. The U.S. Atlantic Large Whale Take Reduction Team (ALWTRT) had previously recommended to test ropeless fishing in a closed area, but practical and regulatory concerns at the time precluded this option. To make ropeless fishing work, several parallel tracks will need to move forward, including technology development, economic analysis of industrial and market challenges, changes in regulatory requirements, and ongoing assessment of NARW entanglements and status.

In this workshop, M. Baumgartner gave a welcome and introduction to the workshop and S. Kraus reviewed NARW status as described above. T. Werner then reviewed previous entanglement reduction concepts and gear modifications. Based on that assessment, one might conclude that the only guaranteed solution was either closures of all trap fishing, or removal of rope from the water column. Ropeless fishing is one of the answers to this conundrum, although

there is also some evidence that 1700 lb. breaking strength rope (Knowlton *et al.* 2016), red colored rope (Kraus *et al.* 2014) and gear (effort) reduction could help in the interim.

M. Moore gave a presentation on some ropeless fishing that already occurs in the U.S. US trap fisheries that legally grapple for traps, golden crab in the Gulf Stream, and Boston Harbor lobster fishing in shipping lanes were reviewed. The need for floating ground line to enable grappling was discussed as a requirement for widespread use of this method in whale habitat, since trawls with sinking ground line can be difficult to grapple. A study of grappling for trap trawls also highlighted the substantial issue of layover conflict when surface trap markers were not used. For ropeless fishing to be feasible, trap and trawl locations must be available to other fishermen and to enforcement agencies. Further, to retrieve traps without end line in a manner that is practical, legal, and commercially affordable, is a challenge for the major fisheries involved such as the Gulf of Maine lobster and Gulf of St Lawrence snow crab fisheries.

M. Baumgartner presented the proposed overall ropeless concept, which uses acoustic trap and vessel modems that report the position of gear on the sea floor and enable trap release when a signal is sent. Trap modems would relay trap position and encrypted registration information (e.g., owner identification) to surface modems mounted on vessels, and these trap positions would be shown on the vessel's wheelhouse plotter. Surface modems would be installed in vessels involved in both fixed and mobile fisheries. Once a vessel returned to shore, the trap and encrypted registration information would be relayed to the cloud (data warehouse), and would then be accessible to the trap owner, enforcement, and regulators. Modem protocols would be universal to enable integration of different products from different manufacturers. Concerns were raised as to how those hauling unmarked traps could be detected in the absence of surface marker buoys. Enforcement might need to focus on assessing traps on a vessel or on land to determine if a modem is integrated and working. Acoustic modem range was identified as a concern, in order to provide sufficient notice to incoming mobile gear users. Modem sound frequency versus range was discussed.

J. Partan described a rope spool design that is close to sea trial stage. The end line is wrapped on a buoyant spool and acoustically released from an anchor to enable hauling. The end line is then stored and returned to shore for cleaning and re-spooling. Concerns were raised about the practicality of storing spooled and used rope given limited deck space for multi-day trips. Participants discussed the option of reducing needed space by using high-strength small-diameter line as well as the potential for rope to be re-spooled on board.

R. Riels described a variable buoyancy trap prototype which uses an acoustically triggered release of compressed air into a suitably sized lift bag attached to a terminal trap or trawl anchor. The issue of windage for single traps once surfaced was discussed, as was reduction in catchability when the apparatus is attached to a trap. The latter concern led to the suggestion to use it to retrieve a trawl anchor rather than the terminal trap in a trawl.

Marco Flagg and Jacob Wolff described an acoustically released bottom-stowed bagged buoyant rope system, and its adoption by rock lobster trap fishermen in New South Wale. Bags are repacked on deck. Cleaning of gear and transponders is required to ensure good acoustic communication. Acoustic connectivity in shallow water where the sound cone angle limited bottom coverage can be an issue, but the system is in commercial use with 1,000 units deployed. Supplier education and support of users was described. A smart phone app is available for trap location messaging via voluntary reporting.

Discussion about these systems focused on scaling, cost, regulatory change, enforcement and gear conflict without surface marker buoys. Reaction from the industry present at the workshop ranged from willingness to test the system, especially in currently closed areas, to concern about where whales were getting entangled and large scale applicability such as the Gulf of Maine fishery with very high trap densities.

M. Asaro described the history of the ALWTRT, with its goals and actions to date. Reduced breaking strength rope and ropeless subgroups are being formed in light of the NMFS legal mandate to significantly reduce right whale mortalities.

P, Burns described the U.S. regulatory process regarding gear marking.

J. Rumboldt described the proposed Canadian amendment to authorize single trawl markers and potentially allow for no end marking at the surface if rope-less fishing technology was developed.

A major concern was to ensure that fishermen from each area were involved in all stages of the process, recognizing the unique challenges different areas represent. Next steps included ALWTRT sub group discussions, further prototype development, at sea testing, experimental use of available systems, development of regulations, and marketing of truly sustainable trap fisheries, and securing funding to accelerate these activities in the U.S. and Canada. This workshop and its attendees have formed the nucleus of a Ropeless Consortium that will next meet, with any other interested parties, at the New Bedford Whaling Museum on November 6th 2018.

Purpose of Workshop and Expected Outcomes

Mark Baumgartner, Woods Hole Oceanographic Institution

This workshop involved a total of 102 people: scientists, engineers, fishermen, fishing organization representatives, US state and federal regulators, US fisheries management councils and commissions, Canadian regulators, enforcement, funders, and NGO conservation groups.

Definition of 'Ropeless'

Trap fisheries that avoid the use of rope in the water column to minimize the risk of entanglement of large whales, turtles and other marine vertebrates (Figure 1).



Figure 1 - The basis of the ropeless concept is to avoid the risk of entangling whales in ropes suspended in the water column by not using a surface marker buoy or line from the buoy to the trap. The challenge is to provide a safe, legal, practical and affordable alternative system to mark the location of traps on the bottom and retrieve traps without a surface buoy or end line.

Workshop Goals

- 1. Discuss the need for approaches to implementing ropeless fishing to reduce entanglement of large whales in trap/pot fisheries.
- 2. Discuss how to develop regulatory pathways to make ropeless fishing legal in the US and Canada.
- 3. Discuss strategies to fund 3 phases of development, commercialization and market outreach, and population assessment.

The current situation is frustrating for all stakeholders as despite considerable regulations to U.S. fisheries, North Atlantic right whale mortality remains high. The workshop goal was to have productive dialogue about ropeless fishing.

Rationale

'Ropeless' has been a discussion point for at least 15 years. Many people have strong negative images of the topic: time consuming grappling if ropeless doesn't work, greater gear conflict, expensive equipment and unenforceable. The goal was to resolve these concerns while recognizing the great urgency for right whales. The fishing gear entanglement problem is worse than it's ever been. There is also urgency for the fishing industry, given actual or potential risk of area closures.

Agenda Overview

Session 1 – Need and Technology

The right whale population had been growing slowly until it began declining in 2010. The estimated size as of 2016 was 450. With a population this small, it is very fragile. Entanglements have increased dramatically since 2009, while mortality due to vessel strikes has decreased. The most recent entanglement mortality was discovered off Virginia on January 24th 2018.

Only about 100 breeding females are left in the population. Given their current mortality rate the species has about 20 years left before these 100 females are gone, at which point the species will be functionally extinct. This translates to similar urgency for the fishing industry as well. Pressure to mitigate the problem will grow, especially from the regulators and the general public. Ultimately closures will occur. This is everyone's problem – fishermen, consumers, retailers, regulators. The workshop covered the following technological approaches: spooled ropes, bagged ropes, lift bags and trap modems.



Figure 2. Key aspects to the ropeless concept include traps that can be retrieved without an end line. Here we show a buoyant rope spool and an inflatable bag, both triggered acoustically to bring a trap to the surface, and an acoustic modem relaying trap location to a wheelhouse plotter on a surface vessel. A commercially available bottom stowed rope bag system was also discussed.

Ropeless fishing is illegal in many areas. Surface buoys are required for visual marking – if you remove the buoy how do you mark the gear?

How do we take the ropeless concept to an operational system for the fishing industry that is affordable and feasible? The following areas need to be developed in parallel over the next 6+ years.

Technology development:



Figure 3. A schematic of the three development threads of the ropeless concept, their phases and timelines. This workshop is focused on ropeless and the need to recognize that its full-scale implementation will take time. But we don't have time, so what do we do in the meantime? Rope with a 1700 lb breaking strength is being put forward as a critical option in the meantime, but that topic was not considered in this workshop.

Why ropeless?

Through looking at gear removed from whales since the 2007 introduction of sinking ground line, 91% of cases involved end line (Morin *et al.* 2018). Prior to 2002, 70% of cases were end line and 30% were likely ground line (Johnson *et al.* 2005), although these analyses have a series of caveats and are ongoing. Thus with entanglements in ground line seemingly reduced three-fold by shifting to sinking ground line, the next major challenge and critical necessity is to remove rope from the water column and thus eliminate risk from end line entanglement. In the interim, reduced breaking strength rope will certainly help whales and some turtles but only ropeless will help all.

Promises of ropeless

- 1. Fishing and whales can coexist
- 2. Gear can be deployed where there are whales
- 3. Presently closed areas could potentially be opened

Benefits for fisherman

- 1. Never buy end lines again for some ropeless approaches
- 2. Significant reduction in lost gear
- 3. Gear position is still apparent using technology, but gear identity only known by gear owner and enforcement
- 4. Less gear movement from current and tidal drag on end lines and buoys
- 5. Fewer interactions with vessels
- 6. Some ropeless options may be safer to retrieve
- 7. Gear identity and location can be monitored remotely
- 8. Better information for regulators (for example fishing effort)

We acknowledge that there are challenges, but with continued dialog and assessment at each step, these can be addressed.

Challenges

Affordability Ease of use Operationally appropriate Safety

Desired Outcomes of workshop

- 1. Education about ropeless fishing and productive dialogue
- 2. Workshop report
- 3. Development of <u>ropeless.org website</u>
- 4. Ropeless Consortium
 - 1. Modeled after North Atlantic Right Whale Consortium (NARWC)
 - 2. Annual (or semi-annual) meetings
 - 3. Connect fishermen, engineers, manufacturers, scientists and managers.
 - 4. First meeting November 6th, 2018 day before NARWC annual meeting

Discussion – Purpose of Workshop and Expected Outcomes

Q: You indicated recent VA whale was most certainly fishing entanglement. Was there evidence of that?

A: Yes

Q: Would ropeless apply to all fisheries that introduce line in federal, state waters?

A: Certainly would be good, but can't say now

Q: You mentioned a benefit would be to hide from other fisherman – I foresee multiple layovers. Great consequences

A: We have a way to deal with that, hold on to that (See 'Resolving Gear Conflicts' presentation on page 21 below).

Q: Less gear movement was another bullet point. Fishermen are concerned that there will be more gear loss. How will they retrieve if it moves?

A: We have a way to deal with that (again see 'Resolving Gear Conflicts' presentation below).

Q: Enforcement can't deal with enforcing rules we have today. Are they going to haul gear and then set it back where it was?

A: Will depend on how universal the retrieval and deployment methods are in a given fishery, as multiple methods for hauling and deployment would make it hard for enforcement to be equipped with all variants. Enforcement methods will evolve with the technology.

Q: Your statistics ended in 2014 for entanglement. 2015-2017 – can document one 2 weeks ago, but what about other years?

A: Numbers shown are from NOAA Stock Assessment Reports which only covered through 2014 at time of analysis. Scott will update recent numbers in his talk.

Session 1: Need and technology

Chair: Amy Knowlton, Anderson Cabot Center for Ocean Life at the New England Aquarium

North Atlantic Right Whale Status and Trends

Scott Kraus, Anderson Cabot Center for Ocean Life at the New England Aquarium

When we are talking about changing fisheries, we need to be certain that the data we are collecting and presenting is defensible. Most of this work has been peer reviewed and published. The NARW catalog and database has been curated by the New England Aquarium and represents data from many contributors. Right whales have distinct faces and we know most whales in the population. Each year the catalog collects 2,000-5,000 sightings and adds around 30,000 images per year. The catalog is available <u>online</u>.

Population size – The latest models suggest 450, but that was before the 2017 mortality event in Canada and off New England. The catalog is large and a great deal of information comes from it. Distribution and movement, annual calf counts, mortalities, case studies.

We can estimate presumed deaths because we have tracked these animals for 30+ years, we are able to track entanglement rates because these events leave scars. Health Assessments have been carried out for sightings since 1980. Over 100 peer reviewed publications have resulted from catalog data.



Figure 4. Graph from a recent paper showing significant decline in numbers of NARW since 2010 (Pace et al. 2017).

Right whale researchers were not surprised by this decline because we have seen evidence over the last several years, involving changes in both mortality and reproduction. A previous reduction in reproduction in the late 1990's showed that these events can be reversible. However, since 1981 there has been a trend of increasing numbers of females available to calve, but a decreasing percentage of them that actually calve. Two reasons have been hypothesized for this decrease in reproduction.

a. Whales have recently moved around more than we have seen in the last 30 years. There have been decreases in whale abundance in the Bay of Fundy, Great South Channel and the Southeast United States, and increases in Cape Cod Bay and the Gulf of St Lawrence. Movement of animals suggest prey resources not available in traditional areas, and females may not be getting enough nutritional input to sustain pregnancy and calve.

b. Sub lethal impacts from entanglement. When an animal gets severely entangled, even if gear is removed, ability to feed may be compromised and available energy is diverted to healing and sustaining increased drag from the entanglement. The chronic stress will also reduce ability to manage infections. Without adequate energy reserves animals will not get pregnant, thus reproduction will be delayed. There is evidence that severely entangled whales have long term problems with health, and decreased calving and survival probability.



Deaths in Right whales - Known and estimates

Figure 5. Detected NARW mortalities as a percentage of estimated population size as reported in NOAA Stock Assessment Reports <u>http://www.nmfs.noaa.gov/pr/sars/species.htm#largewhales</u>

Vessel strike mortalities have been diminishing since 2005 since implementation of speed and routing measures throughout the right whale's range, whereas death from entanglement (Knowlton *et al.* 2012) has been dramatically increasing since 2009. We are only detecting about 1/3 of all mortalities. This is supported by the Pace model (Pace et al. 2017) and catalog data. Why?

1. Usually chronically entangled whales lose weight and sink when they die thereby decreasing detectability.

2. Evidence shows that chronically entangled whales seek out warmer waters, leading them into areas where there is little effort to look for whales.

This is a range wide issue. Whales get entangled anywhere there is rope in the water. Whales can travel long distances while entangled. They are often sighted carrying gear a long way from where they initially got entangled.



Figure 6 summarizes the status as of 2015. Those trends have only accelerated since 2015.

Figure 6 – Annual calf counts and mortality and serious injury determinations 2000-2014 as reported in <u>NOAA Stock Assessment Reports</u>

Note: PBR = Potential Biological Removal (see above NOAA report for further information).

Ideas for mitigation

- 1. Closures
- 2. Sinking ground lines
- 3. Reduced breaking strength rope
- 4. Ropeless fishing

Vessel Strikes – have declined substantially since 2005 as measures were implemented. There were some vessel strikes in the Gulf of St. Lawrence this summer (2017) where no management measures had been in place and usage of this habitat appears to have increased. Two types of measures that have been used to reduce vessel strikes are:

- 1. Ship routing
- 2. Speed restrictions

To address entanglements, measures need to be implemented range wide. We do not have long.

Review of Gear Modifications to Reduce Entanglements in NARW

Tim Werner, Consortium for Wildlife Bycatch Reduction at the New England Aquarium Main focus is developing modified fishing gear designed for viable fishing with reduced entanglement risk.

This talk is only focused on end lines.

Over 20 years Atlantic Large Whale Take Reduction Team (ALWTRT) has come up with a number of potential solutions to gear entanglements. The list was reviewed. Several were highlighted.

A recent global workshop (Werner & McLellan-Press 2016) was held to see what evidence there was to support effectiveness in reducing whale entanglements, of various mitigation ideas (see slides 4, 5 and 6 in Werner presentation.

- 1. Minimum ratio of vertical lines to units of gear deployed
 - a. Some evidence shows reduction of interaction
 - b. Fishermen accounts trawling up can lead to increasing diameter of rope which may increase severity of entanglement
 - i. May also increase probability of derelict gear
- 2. Reduce rope or net length
 - a. Possibly less rope carried by entangled whale and thereby may reduce severity
 - b. Still have gear entangling whale and don't know where in the water column these entanglements happen
- 3. Reducing wet storage of gear
 - a. No gear in water, no entanglement possibility
- 4. Making buoy lines negatively buoyant
 - Assumes entanglement risk is higher at surface, don't have observations to support this
- 5. Change color/luminosity of rope

- a. Some research showing that there is some avoidance behavior
- b. Carried out in well-lit waters
- c. Don't know impact on sea turtles.
- d. Don't know behavioral response of other species (humpbacks, for example)
- 6. Sound emitting devices
 - a. Jon Lien showed it can reduce entanglement rates for humpbacks off Newfoundland
 - b. Raises soundscapes issue in ocean
- 7. Materially stiffening rope
- 8. High tension rope
 - a. Increases tension but still seen to cause entanglement in W Australia
- 9. Reduce knots
- 10. Whale free buoy
- 11. Slippery rope
- 12. Post entanglement release
 - a. Time tension cutters
 - b. Weak links
 - c. Reduced strength rope
 - d. Galvanized release

So, the general uncertainty of the efficacy of the above options leads us to the concept of ropeless fishing. The strong message that came out of the 2016 workshop – it's the only thing we know that will prevent entanglements. All others have uncertainty attached and we are not able to do adequately controlled experiments with those options.

Ropeless already being used commercially in SE Australia where it has shown functionality.

- 13. Area Closures
 - a. As a bycatch deterrent tend to need to be really large, located in the right areas, effectively managed, and introduce no new threats.
 - b. Would need to be a massively large area if this was to be an option for right whales.
- 14. Effort reduction
 - a. Still have issue of lines being in water column
- 15. Catch share fishery
 - a. Some thought that there is a benefit, but no data on large whale applications
- 16. Ban or boycott products / promote whale safe fisheries
 - a. Certainly, one tool but won't completely solve what we are trying to do here.

Summary of options

No evidence required

Terminate pot fishing Fish without ropes

Some supporting evidence (see slide 14) Whale release rope Colored ropes Reduce gear

More evidence needed

Various types of closures Reduce effort Catch shares Promote "sustainable" fisheries/boycotts Gear mods

Our working strategy

Gear modifications have to be centerpiece of whale entanglement prevention Using reduced breaking strength (that may be visually enhanced) in the interim where feasible

Increase evaluations of ropeless with fishermen

Disentanglement

Not a technique that prevents entanglement Ethically fantastic thing to do Can contribute to the survival of individuals Learned a great deal about gear characteristic from gear retrieved. Gives general public sense that the issues can't be solved and that disentanglement is the answer. Not a long-term solution. Preventing entanglements need to be the priority.

Acknowledged all who have worked collaboratively on these issues.

Ropeless Fishing in Practice Today

Michael Moore, Woods Hole Oceanographic Institution

To haul without end lines is a fundamental change in how most traps are fished. Major imposition on industry.

Questions – Look at where fishing without end lines is currently practiced Benefits? Drawbacks? Enhancements?

Boston Harbor - It is legal to grapple for trap trawls fish inside harbor to avoid loss of endlines from vessel traffic (it was clarified in the discussion, that these traps are still surface marked with light line and surface floats).

Grapple – deep industry understanding of this tool. If there is a way to deal with layover problem then maybe grappling is an option, then that may be a place to start in the broader discussion. Let ropeless technology proceed, maybe use this technology in interim.

Golden crab fishery

Deep water east of Florida in the Gulf Stream (3-5 knots). 35-40 yr old fishery. If there were end lines traps would get dragged away by the current. They deal with layovers by creating zones with clear communication between fishermen. This is a small functional fishery with no end lines

<u>Evaluation</u> of fixed gear fishing with no vertical lines by Pemaquid fishermen's Co-op Summary – slower and more set overs.

Important to get a sense of how ropeless trap retrieval could change with new technologies. Acoustic modem on trap and vessel

Essentially a virtual buoy marker. Not a fundamental difference between seeing the buoy on surface versus on wheelhouse plotter screen detected from modem.

Combination of grapple and smart trap (modem) may help to minimize disruption of well-known techniques and help move toward ropeless release as technologies are developed.

Interview with NOAA gear specialist

Listed several challenges (see slide #12)

Issue could be resolved with acoustic marker and release

Questions and answers

- 1. Where traps fished without endlines?
 - a. Golden crab, American lobster
- 2. Drawbacks
 - a. Haul time
 - b. Layover/draggers/illegal
 - c. Safety
- 3. Benefits
 - a. Fish in closures, increased current areas and areas with high vessel traffic
 - b. Compliance with MMPA in that entanglement morbidity and mortality would substantially reduce in areas where used

Bottom-stowed spooled rope

Jim Partan and Keenan Ball, Woods Hole Oceanographic Institution

Engineers at WHOI working on bottom stowed spooled rope

Vertical end line spooled at bottom, when time to haul, vessel sends release command (only captain can release), unspools and brings end line to the surface. Then hauled with standard hauling gear.

WHOI Acoustic Communications Group

Expertise in underwater acoustic communication systems

Extensive deployment 20+ years with hundreds of autonomous vehicles, buoys, and seafloor sensors.

Manufactured underwater acoustic modems for military, academic and industrial groups

Problem and Design Space

- 1. Southern New England for offshore lobster fishery
 - a. Strong currents and surface layers need a lot of buoyancy to bring system to surface
 - b. Near canyons and shelf break deep and rapidly changing bathymetry
 - c. Existing gear uses 150-180lb flotations with scope up to 3x
 - d. Weak ropes and weak links not viable with heaviest offshore gear
- 2. Try to minimize impacts to fishermen
 - a. Use existing haulers
- 3. Similar sizes and weights to existing weights of offshore gear
- 4. Quick turnaround on site

Line diameter is a critical design parameter for this technology

Looking at different line length, diameters, water depths to determine appropriate amount of flotations to remain on surface

Able to inform design based on area characteristics where fishing

Design – Acoustics and Release

- 1. On-call acoustic release
 - a. Multiple levels of access
- 2. Electronics can actuate many types of releases
 - a. Lever-arm releases
 - b. Compressed gas release

Design of buoy

Want to make design flexible to be used and scaled to fish in a variety of areas (i.e.

shallow vs deep)

Flotation foam

Protective cages – keep line on spool, protects mechanical releases, acoustic transducer at top of spool

Designed to allow a clear acoustic path from vessel to transducer on release

Release can be scaled for different loads

Rechargeable batteries

Question that is often asked – need to wind line on this?

No – pre-wound self-supporting line cartridge to minimize time resetting at sea. Quick 15 minute turn-around time at sea

Service provider takes away recovered line, inspects line and rebuilds cartridges

Stages of release – Slide 9

Testing status

Three units have been built, lab based tests to optimize release mechanism and controller code

Have done dock testing and then will test at sea Conclusions

Robust acoustic communication

Robust line payout even with up to 500-900m line Quick turn-around at sea Critical detail is line diameter

At sea tests scheduled for 2018

<u>Lift bag</u> Richard Riels, SMELTS

Grandfather was lobsterman in Marion. Trained for disentanglement. SMELTS: Founded 2014 in Washington state - engineering and marine education non-profit

Develop engineering solutions to solve environmental challenges

- 1. Partnering nationally with marine rescue and conservation groups
- 2. Education about challenges facing oceans
- 3. Conservation engineering

Crab raft – presented poster at Society for Marine Mammalogy conference. Airbag based in salvage work, could the bag be used in fishing industry. Slide 6

Buoyant force of bag can lift any gear

Slide 7 – Dungeness crab gear – lot of effort and time required to get sets ready using current system

Slide 8 – lobster – might be a challenge to bring pots to surface with single bag

Benefits -

- 1. Eliminate entanglement potential
- 2. Inflation module does the work
- 3. Reduce trap loss. Redundancies are in place. If trigger doesn't work properly, fishermen can set timer to recover gear.
- 4. Promote buddy system email notification that gear is at surface. If fishermen not able/ready to grab, other fishermen could potentially haul or mark gear for later retrieval.
- 5. Reduce damage to benthic environment ascend only
- 6. Reduce occupational hazard from hauling line
- 7. Reduce poaching
- 8. No vessel interaction with line and buoy.
- 9. No visual pollution
- 10. No depth to surface line ratio issues
 - a. Not moving gear around by floatation at surface and end line frontal drag
- 11. Deflated bag is negatively buoyant so adding a bit more force that will help to keep gear in place.
- 12. Bag power is impressive and exciting. Can work with bag and pot configurations

Challenges of ropeless fishing

- 1. Illegal
 - a. Testing that is being done is in water but not in fishery areas.

- 2. Cost of development
 - a. Will come down with time
- 3. Confidence of fishermen and regulatory agencies
 - a. Will require input from all stakeholders to build confidence
 - b. Not changing gear
- 4. Drift potential
 - a. Bag creates sail, working on testing to see how far and fast movement would occur
- 5. Anthropogenic sounds
 - a. Release of bag does introduce sound to environment
- 6. Adaptation to new technology
- 7. Additional equipment required
 - a. Some new equipment to add to existing equipment.
 - b. Existing trawls need to get first pot onto deck.
 - c. Possible tag line and small buoy could be used for marking until regulations are changed.

Resources

Testing

- 1. Autumn 2017
- 2. First system was about \$100

Bottom-stowed bagged rope

Marco Flagg and Jacob Wolff, Desert Star Systems

Two benefits to using an acoustic release (ARC)

- 1. Environmental
 - a. Effective prevention of marine mammal entanglements
 - b. Ghost fishing mitigation
- 2. Benefits to fishermen
 - a. Releases for peak market price
 - b. Easier fishing in high currents
 - c. Avoids gear theft and vessel damage to end line
 - d. Better time management

Shared <u>video</u> of deployment aboard Vessel Sea King

Deployment

Triggered release

Buoys rise 2m/second

Release mechanisms – single moving part (lever)

Once at surface – grapple, use standard line and winches.

Trap hauled

Empty bag comes up first

Bags being prepared while fishing is going on

Bag re-load with line

Floats attached on top of the bag Release line secured over top of buoy No time loss in the operation

Fishermen's experience New South Wales rock lobster fishery Continuous use since 2013 Some found great success, others struggling

Reliability Scott Westley – indicates release is 99% effective 97-98% recovered by remote release Rest of releases not talking. Also, flooding and battery issues observed

Getting operations right is challenge

- 1. Well serviced acoustics, ropes, floats, bags and boat equipment
- 2. Well thought out deployment and recovery
 - a. Based on constraints of boat
- 3. Understand boat and environmental constraints

Fishermen experience – problems and solutions

- 1. After years of good performance, suddenly couldn't talk to most releases
 - a. Barnacles covered transducer. Transducer regularly serviced and cleaned
- 2. Fishing in more shallow water, sometime hard to link to releases
 - a. Strong winds and current. In shallow water transducer coverage cone is smaller and boat drifted past trap too fast. Steaming against the current/ seas solved it.
- 3. After months of continuous use, almost half of releases reported trigger but floats didn't surface
 - a. Barnacles grown all over release and bags, now regularly clean

Conclusion – must support individual fishermen

Regional difference in conditions and impacts on systems.

Other concerns

- 1. Gear overlay without surface buoy
 - a. Developed ropeless fisherman app
 - b. Show other fishermen where your gear is. Set visibility range, radius determined by fishermen
 - c. Talk about developing regulator aspect so that regulators can see all gear
- 2. Handling time
 - a. No increase
 - b. Example captain handling release range and trigger
 - c. Crew 1 bag stuffing and arming, catch tagging and boxing
 - d. Crew 2 trap and bait, no involvement in trigger system
- 3. Cost and Maintenance
 - a. Cost offset by business operation advantages
 - b. Lower cost version in testing (ARC-2)

Fishery integrations Pilot program recommended See slide for details of offering (slide #19)

This technology is available today

Three requests:

- 1. Fisherman association: give this a chance and put forward some pilot fishers who are willing to give it a try. We will help them and work out bugs.
- 2. Government and private funding: These pilot programs need to be supported. Can give quote for full pilot program today for interested parties. Needs to be funding to support fishermen. Benefit to fishermen and community.
- 3. Regulators: Sufficient gear marking is in place if I record my gear on the app so that you can see where my gear is. When you go out on site, you can ping and see that gear. If I was a fisherman I would request this is legal gear marking.

Resolving gear conflicts

Mark Baumgartner, Woods Hole Oceanographic Institution

I'll speak directly to questions asked earlier.

Gear conflict is a major concern when discussing ropeless fishing TRT only came to consensus once it was to open closed Great South Channel area to ropeless fishing.

NMFS: "Gear conflicts would need to be addressed"

Requirements

- 1. Position of traps or ends of trawl must be available to fixed and mobile fishers
- 2. Orientation of trawls must be available to fixed and mobile fishers
- 3. Registration / permit information must be available to owner and regulators

Also

Trap trawl positions available to non-owners only when on scene Identity only available to enforcement Trap trawl positions associated with gear that is physically on seafloor.

New approach

Acoustically mark the location of each trap or ends of trawl Enable the trap/trawl to report its position to fixed or mobile fishermen Enable trap/trawl to report registration/permit info to enforcement Commercial plotters to show positions of acoustically marked gear

Technology

- 1. Acoustic modem allows data to be passed through water via acoustical waves
- 2. Proven technology with several commercial manufacturers
- 3. Propose to use modems on traps and vessels

System – described how the system would work (see slide #7)

Same modem will release whatever mechanism is being used (integrated already into spool and funding obtained to integrate with the crab bag)

See Powerpoint animations (download) to illustrate how this works.

- 1. Trap outfitted with a lift bag, attached modem with GPS, grab location position
- 2. Trap dropped, illustrated single but could also be a trawl just would attach modem to last trap in the trawl or trawl anchor
- 3. Vessel modem to determine if there is gear on the seafloor.
- 4. When the trap modem sends its position, information passed to chart plotter. Can see individual traps and trawls including end traps and orientation
- 5. When vessel makes request, sending out its position and ship identifier, trap can compare what ship's location is and compare it to where the trap location should be. If the trap is off from its deployed location, then it can update its position and send that information to vessel.
- 6. Trap sending both public and private data
 - a. Public last known position of trap/GPS/ranging
 - b. Private encrypted data
 - i. Last surface date and time
 - ii. Fishers registration number
 - iii. Unique device identifier
 - iv. User designated ID
 - v. Sensor data (trap occupancy)
- 7. Ship gets back to shore, data gets sent to data warehouse via cell tower. Collected a lot of information about traps and trawls.
- 8. Trap modem also acts as trigger mechanism to get trap back

What happens if gear moves?

Details of action – slide #17

Animation of what that would look like

- 1. Storm moves trap
- 2. Fishermen can't find gear
- 3. Another ship travels by trap and when it returns to port, data downloaded to warehouse
- 4. Original fishermen would get message via cell about moved gear and where it is.

Autonomous Enforcement

Cost effective means to survey for gear in areas where there isn't much vessel traffic passing through

- 1. Example gliders
- 2. Don't need people associated with them
- 3. Enforcement wouldn't need to go to sea

Summary

Trap modems serve same location marker system as surface buoys.

Allows owner, other vessel and enforcement to locate gear on the sea floor

Allows gear to be retrieved by owner only

Allows for relocation if gear moves. Easy to use (think GPS) Allows enforcement to monitor gear location and owner

Discussion: Ropeless need and technology

Are there concepts we have overlooked? Concerns about overall visions?

Q: Must have scope enough between traps? A: Can have extended ground line between 1st and 2nd trap to lighten load Would scale lift bag relative to how you are going to fish it. If you don't want long ground line, use a lot more lift in bag.

Q: Re Lift Bag system. Maintenance of bag – if you are deploying and bring trap back up can you reset the bag, new air system? What kind of time is needed to reset the bag? A: One of the things we did right from the beginning is think about cost. Off shelf dive industry gear. Bag is collapsed instance it comes out of water. It will vent, collapse. Working on multiple deployments. Show how to exchange bottles. Trying very hard to not add extra time for fishermen to work. Maintenance of bag – plastic bag material is tough. I've seen project where they are lifting sea cable and bags laid out for extended periods of time. Cleaning with soap and water. Beauty of system is that it's always being purged with air so being flushed all of the time. Bags can be flushed at end of season and rolled into stuff sack for storage.

Q: For refilling air, need compressor?

A: Yes. Many boats already that have high pressure air compressor.

Q: For engineers – I don't want anything put on my trap. Once you put stuff on my trap it will affect the trap. My suggestion would be to put it somewhere other than on my trap. A: Tend to put bags on tether that is attached to trap. Use 10 fathom for ease of handling at surface.

Q: Any type of hold on trap will move them around.

A: Other thing on that is that every fisher will have their own and regional requirements. Issue for optimizing that needs to be addressed for each fisher.

Q: Could you use a dummy trap?

A: Offshore guys use sled. Yes. Would rather use something like that and leave my traps alone.

Q: One issue I would have is you assume buoys marking gear is so we don't set on top. We mark our gear so that it levels playing field. There could be additional vents in trap.

Grappling – worst thing that you would ever want to happen. If I had to grapple, I would have as much float line so that I could guarantee grapple. Unintended consequences of some of the things we have talked about that would not be in the best interest of why we are here today.

Q: Is there a lot of dockside enforcement of gear?

A: There is dockside but most at sea. Most effective enforcement is at sea. Going off what was just talked about unbuoyed traps with floating groundline to grapple, that looks like a whale trap to me. Found one with 100 ft float line. Unbuoyed traps are going to lead to entanglements.

A: Grappling is offensive – if probable cause, track and pull gear

A: As the situation is currently grappling is illegal in most places. If it can't be grappled without a substantial float line then it's not a solution.

Q: Boston Harbor is not a place that can fish without end line. That is not accurate. Only exception in that harbor is that they can use modified buoys (bleach container) but illegal to fish that gear unmarked.

Q: What is the max depth that you have been working with in New South Wales and whether the business of packing a bag is practical?

A: Gear rated to 300m depths, in NSW deepest traps are a bit deeper – 350m. Fail point of release is 1000m. Another question to ask is - what is the range of acoustics itself? See potential problem if you use just acoustic – may not pick up signal. Advocate for virtual marking and acoustic marking.

Q: Is there a practical limit to packing line in areas here where fishers are in deep water set up bags

A: In NSW they set up bags for maximum depth. They have enough scope to do 350m. Fishing deeper than 350 then bag would be bigger, but perhaps boat would be bigger as well. Needs to be seen in combination. Fishery specific optimization issues. Important to go out with individual fishermen to optimized.

Q: About noise – anticipating modem working in close proximity. How many can work closely before noise becomes an issue? Also – any evidence that noise won't affect target catch? In high current areas will noise be an issue for modem.

A: Trap modem only making noise when interrogated by ship. May be able to have trap modems pause when multiple modem attempting to communicate. Perhaps Keenan/Jim speak to noise? A: Envision 40-50 kHz, range of 1km, above hearing range of most or all baleen whales. Also, relatively quiet area – sea floor. At surface, potentially more challenging with flow noise. Not sure how it would affect target catch.

A: Talked about for draggers, they are mostly interested in what's in front of them – can baffle so they are pinging out in front of them. Don't need to be listening 360 degrees around them. Help greatly with noise issue.

A: Speak to how close modems can be - In most case you can do it by serials, so doesn't matter how close modems are together. Signals really short. Only interaction seen was with curious dolphin.

Q: I have pages of rebuttals and Qs that I don't have time for right now, but what I see in a nutshell is that we have blinders on that ropeless is the only way to go. It's clear that this is a means to make money to some people. We are looking for a way to force people to do something to make money for certain groups. Easier ways to start this process. Laws – change the laws. Very simple to change law, but no money to be made. Law been in place since 1941. Change some basic laws that go against what you are trying to do. (To reduce end lines where it is currently required to have an end line on every trap.)

Q: Two points. Can we create some email chain for questions? Bag system – need ropes to be clean. Rope growth here is staggering. Cleaning rope would mean additional cleaners on board. Gear conflict issues – using pinging to identify vessels going through other areas – point of clarifications?

Q: How quickly is GPS acquisition happening? What about drift – where it goes overboard isn't necessarily where it lands. Tides and currents – how will you overcome that difference to avoid overlay?

A: After you put it over – imagine trap has radius around last known position. Vessel would range to it after it is deployed. Then it can determine its own position on the bottom. I think you can overcome that.

Q: Examples for where these are working don't translate to our areas and/or fisheries. Even if we fundamentally change what we are doing, we have 4000 small businesses in Maine trying to make a living. This is very hard for fishing industry to wrap head around because examples aren't applicable. Operational scalability is hard to translate from examples given. Missing mark for enforcement. Struggle constantly for self-enforcement. Autonomous enforcement is just saying traps are there.

Q: When enforcement pulls gear, what do they do with it?

A: One big issue – are they fishing over trap limit? Under your scenario it's easy to figure out trap numbers, but can't see illegal gear running in between.

Q: Don't fully understand enforcement issues. When you have just markers at surface, you don't know what's at depth. The only way to see what the gear is to haul it. What if we allowed enforcement to trip release?

A: Enforcement would need to be able to redeploy. Doesn't get at fundamental issue. Guys can go dark. Now – easy to know right now because people notice a guy not fishing with buoys. Want to say one more thing. In terms of buy in, Scott, you showed a graph predominantly with entanglements prior to changes in gear mods. We need better information about how gear is involved. Why are we going to invest millions of dollars if it's not our gear?

A: The guys that are doing that now are doing above what they are legally doing. Going to make honest people dishonest so that they can keep up with their catches.

Q: In NSW fishery committee realized that entire fishery could use the Desert Star system. We are missing the point about gear marking. Shouldn't be done just acoustically. If you have a multi-faceted approach, now have enforcement on shore that can cross check. In conjunction with acoustic modem.

Q: how many traps are fished with technology in NSW? A: 1000

A: My Bay of Fundy vessel already carries technology needed. Acoustic modem seems cumbersome. Need satellite up-loadable database mark on plotter.

Q: what if a fisherman doesn't actually mark when they deploy or retrieve? Trap modem is involved, but it is tied to physical presence of trap and I think that's important.

A: If I fail to mark trap I can't retrieve it. Conservation benefit is questionable. Poachers will just not mark traps. A lot of this technology would not survive in the environments we are fishing in. A: To respond abut unmarking of gear. The only way to enforce would be if a person was hauling an unmarked modem trawl. Would need CG to stop vessel, verify and then pull license. Need very severe consequences.

Q: What is the range of the modem? This is a scenario I see. Set trawl. Trawler sets a mile away, comes up on trap, what does he do? No one around, I'm towing through it, no one will know. Would never find out who or why went through gear.

Q: What's the range you can see buoys now?

A: Could be 2-3 miles.

Q: What is the ramification of someone knowingly going through gear when no one else is around? – Not answered

A: Range depends on frequency. Lower 25 kHz – several kilometers (2-5km). That's right at the top of baleen whale hearing range. Move up to high frequency more energy loss and lessened range. 40-50 kHz would be about 1 km. That would be difficult in the scenario you just described.

A: Another possible solution – if you had all your gear marked, upload to satellite, and distribute it out. Doesn't have to say name, but could look before leaving dock.

Comment: Candor we are getting is really encouraging. Kudos to fishermen and women and organizers for speaking candidly. Question and concern – whatever is done locally east coast/NE need lower tech options that could have ripple effect internationally to offer prospect for broader roll out.

Comment: Echo concerns about scalability to Maine lobster fishery. Examples given are small fisheries. Just US lobster fishery comprises >3 million traps, 7000 individuals. That's several orders of magnitude larger than examples shown here. Other thing to consider is there is a great diversity of scale and size of fisheries, but also areas that are fished (shallow, deep, etc). 800 lb gorilla in room is who is paying for this? One of the things I like to see focused on is the financial feasibility and scalability. Magnitude of Canadian fisheries is slightly larger than ours.

Comment: Humpback entanglement issues (300-500,000 single crab pots), on west coast. Low cost technology I'd like to see considered is idea of using recycled metal. Corrodible metal releases designed for different time lengths based on mass of metal.

Q: For lobster fishermen. Vision that I have is hybrid fishing season. In NE there are closures – if there was a system where you could fish during closed season with ropeless gear, and then move

back to traditional methods when whales move out? Are there fishermen in this room who would try it?

A: Had a group of fishermen step up but not getting anywhere. There are guys ready and willing.

Q: Wrap up for tech. There are multiple frequencies – in your vision do you see this needed one single technology/gear type or figure out where multiple gear types might be used.

A: One solution to this. Spool won't work in Cape Cod Bay. Designed for offshore.

Q: Need to focus on 1 frequency?

A: Could change depending on water working in. Frequencies can vary. Cell phones in room all talking to cell towers at once right now. There are tech solutions.

Comment: High trap and vessel density – need to keep a biological eye on other organisms.

Session 2: Regulatory challenges

Chair: Michael Moore, Woods Hole Oceanographic Institution

<u>Introduction to the regulatory landscape: ALWTRT</u> Mike Asaro, Greater Atlantic Regional Fisheries Office, NOAA Fisheries

Overview of Atlantic Large Whale Take Reduction Team (<u>ALWTRT</u>) and regulations and accomplishments of ALWTRT.

One of the oldest, established in 1996. Described the purpose of the team, which is to develop a plan for reducing incidental take of right whales, humpback whales, fin and minkes in commercial trap, pot and gillnet gear in US waters from Maine to Florida.

Goal – reduce serious injuries and mortalities to <<u>PBR</u> # that can be removed without harming its survival NARW PBR – has been 0 or 1 Large team membership, largest in country, >60 members Accomplishments (slide #6) 1997 initial plan in place – weak links, gear markings, closures Early 2000: SAMs and DAMs 2007: SAM and DAM replaced with sinking ground line rule 2014: Trawling up, min trap per trawl requirements to reduce # end lines

Figure showing all managed areas – gives sense of geographic scope of the plan (slide #7)

Universal requirements – weak link coast wide on vertical lines Gear marking is required coast wide - Three 12" marks Number of seasonal closure areas

Over 32000 square miles of seasonal closures (maps included in presentation, slide #10)

Gear Research

- 1. Throughout its history, a pattern of coming up with modification ideas, funding and executing ideas. Website includes matrix of ideas and outcomes
- 2. Ropeless has been a topic that TRT has talked about for years.

Process for considering gear modifications

Threshold for considering new ideas is low – detailed explanation of proposed mods, how it differs from what is currently required, as quantitative as possible – what is the conservation equivalency (does the measure have the same or less risk to whales than what is currently required).

Many ideas that have come up today are ones that we will need to address going forward. Discussions happening here are exactly the conversations we need to be having. There are many details and challenges to new ideas that need to be vetted.

Over next 6 months, working with 2 TRT subgroups. Will allow group to be nimbler than currently are. These are fact finding groups.

- 1. Reduced breaking strength rope/gear marking Majority of rope we get back is still unmarked. Take a look at better way to mark gear to increase of recovered gear being marked
- 2. Ropeless fishing

Can use conversations today as springboard for this group.

These groups are assessing feasibility.

- 1. Looking at functional and technological feasibility
- 2. Considering both short and long-term implications

Subgroups will report to TRT in fall 2018.

Long term planning for TRT. We think that the system is good. Good to have as many interested people at the table. Fundamentally, this is good. What is NOAA's role in that process? It is incumbent upon the agency to bring forward as much information as we can, to maximize the value of the TRT. Sometimes answers will be: no that won't work. But hoping to be able to provide better explanations for rational progress.

Long term planning: In the past, the long-term plan was to address ßvertical lines, and then ground lines. At this point in time with respect to right whales and given issues TRT needs to tackle, we are in need of long term planning.

- 1. Would like to pose to TRT where does ropeless fishing align with TRT working towards long term? Important to look at time scales. There is skepticism about how ready some of the ropeless ideas are for use. We need to be thinking about what the development path is over the next several years. Discuss with TRT is this a good idea, how do we chart our path, in specific and practical terms, how do we get there?
- 2. TRT is mandated by law to essentially eliminate right whale mortalities
- 3. With that goal in mind, what measures may be available to eliminate mortalities?

Federal Surface Gear Marking Requirements and Regulatory Process

Peter Burns, Greater Atlantic Regional Fisheries Office, NOAA Fisheries

Legislative authority for how gear markings are regulated

- 1. Identified federal statutes (slide#3)
 - a. Lobster trap/pot: Atlantic coastal act 50CFR 697
 - b. Bottom tending fixed gear
 - c. MMPA
- 2. First two enforcement and navigation, third for whale management.
- 3. Fed gear marking areas (slides 4 and 5 slide and map illustrate required marking areas)

Gear marking requirements

- 1. Universal requirements
- 2. Lobster trap trawls of three or fewer traps in EEZ
- 3. Lobster trap trawls more than three traps in EEZ
- 4. Max trap trawl length
- 5. Gear markings

Bottom tending fixed gear marking requirements (slide #8) Red crab trap/pot marking requirements (slide #9)

Regulatory process

- 1. Lobster actions generally initiate via Atlantic States Fisheries Management Council (ASFMC), other fisheries initiated via fishery management councils
- 2. Changes to gear marking requirements most effective if processed via ALWTRT and consistent with ALWTRT
- 3. Allows for active engagement and consultation with the councils, ASFMC and NGOs

Recommends continuing with the existing process via ALWTRT. Would have more wellinformed discussion at council and commission levels.

<u>Amendment to the Fishery (General) Regulations: Overcoming Development, Regulatory, and</u> <u>Funding Challenges for Rope-less Fishing in the U.S. and Canada</u> Annette Rumbolt, Fisheries and Oceans Canada

In Canada – National Fishery General Regulation (FGR). Requirements reviewed on slide #2 There is a proposed amendment that would create an exception to this requirement if it is specified as a condition of the license.

Section 22 of FGR allows for Minister to specify license conditions (slide #2) Proposed amendment – gives minister authority to authorize single marker (slide #3) and potentially allow for no end marking at the surface if rope-less fishing technology were developed and implemented in fixed gear fisheries. Amendment would be national in scope but flexible in its application

Next steps - review feedback concerning single marker proposal

Then develop regulatory documents to move amendment forward (slide #6)

Q: Does minister have discretion to authorize fishing of non-conforming gear? A: Yes. We also could issue experimental licenses. But – cannot retain their catch. There are ways and means to make it happen.

Discussion: Overcoming regulatory challenges to rope-less fishing

Q: In NSW, position is all gear must be marked, but gear could be marked but not at surface. Would you hold to same interpretation in Canada?

A: Interesting concept, don't know if we have had that conversation on national level.

Q: How long since U.S. gear marking compliance letters have been sent out? If folks aren't compliant with rules, it reminds them.

A: NMFS has a couple of approaches: Direct mail outreach to permit holders, gear experts, port agents, OLE outreach. Not sure when last time gear marking reminders were sent out Follow up: most in business today weren't around when regs were put in. Might be good time to remind them.

Q For NMFS: Do you have discretion as DFO Minister does, to conditionally allow for something that is non-conforming? I hope we don't have to go to TRT before NMFS could do that.

A: Yes, we have exempted and experimental permits, LOA where you can get exemption for gear research, experimental fishing. Process we could consider. From fisheries management side we would want to do in conjunction with protected resources folks.

A: NMFS allowing experimental in closed area would require regulatory amendment.

Q: What is the time scale on those NMFS regulations?

A: Depends on scale – could issue permit within 30 days. Different issue when trying to authorize something in closed area.

A: Tough to estimate process, it is burdensome. Scale and scope will dictate how long the process takes. Allowing access to MA closed area – consideration are # vessels, there are necessarily economic burdens involved, conditions surrounding that circumstance suggest it would be quick.

Q for DFO: Heard new regs put in for snow crab fishery. Can you explain those? Why haven't they been implemented into lobster fisheries?

A: Will do my best. Not sure about lobster fishery.

A: DFO have 4 administrative regions and no one from Gulf Region was able to come. New measures were just announced are short term -2 are preventative

- 1. Reducing floating rope
- 2. Kicker buoy line can only be 2 fathoms
- Another is Non-preventative

1. Sequential buoy numbering, line marking,

There will be more coming with regards to regulatory measures.

Q: Address issue of gear marking to US regulators. In NSW gear must be marked but doesn't have to be a surface mark. If we had a fishery come to Desert Star, would you be satisfied with gear marked at bottom until commanded OR would you be satisfied with being given location A: In Canada –not sure. Would have to take it back to be discussed.

A: U.S. gear conflicts will exist until all vessels are outfitted with capability to see bottom stowed gear.

Q: How do we handle changing technologies and new ideas in conjunction with the legal time line?

A: To go back to bottom gear marking questions – I suspect that Canadian process much less litigious and legislative than in the US. It does require a lot of consultation with fisheries (commercial and first nations) but we don't have any steps because of the status we give our minister.

A: Canadian Fisheries minister can sign legislature with the stroke of pen. Unique in Canada. Fishermen are the most resistant to change unless it makes their life easier and makes them more money. Let's incentivize fishermen.

A: DFO – Maritimes – add a further clarification about gear marking. Section 27 does specifically say it has to be readily visible without raising gear out of the water.

Q: Primarily for NOAA folks: Much of the discussions re alleviating over setting or gear conflicts involves system of acoustic modems. Are there any examples of fisheries in the US where fisheries were closed due to conflicts or where bottom rights have been assigned in fed fisheries where lobstermen would have rights?

A: Lobster fishermen have no grounds owned. Seasonal agreements.

Q: How do seasonal agreements get worked out?

A: Sit around a table and work it out. With consolidation of industry, able to work together, fishermen all know each other.

A: There are gear restricted areas (example Hudson to W canyons), seasonally restricted to either fixed or mobile. There are closures south of Long Island for one month for lobster conservation, but others can fish there.

A: When thinking about regulatory amendments there are big differences between allowing ropeless and requiring ropeless. Former – significantly easier.

Q: Are electronic log books/vessel monitoring systems in place? If so, would that help reduce some concerns about gear markings?

A: Yes we have those. Some cases they are mandated some more voluntary. Another tool.

Q: These are in mobile but not fixed?

A: If you have both lobster and ground fish permits, there are VMS requirements.

Q: Do we have statement anywhere that states that ropeless conservation equivalency would be 0? It's a needed statement.

A: Re conservation equivalency - In a closed area – the conservation equivalency is already 0. How do we then work towards getting in there with any gear at all?

Q: Is ropeless 0 mortality? We need to deal with that – what is the potential mort reduction with ropeless?

A: We did conclude at Baltimore meeting that ropeless would have 0 impact but I don't know if that made it into the notes. We did vote unanimously to support concept and open closed areas to ropeless.

Q: If spool fails and whale dies, is burden on fishery or spool manufacturer? – No answer recorded

A: On Jan 31 2018 TRT call, 91% deaths were end line. But other line does present some level of risk.

A: Conclusion was based on single pot.

A: Just because 91% - can be caveated that in the 9% remaining isn't necessarily caused by groundline

Q: Did webinar show 9% whales in groundline?

A: Doesn't tell what whale actually hit.

A: Great difficulty determining ground line on an entangled whale. If you don't get marked area of gear, difficult to tease out which part of the gear is entangling. Need gear markings that ensure that we are getting markings on any gear retrieved from whale.

Comment: Vertical line – covers 100% of water column. Ground line covers far less of the water column.

Comment: gear marking – I personally like marking gear with color codes. We are showing that our colors aren't going to be on the whales. Perception in room is that lobster industry is bad.

Comment: Yellow tracer in our line, not in groundline

Q: with emerging situation, what is the quickest way to get all of our gear into the water and into hands of fishermen to try to see if this is an effective solution?

A: Talk in next session how to move forward. Right now no impediments for testing. Can close off traps, add surface markers for testing. Need funding and time to make prototypes. Some are poised to do that. There are steps to go through before we engage fishermen with the prototypes.

Q: Technology of rope spool. Who is in charge of keeping rope in good shape? Is fisherman renting rope from the service? Other questions is if fishermen are implementing costly equipment, do they ever get insurance for their gear? Can that be part of the equation? A: Generally the concept is very similar to linen service. Can imagine system of leasing spools or modem. Gear always in rotation and being serviced. Not to say that people properly trained couldn't take ownership of their own gear. We did talk about question of trust. Do you end up with someone else's line that was poorly treated? Another possibility is that people have their own line that they turn in to be used. One of the difficult things is the physical volume of rope. How do you move rope from shore out to fishery and back because currently it's sent right back out with trawl. Maybe line lockers. If the line diameter can change, spool size changes a lot. The trade-offs with line diameter were discussed and it's a critical question. There have been many hundreds of line spools manufactured with great care and maintenance. Not a trivial process to

wind one of these spools. I don't have cut off line length, but I believe probably for volume of rope, a line bag will be less robust than a line on a spool. In deeper waters, spool would be more robust. Galvanized time release used in NSW.

A: Can provide perspective on how much line can you have in bag – fishing to depths of 350m. Line diameter I think is 3/8" in NSW. Do not use 1 to 1 scope. More scope than 1 to 1 because they want to fish in higher currents than they have previously been able to. With static buoy, buoy will get pulled down, could fish in .75 knots. Increased ability to fish in current to 2 knots.

Q: Maine boats move between various depths seasonally. Different spools required?

A: Would have different spool sets depending on where fishing.

Q: For offshore fishery – these vessels for 1 trawl looking at 700 fathoms of end line. 32000 fathoms for a set of gear. On 80ft vessel would need 100 spools, handle line, bring home, remove gear for service. Trips 8 days, hauling 10 trawls to 20 trawls a day.

A: Logistics are somewhere between challenging and impossible.

Comment: These lines are extremely heavy.

A: Tub storage is an option.

Comment: - NSW - all single traps. Yes - heavy and long soak times.

Q: can respool at sea? That would alleviate having 100 spools on board.

A: Line cartridge concept has restriction of time factor to reassemble

A: A question we have asked - can you spool to new spool as you are hauling – I don't think there's a fundamental reason that couldn't be done. Can use anti-fouling agents if this was to be employed.

Q: Regress to earlier conversation. Are there places in closed areas where draggers don't go?

A: There are certain sections where traps could go where draggers don't go.

A: Folks who put out passive acoustic recorders would know where draggers are not as well.

A: Oceanographic gear should have modems so that that they are well marked for draggers.

Comment: logistics of ropes – point out that the speed at which rope feeds into Desert Star bag is faster than rope is being hauled.

Comment: Safety is absolutely critical and need to make any new gear safe.

Comment: Fish in critical habitat, close to beach. Very dense gear and overlay is inevitable. Can't fathom enormity of gear conflict in congested areas.

Comment: Ropeless won't fix the congestion issue. Need to focus on whether we can make this technology so that it's at least as good as what we have now.

Comment: Emerging lionfish fishery in the southeast U.S. – that might be an applicable fishery in which to test ropeless.

Q: How much consultation has DFO had with compliance officers?

A: Discussions are ongoing and ropeless has been introduced and discussions are preliminary. We have had DFO folks involved in those discussion. They are interested. Process and discussions are just beginning.

Comment: Love the way the discussion is going. Working towards what solutions might be, keeping in mind safety, species preservation. Struck by comment about protracted timeline for development, implementation. Need team approach in parallel instead of linear. By structuring team approach with conditional approach this can be a win-win situation.

Comment: This is ultimately going to get back to TRT. We will have a good record here. I think there is a positive if we go back to the TRT with a statement that states we believe that this is a valuable direction to go. It may not be the absolutely solution and there is much to be done to develop it. But it would be a valuable statement to take to TRT.

Comment: Can we be careful how we use the word "we".

Comment: I'm not sure we can make a recommendation coming out of this workshop. Comment: if you want the TRT to do something, it would be helpful in some way to encourage something going forward.

Comment: I don't think we are at a point where we can say we need to require ropeless or at a point where we say we abandon it. Out of this I hope to come out of this with real promise about ropeless fishing and take the net steps to develop it further.

Comment: Need to encourage TRT to do something, otherwise nothing will happen Q: What role does economics play in TRT process?

A: Desert star – \$700-1500 per unit, \$250 – annual maintenance.

A: That's not an option for the lobster fishery.

Comment: suggest a rare opportunity to bring information to TRT ropeless subgroup Comment: Agree. Need to take this information back to delegates and present to them for position.

Comment: Opportunity with emerging lionfish fishery to issue permit that includes ropeless requirement. This does not address a fishery that is impacting right whales. Is there an opportunity to experiment in fishery that would have impact on right whales?

Comment: High level of Canadian interest in concept of ropeless. There are emerging fisheries in Canada as well. We don't have an endangered species act with consultations - but room to explore. Snow crab quota – doubled last year. Is likely to go down 30-40 % for this year.

Session 3: Development plan

Chair: Tim Werner, Consortium for Wildlife Bycatch Reduction at the New England Aquarium

Development plan for rope-less fishing

Mark Baumgartner, Woods Hole Oceanographic Institution

Path - we want to assess feasibility of ropeless fishing. Not talking about mandating ropeless fishing.

Talk about a plan and how to fund it.

Goals –

- 1. Operationally feasible
- 2. Catches what they want
- 3. Affordable
- 4. User friendly
- 5. Safe
- 6. Enforceable

Technology development

TC1: mechanism to move gear from sea floor to sea surface

TC2: remote triggering mechanisms

TC3: Location marking to avoid gear conflicts

Phase 1: development and evaluation

Process we are in right now.

Slide 3 - time is going across on slide, same columns happening simultaneously

Step 1. Fishermen, manufacturer, and engineer engagement

- **a.** Problem statement journal articles
 - i. Tim and Mark putting out 2 journal articles; Sea Technology, Marine
 - Technology Society
- b. Ropeless Consortium
 - i. Board are organizers of this workshop
 - ii. Want fishermen engaged with innovators
- Step 2: Prototype development and engineering test (TC1, TC2, and TC3)
 - a. Engineers build prototypes and conduct bench, dock, at sea tests
 - b. Task ends with engineer led demos
 - Costs costs associated with step 2. For every 10x in units, cost goes down by factor of 2
- Step 3: prototype testing with fishermen (TC1 and TC2)
 - a. All about partnerships. Test prototypes at sea
 - b. Engineers make incremental changes to tech design based on fishermen input
- Step 4: Prototype testing with fishermen, enforcement and regulators (TC3)
 - a. Develop data standards
 - b. What data are passed back and forth?
 - c. Who owns the data?
 - d. Lots of testing needed at sea testing: accuracy testing, frequency/range testing
 - e. Need to engage with mobile fishermen
- Step 5: Developing of data warehouse (cloud service)
 - a. Development process for this as well
 - b. Prototype and tests
- Step 6: Certification program
 - a. Who gets to say what is and is not ropeless?

b. Government or private program to certify technology

Phase 2: experimental fisheries

- 1. Manufacture needed equipment
- 2. Incentive, pre-experiment training, post experiment evaluation

Around 15 fishermen use ropeless methods operationally for 1-2 seasons in particular fishery Establish 3 fisheries – US east coast, US west coast, GoSL Canada Evaluate goals of operational feasibility, user friendliness and forcibility

Phase 2 – who is going to pay for this? Mark reviewed cost base on slide 24. For 15 fishermen 3.6M per fishery. Need to have conversations about who will pay for this?

- If government signals there will be a market for ropeless, manufacture with venture capital may help to subsidize

Phase 2 – how do we incentivize?

- a. Market based incentives or cash
- b. Provide thorough training for all equipment
- c. Conduct post experiment interviews and evaluated performance.

Phase 3 – Operational Use

When entire fishery converts to ropeless

Get to take advantage of high unit volume to drive down costs.

Requires significant manufacturing capacity

Markets for these products potentially very large if ropeless considered best practice Who pays for it at this point?

a. Government or private subsidies are needed to help fishermen convert from rope to ropeless.

Commercial studies and market outreach

Commercial Studies:

- a. Analyzing costs
- b. Assessing costs vs realized benefits
- Market Outreach
 - a. develop market around sustainable catch

Population assessment

- Phase 1 assessing present level of entanglements
- Phase 2 Health assessments
- Phase 3 Measuring changes in entanglements

\$\$ considerations: From tech side in phase 1. Mark outlined partners and funders who have supported technology development to date

Ropeless Consortium will allow for updates and collaborations going forward.

2018-2020 phase 1 2020-2024 phase 2 2023+ phase 3

Discussion: Development plan for rope-less fishing

Q: when you evaluate financials of this projection could you also attempt to estimate costs of current regulations to fishermen with regards to seasonal/geographic closures and also disentanglement effort costs, and enforcement costs.

A: Great suggestion. Should also build in costs of not having TRT meetings.

Comment: What I've seen is that you are ignoring the problem. Whales aren't having babies any more. The rules were working up until 2010 but then they stopped having babies.

A: I don't think that's true. Fishing gear entanglement is through the roof right now. Entanglements are nearly twice what ship strike mortalities were at their worst. On the calving side, you are right calving is down. Probably 2 reasons – environment but the other is the sublethal effect of entanglement. When females are entangled and do survive, it takes them a long time to recover before they can calve again. Environment is only a piece of the issue. There were periods of low calving if it's environmentally driven. They are resilient and we have seen them recover from low calving years. Entanglements are a huge part of the problem.

Q: I agree they are a huge part of the problem. Thinking about what we go through at the council, do you think the population is growing and you are missing it? The rules haven't changed and there is less gear in the water.

A: Comparing now to early '90s, there was 50% less gear in the water then. Ropes were much less strong then as well. Amy Knowlton has shown that the entanglements we see today are very different than there were in the '90s. Entanglements are much more complicated and much more lethal. There are environment changes that are causing whales to move around and putting them at more risk in areas they haven't traditionally been.

Comment: Looking at graph of entanglement increase and shipping strike decrease. In area 3 the number of traps has gone from (1990s) 210k to 190k traps – almost all federal water through MIDA. When TRT went to trawling up the trawls got longer. When you factor in those two considerations, in the predominant area where whales occur, vertical lines have gone down substantially. What I struggle with in the figure is why have interactions gone up.

A: In the Knowlton et al 2012 paper, the rate of total entanglement didn't go up, but the rate of severe and serious injury did go up.

Comment: southern New England lobster 700k now down to <100k traps. 1 vertical line per 20 sq. miles. But they are clumped. A lot more work needs to be done to pinpoint what is causing the problem. We need to get right down into the specifics of where the problems are. Problems may not be as widespread as people make them out to be.

A: When you get gear off an animal and you can trace it back to the fishermen – entanglements are happening everywhere. There isn't just one place where this is happening.

A: The point I'm trying to make is the parameters of each of these interactions needs to be understood. Second point is enforcement. This is a major problem. There has to be a group, I hope that it's NOAA that addresses this so regulations can be enforced. Regulations that aren't enforced are useless.

Q: Tagging great white sharks. Why don't we tag right whales? Bring back idea I had with interactive map and had locations of tagged whales so that their location could be known. A: Can't keep tag on right whale very long. Whales bump into one another and tags last for maybe 4-6 weeks. To do what you said, we would need to find every whale every 4-6 weeks to tag. There is a lot of concern in research communities about intermuscular tagging with right whales. Substantial trauma associated with these types of tags.

A: Recent study of blue whale that was reproductively active, was tagged, stopped having calves, as once tag remnant was shed, she started calving again (Gendron *et al.* 2015).

Q: On these entanglements – has anything else been looked at with these whales (ie blood).

A: Stress levels in whales – highest stress levels ever measured in entangled whales (Rolland *et al.* 2017).

Q: What about toxins?

A: Images from the whale recently found dead in VA. Rope killed this whale. Vast majority of these deaths are due to the rope.

A: There has been examination of toxins in necropsies. Animals from Gulf of St Lawrence 2017 – all negative for toxins.

Comment: On plan put forth by Mark. From industry perspective, after money put in for testing, have hard time believing there would be turning back after that point.

Testing with only 15 people, does not address scalability concern that I have. That doesn't tell me how we scale that up. That scalability needs to be reflected in the plan. And - for the record, Maine is down to pre-1997 trap numbers.

Comment: cost is still huge even at large scale. Couldn't find fisherman that isn't up against it now with respect to cost. When the newness goes away, costs still gets passed on to us. I think it will be insurmountable.

Comment: Several ways to approach adoption of ropeless. It was pointed out that putting financial load on fisherman is bad and a scalability issue. Would propose – that there is already technology in place, we are at the stage where pilot programs could be done this year. Gear delivery in April. Costs have already gone down. 5 fishers, each gets 5 releases, class for fishers, individual boat support at seas, cost for all 5 fishers is 125k. If we say we take 8 pilot programs, that's 40 fishers. Now by the end of the year we would have 40 points of feedback. Then we would ask – is this successful? Fishermen will determine that. NSW fishermen bought into the program themselves. Realized costs can be low – costs down over time and gear has life of 10 years.

Q: is there a way that the fishing community feels they should or could be involved that they haven't yet? Are there needs or places you would like to see happen?

A: Recognize the problem and this is just one potential solution. Hope for other options as well, perhaps that aren't as draconian. Hopefully that the fishing community can come up with solutions as well in the meantime.

Q: Sneak peak at what those are?

A: Meetings coming up by invite. Entanglement avoidance, severity mitigation. There might be other things we can do. We don't know how whales are getting entangled so huge leap of faith for the industry to switch without a guarantee.

Comment: An opportunity here – Closed area (for a month?? area 1) there is an experimental possibility there.

Comment: need to find the funding to get this done. Akin to buying a house. Need to start somewhere. Don't know how you find the funding, but the ball needs to get rolling.

Comment: Ran bottom line project in Maine, there were other buyback programs in Mass. The value that NOAA assigned to switch over gear totaled over \$4 million over 4 years. If the problem of entanglement is still that valuable, perhaps there are earmarks that can be investigated.

Comment: Still get back to idea that it is saving whales, but also helping industry. Well worth money to avoid more severe crisis. Have to believe subsidies are money well spent.

Comment: We need to get to fishermen. We need to reduce entanglement. We can't hide from it, it's all of us from Canada to Florida. Anyone who has a vertical line in the water is contributing to the problem. Need to get fishermen and engineers in the same room. That should be the first step.

Comment: Exactly what SMELTS is trying to do. Trying to raise money to get gear built and get it to you. Whatever we need to do to get the technology into your hands, we need to do. There will be challenges but we can figure them out. At this moment, this is our chance to come together and say, we have money, ideas, and technologies, let's work together.

Comment: Speaking of getting tech into fishermen's hands, what you are missing is having them involved in the building of the gear. There may be other ideas that haven't been vetted yet because fishermen haven't had opportunity to be involved.

Comment: Agree – and fishermen have been involved in several of these technologies. But engineers do need the ability to develop and engineer.

Comment: Need design and input from fishery specific fishermen. Saying that it's been tested and a success in Cape Cod Bay and suggesting that it will work in Maine is a no go.

Comment: Operations vary so much from area to area, need to ensure to get broad cross section and that gear will be applicable. Regarding – Mass closed area – yet closed to fixed fishing gear, but not closed to mobile.

Comment: I think its okay for engineers to work with particular fisherman to develop something, then take that gear to other areas and ask how might it work for them and make tweaks.

Q: Have you reached out to other trap pot fisheries or is focus on lobster and crab?

A: We make a point to network with all fishermen and we respond that anyone who wants to test gear is more than welcome to. On whale release rope working with whelk fishermen. At moment we are still very early stages so we don't have takers yet but would be open to it.

Q: with eye to expense – encouraged by suggestion to use modular gear. Wondering if it's possible for engineering groups to work on modular components that can be used in several operation types to keep cost down.

A: Yes. Trap modems vision – not one manufacturer, but they all have same data protocols so they can talk to one another.

Comment: Thinking about this in a system rather than stand alone. Paradigm would need to change, including costs to consumer, areas fished, fishery scale. Tech is amazing and can certainly work in a system that accommodates it. Might take generation or two for industry to move towards ropeless. Requires cultural shifts. Not just tech shifts.

Comment: I have been very closely involved in efforts to save Vaquita. Thank you for bringing in paradigm shift. Parallels to vaquita are chilling. 20 years ago, there were 400 vaquita left. Only source of mortality was drowning in gillnet. At time, workshops on developing alternative gear, ways to change market, etc. All talks happening outside of fishing community. When there were 30 individuals, there was a ban on gillnet fishing and efforts to capture. What are the lessons learned? You can't save them when you are down to 30 animals. Need to start right where you are right now with right whales. Problem will be solved by fishermen, people on the ground. Vaquita nearly extinct, as is the fishery that used to exist there. Has to be fishing community that can advise engineers and work with regulators. Won't work if it comes from top down. Need more ways to get fishermen involved, more money involved. Last rescue effort was \$7MM. Compensation to fishermen \$87MM.

Q: Hand is on the panic button. When are we in full blown crisis?

A: It's going to get worse because we aren't doing anything about it. I would bet there will be mortalities in GoSL and the crab fishery is in real risk of being shut down because the Canadian government is amenable to that.

Q: How many whales have gear on them today?

A: Lost count

A: 10-20?

A: Risk public getting involved in this and then it gets ugly

A: I'm fearful about what Minister will do in Nova Scotia, that's why I'm here today

A: If more whales are lost, there is potential for loss of Eco certification.

Comment: Could actually have some campaign and scope for engaging public in getting out ahead of this. Take issue in saying we aren't doing anything about it. There have been measures taken – more south of the border than north, but this does come as one in a stream of requests and we need to remain aware of that.

Participant		Organization	Country
Terry	Alexander	New England Fisheries Management Council	U.S.
Dee	Allen	Marine Mammal Commission	U.S.
Mike	Asaro	NOAA Greater Atlantic Regional Fisheries Office	U.S.
Regina	Asmutis- Silvia	Whale and Dolphin Conservation Society	U.S.
Keenan	Ball	Woods Hole Oceanographic Institution	U.S.
Mark	Baumgartner	Woods Hole Oceanographic Institution	U.S.
Kathryn	Bisack	NOAA NEFSC Social Sciences Branch	U.S.
Andrea	Bogomolni	Woods Hole Oceanographic Institution	U.S.
David	Borden	Atlantic Offshore Lobstermen's Association	U.S.
Diane	Borggaard	NOAA Greater Atlantic Regional Fisheries Office	U.S.
Catherine	Boyd	Clearwater	Canada
Sean	Brillant	Canadian Wildlife Federation	Canada
Erin	Burke	Massachusetts Division of Marine Fisheries	U.S.
Peter	Burns	GARFO Sustainable Fisheries Division	U.S.
Beth	Casoni	Massachusetts Lobstermen's Association	U.S.
Dave	Casoni	Massachusetts Lobstermen's Association	U.S.
Major Rene	Cloutier	Maine Marine Patrol	U.S.
Colleen	Coogan	NOAA Greater Atlantic Regional Fisheries Office	U.S.
Peter	Corkeron	NOAA Northeast Fisheries Science Center	U.S.
Kiley	Dancy	Mid-Atlantic Fisheries Management Council	U.S.
Jane	Davenport	Defenders of Wildlife	U.S.
Katherine	Deuel	Pew Charitable Trust	U.S.
Kara	Dodge	Woods Hole Oceanographic Institution	U.S.
Jarrett	Drake	Massachusetts Lobstermen's Association	U.S.
Marco	Flagg	Desert Star Systems	U.S.
Mike	Fourtner	Lobster fisherman, U.S. west coast/Alaska	U.S.
Bob	Glenn	Massachusetts Division of Marine Fisheries	U.S.
Kathleen	Gobush	Vulcan	U.S.
Caroline	Good	Duke University	U.S.
Erin	Grant	Wild Lives Foundation	U.S.
Dan	Greenberg	SMELTS	U.S.
Frances	Gulland	The Marine Mammal Center	U.S.
Robert	Haché	Association des crabiers acaadiens	Canada
Marin	Hawk	Marine Stewardship Council	U.S.
Sean	Hayes	NOAA Northeast Fisheries Science Center	U.S.
Tim	Hayman	Fisheries and Oceans Canada, Resource Management	Canada

Appendix 1 – Attendees (94 total)

Sarah	Heil	GARFO Sustainable Fisheries Division	U.S.
Heidi	Henninger	Atlantic Offshore Lobstermen's Association	U.S.
Hansen	Johnson	Dalhousie University	Canada
Steve	Katona	Conservation International	U.S.
Sarah	Kelley	Island Foundation	U.S.
Hauke	Kite-Powell	Woods Hole Oceanographic Institution	U.S.
Alison	Kline	Woods Hole Oceanographic Institution	U.S.
Amy	Knowlton	New England Aquarium	U.S.
Scott	Kraus	New England Aquarium	U.S.
Lesanna	Lahner	SR3	U.S.
Scott	Landry	Center for Coastal Studies	U.S.
Mike	Lane	South Shore Lobstermen's Association	U.S.
Bill	Lister	Massachusetts Lobstermen's Association	U.S.
Keith	Lohnes	Clearwater	Canada
Martin	Mallet	Maritime Fishermen's Union	Canada
Richard	Malloy	New England Aquarium	U.S.
Rob	Martin	South Shore Lobstermen's Association	U.S.
Stormy	Mayo	Center for Coastal Studies	U.S.
Patrice	McCarron	Maine Lobstermen's Association	U.S.
Dan	McKiernan	Massachusetts Division of Marine Fisheries	U.S.
Bill	McLellan	University of North Carolina Wilmington	U.S.
Cathy	Merriman	Fisheries and Oceans Canada, Species at Risk	Canada
Henry	Milliken	NOAA NEFSC	U.S.
Michael	Moore	Woods Hole Oceanographic Institution	U.S.
Grant	Moore	Atlantic Offshore Lobstermen's Association	U.S.
Adam	Mugridge	Eastern Nova Scotia Marine Stewardship Society	Canada
Martin	Noël	L'association des Pêcheurs Professionnels Crabiers Acadiens	Canada
Marc	Palombo	Massachusetts Lobstermen's Association	U.S.
Jim	Partan	Woods Hole Oceanographic Institution	U.S.
Geoff	Perry	Fisheries and Oceans Canada, Atlantic Fisheries Fund	Canada
Heather	Pettis	New England Aquarium	U.S.
Kristan	Porter	Maine Lobstermen's Association	U.S.
Patrick	Ramage	International Fund for Animal Welfare	U.S.
Fran	Recht	Pacific States Marine Fisheries Commission	U.S.
Randy	Reeves	Okapi Wildlife Associates	Canada
Joel	Reiter	Vulcan Tech	U.S.
Richard	Riels	SMELTS	U.S.
Rachel	Rivera	Wild Lives Foundation	U.S.

Jooke	Robbins	Center for Coastal Studies	U.S.
Michael	Ruccio	GARFO Sustainable Fisheries Division	U.S.
Annette	Rumbolt	Fisheries and Oceans Canada, Resource	Canada
		Management	
Hubert	Saulnier	Fisherman, southwest Nova Scotia	Canada
Brian	Sharp	International Fund for Animal Welfare	U.S.
Kurt	Simmons	Eastern Nova Scotia Marine Stewardship Society	Canada
Colin	Sproul	Bay of Fundy Inshore Fishermen's Association	Canada
Mridula	Srinivasan	NOAA Office of Science and Technology	U.S.
Erin	Summers	Maine Department of Marine Fisheries	U.S.
Eric	Thunberg	NOAA NEFSC Social Sciences Branch	U.S.
Jonathan	Underwood	Fisheries and Oceans Canada	Canada
Angelia	Vanderlaan	Fisheries and Oceans Canada	Canada
Lisa	Volgenau	Volgenau Foundation	U.S.
Megan	Ware	Atlantic States Marine Fisheries Commission	U.S.
Tim	Werner	New England Aquarium	U.S.
Erin	Wilkinson	NOAA BREP program manager	U.S.
John	Williams	Maine Lobstermen's Association	U.S.
Tonya	Wimmer	Marine Animal Rescue Society	Canada
Jake	Wolf	Desert Star Systems	U.S.
Sharon	Young	Humane Society of America	U.S.

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