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# Urgent Need for Ropeless Fishing

*Removing End Lines to Protect Right Whales*

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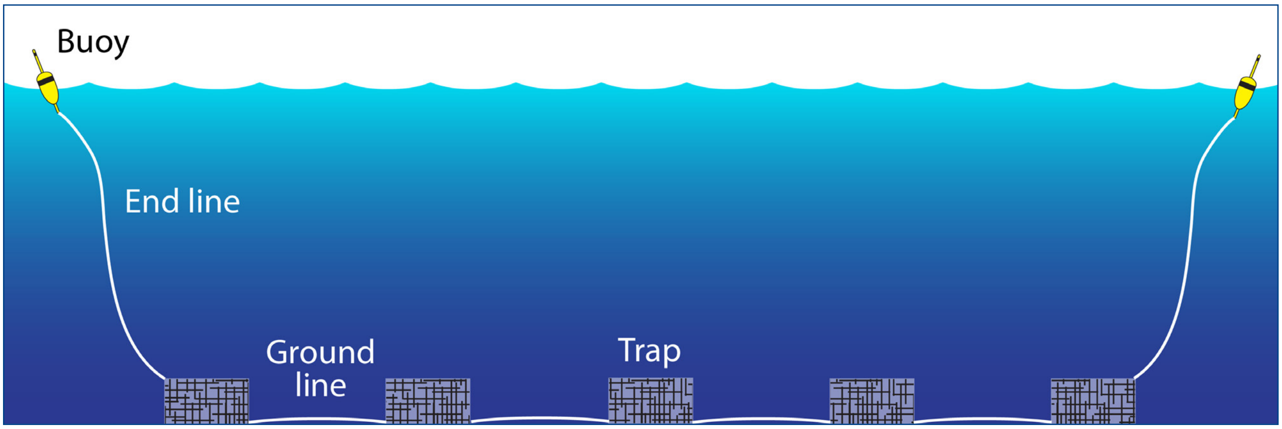
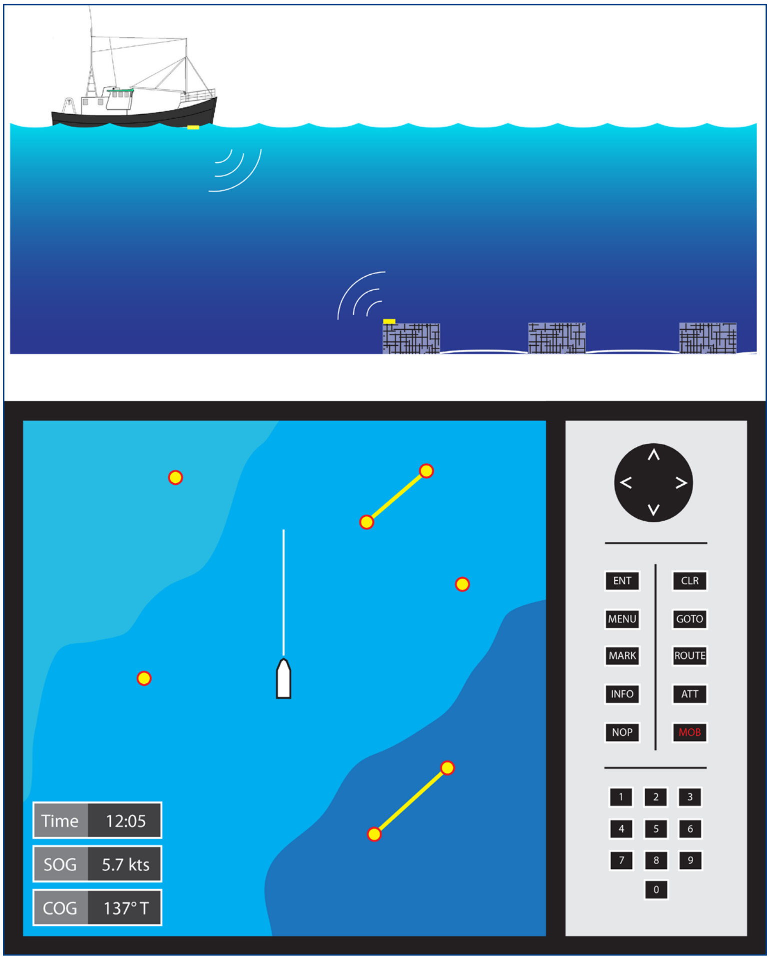
Trap (also known as pot) fishing for lobster, crab and some fish species is a vital part of both the economy and the culture of coastal communities throughout the U.S. and Canada. For example, revenue from lobster fishing in Maine alone during 2017 totaled $433 million, and an economic impact study by Colby College and the Maine Lobster Dealers' Association in 2016 suggested that the lobster supply chain contributes $1 billion to the state's economy each year and generates 4,000 jobs. Lobster is as iconic in New England as clam chowder and the Boston Red Sox and arguably contributes as much to the culture as it does to the economy.

Traditionally, trap fishing uses ropes (called vertical, end or buoy lines) that connect traps to surface buoys, and sometimes ropes (called ground lines) that connect together a series of traps that lay on the seafloor. These ropes can entangle whales, sea turtles and sharks. Entanglements are a serious problem for many species, especially the North Atlantic right whale, a declining species that has fewer than 450 animals left, of which only 100 are breeding females. About 85 percent of right whales bear scars that indicate that they have been entangled at least once in their life, and more than half have been entangled two or more times. Right whale entanglement deaths have been increasing since 2010, likely because of increases in rope strength and changes in the whales' movement patterns.

Fishermen on the U.S. East Coast have been involved in efforts to mitigate right whale entanglements for nearly two decades. A variety of approaches, including seasonal closures, weak links, sinking ground lines and more traps per trawl, have been mandated in many areas along the U.S. East Coast. While some of these efforts have undoubtedly helped, none has solved the problem of lethal entanglements. The recent development of reduced-breaking-strength rope (i.e., rope out of which a whale can more easily break and escape entanglement) has the potential to reduce entanglement severity for adult right whales and may be a viable near-term solution for some fisheries; however, this approach is not


***A live, entangled right whale that later died from its injuries. Rope can be seen caught in the mouth and wrapped around each flipper. (Credit: Florida Wildlife Commission under NOAA Permit 17355-01)***




*(Top) Trap fishing gear with several traps on the seafloor configured in a trawl. The number of traps will vary among fishermen. (Bottom) A trap modem communicating its location to a nearby ship, and the ship's chart plotter showing single traps (dots) and trawls (dots connected with lines).*

appropriate for all fisheries, and will not help alleviate lethal entanglements of smaller whales and turtles.

One promising solution that has been discussed in New England for the past 10 to 15 years is the removal of rope from trap fishing, which has the potential to significantly reduce or even eliminate entanglements of all marine animals. This approach has been dubbed ropeless fishing. For the purposes of this article, we define ropeless fishing as the removal of end lines only (also known as buoyless fishing).

In 2009, ground lines were mandated in the U.S. to be made of sinking material so that they do not float above the seafloor and pose an entanglement hazard. Although not enough data have been collected to definitively conclude that ground lines are safe for whales, it appears that most entanglements since 2009 occurred in end lines.

End lines serve two purposes: to facilitate the retrieval of traps from the seafloor and to secure a buoy at the sea surface, which allows fishermen and enforcement agencies to see where traps have been set on the seafloor. Any ropeless fishing system must replicate these two functions.

## Retrieval Methods

There are currently three mechanisms that have been developed or are under development to retrieve gear from the seafloor. The first involves buoyant rope and one or more buoys that are attached to the gear and stored at the seafloor until the fisherman wishes to retrieve it. The rope can be coiled around a spool or flaked into a mesh bag or container, and its release is triggered with an acoustic signal sent from the fisherman's vessel to an acoustic device attached to the spool, bag or container. The actual release can be accomplished with a burn wire or motor-driven lever arm. The buoy floats to the surface bringing the rope with it, and the fisherman hauls the gear using the rope. This method has a variety of names, such as bottom-stowed rope, on-call buoy or on-demand end line, and has been used for oceanographic applications for decades.

The second mechanism for retrieving gear involves the use of a deflated ruggedized bag that is deployed at one end of a trawl. Upon receiving an acoustic signal from the fisherman's vessel, the bag is inflated from a connected compressed air tank, and the buoyancy provided by the inflated bag brings the first trap in the trawl

*"Gear conflict occurs when a trap fisherman lays his or her line of traps (called a trawl) over another fisherman's trawl, resulting in a tangled mess when the laid-over fisherman retrieves his or her gear."*

to the surface. The fisherman can retrieve this first trap, and then haul the rest of the gear using the ground line that connects the first trap to the other traps. This method is called a lift bag, and is used regularly in the marine salvage industry.

The third method for retrieving gear requires no development at all, because most fishermen already use this method out of necessity: grappling. Today when fishermen lose access to the buoy and end line (e.g., because a passing ship's propellers cut the end line or the buoy is pulled under by strong currents), they must resort to grappling for the gear. In some fisheries, grappling is the norm because of logistical considerations. For example, the golden crab fishery in the Gulf Stream off the U.S. Southeast Coast uses grappling to retrieve gear because very strong persistent currents do not allow buoys attached to the end line to remain afloat at the surface.

**Gear Location Marking**

Replacing the function of the buoy as a marker of where gear is located on the seafloor is a particularly important and often overlooked aspect of ropeless systems. Gear conflict occurs when a trap fisherman lays his or her line of traps (called a trawl) over another fisherman's trawl, resulting in a tangled mess when the laid-over fisherman retrieves his or her gear. Gear conflict also occurs when mobile fishermen using a bottom trawl net or a scallop dredge drag their gear through traps on the seafloor. These gear conflicts are largely avoided today through the use of buoys attached to the end lines as visual location markers for the trap gear. In a 2010 report, the U.S. National Marine Fisheries Service stated that avoiding gear conflict was the most significant challenge facing ropeless fishing.

There have been a few approaches proposed to reduce gear conflict. Zoning areas for particular fishermen to fish only their gear is likely impossible to implement, since this would require a significant change in culture and a high level of cooperation among fishermen that does not exist in most fisheries. Fishermen do record the location of their own gear, and it can be argued that if this information is systematically collected and automatically distributed to other fishermen, then the location of all deployed gear could be available to reduce gear conflict. Such a system has three significant drawbacks. First, fishermen will likely refuse to share the location of their gear with other fishermen out of fear that these fishermen would then fish in those locations. Second, the system is completely voluntary, and therefore easily manipulated; not reporting deployed gear is a way to hide fishing locations, and not reporting retrieved gear is a way to "hold" an area for the exclusive use of a single fisherman. Third, gear that is moved to a new location after deployment (e.g., by a storm) will be forever lost because the deployment location will no longer represent the location of the gear. Marine debris is a substantial problem already, and the use of surface location marking only for ropeless gear would significantly exacerbate this problem.

Like a buoy that can only be detected on location, the replacement location marking system should be detectable only when a vessel is near the trap gear. The most promising technical solution proposed to date is the use of acoustic modems to relay information about the location of gear on the seafloor to passing ships. A modem affixed to a trap (a trap modem) can communicate information about the trap (or the trawl to which the trap is attached) to an acoustic modem at the sea surface (a surface modem). The surface modem could be mounted on any vessel, such as a trawler, dragger, trap fisherman's boat or enforcement vessel, and it would send out broadcast messages regularly (e.g., once a minute) to request information from any nearby traps. In response to an information request from a surface modem, the trap modem would report its location, as well as encrypted data that would include the trap owner's registration number, trap modem serial number, trap identifier and possibly other sensor data (e.g., occupancy sensor data to determine remotely how many lobsters are in the trap). Only the trap owner, regulators and enforcement would be able to decrypt the encrypted data. For trawls, acoustic modems can be mounted to the terminal traps so that the location of both ends of the trawl (thus the orientation of the trawl) can be reported.

The location information from all interrogated trap modems could be displayed on commercially available chart plotters or on a dedicated display system. When a ship equipped with a surface modem returns to port, all of the received data from all of the trap modems with which it communicated that day could be automatically uploaded to a central repository (most trap fishing boats are not equipped with satellite communications systems, and cellular service does not extend very far offshore). From there, all of the data could be decrypted, and information about a specific fisherman's gear could be delivered to him or her electronically. These decrypted data could be made available to regulators and enforcement as well. This would be particularly useful for fishermen to aid in the recovery of lost gear, since gear that is moved by a storm would be discoverable afterward by passing vessels, and the owner could be notified immediately about the new location of the gear.

The trap modem must have a way to determine its location, which could be partly achieved by attaching a submersible GPS receiver and using the last position at the surface as a proxy for the location at the seafloor. This would not be a complete solution in locations where gear sets are separated by only a few meters or tens of meters or when storms move gear. In such circumstances, the trap modem must have a way to self-localize. This can be accomplished by simply having surface modems transmit broadcast messages exactly at a known interval and encoding the surface modem's GPS position in the broadcast message. The trap modem could use this information to determine its own location.

To ensure interoperability, trap and surface modems would need to use an industry standard communication protocol, and messages would be standardized (i.e., similar to NMEA for marine electronics such as a GPS or depth sounder). JANUS is a recently published acoustic communication protocol that may be useful for this application. Trap modems could also fulfill the role of an acoustic release for retrieval methods that require one (e.g., bottom-stowed rope or lift bag). Acoustic messages from a fisherman's surface modem could include the serial number of the trap modem to be released and a password to ensure that only the gear intended for retrieval is triggered for release.

## Challenges and Opportunities

There are significant challenges to the development and adoption of ropeless fishing. Ropeless fishing is currently illegal in the vast majority of trap fisheries, so there is no market to incentivize commercial manufacturers to develop products. The market will only open up if ropeless fishing can be proven to be safe (for both fishermen and whales), operationally feasible and affordable. Affordability, in particular, will be absolutely essential; fishermen will be understandably reluctant to support the development of methods that, at the outset, appear to be unacceptably expensive. Once developed, however, ropeless fishing will be used where the government mandates its use, or by fishermen that are selling their catch in markets where a "whale-safe" product is valued. To date, ropeless retrieval systems have been developed on a very small scale by small commercial companies and nonprofit institutions and, as of winter 2018/2019, are being put through both engineering tests and preliminary testing by fishermen. These activities are intended to incorporate fishermen feedback on current designs and to cultivate understanding and acceptance of the technology among the fishing and regulatory communities.

The commercial opportunities for ropeless fishing may be significant depending on how widespread the technology is adopted. Whale entanglements are a worldwide problem, including on both the east and west coasts of the U.S. and Canada, and if every fisherman converted to ropeless methods, the market would be massive. The key to affordability will almost surely be manufacturing modems and retrieval mechanisms in the hundreds of thousands to millions of units. The commercial marine technology sector will play a vital role in the development and adoption of ropeless fishing, and this article is intended to encourage the sector's engagement in the problem.

There are many challenges to overcome to make widespread use of ropeless fishing methods a reality, and we are just at the very beginning of a long process.

But we do not have decades to work on this problem for North Atlantic right whales.

The problem is urgent, and fishermen, regulators, scientists, conservationists and consumers in both the U.S. and Canada are looking hard for a viable solution. Ropeless fishing has great potential to be that solution.


## Acknowledgments

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For more information about whale entanglement mitigation research, visit the Consortium for Wildlife Bycatch Reduction at bycatch.org, and for more information about ropeless fishing, visit the Ropeless Consortium at ropeless.org. **ST**



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