NOAA FISHERIES

On-Demand Gear Guide

Development and Implementation of On-Demand Fishing in the Greater Atlantic Region

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National Oceanic and Atmospheric Administration
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About This Guide

Of all the tools NOAA Fisheries has used to reduce incidental injuries and mortalities to large whales due to U.S. commercial fishing gear, reducing persistent buoy lines (i.e., “end lines” or “vertical lines”) from the water is the most effective at reducing entanglement risk. Seasonally restricting persistent buoy lines is a solution for whales and likely benefits other protected species. Fishing with “ropeless,” “buoyless,” “on-call,” “pop-up,” or “on-demand” gear (hereafter called “on-demand”) provides a solution for fishermen, one that would allow continued fishing during restricted periods. However, we recognize that there are challenges to overcome to make on-demand gear a viable option.

This guide outlines the current state of knowledge, and identifies the tasks required and likely timelines that will allow fishing with on-demand gear by the end of 2028 in the Greater Atlantic Region. While on-demand research and implementation is under development elsewhere, this guide focuses on fisheries from Virginia through Maine and on efforts to reduce entanglement deaths and serious injury to North Atlantic right whales.

For fixed gear fishermen, on-demand gear presents an opportunity to access fishing grounds that have persistent buoy line restrictions. Instead of using the standard configuration of a string of traps, pots, or nets connected to surface marking systems with buoy lines, a fisherman’s gear is connected to devices on the ocean floor that releases retrieval mechanisms when the gear will be tended, greatly reducing the time that lines are suspended in the water column. In the lobster and Jonah crab fishery, which fishes the majority of fixed gear in the region, approximately 644,000 buoy lines are deployed during high effort months.

While on-demand gear will open up opportunities for fishermen closed out of high risk areas, it may not be a practical choice for everyone. The choice to adopt this new technology will be an individual one, subject to equity considerations, and will depend on where and how each person fishes. Fishing with buoy lines will still be permitted when and where risk of mortality or serious injury due to entanglement is low; for example, in places and seasons when whales are likely not present. For gear awareness and conflict avoidance, using on-demand gear may require adopting new gear marking approaches and detection technology to alert mariners operating in the same areas.

This guide builds on the 2022 draft Ropeless Roadmap, incorporates comments and feedback NOAA Fisheries received, and describes advances in the state of knowledge and technology since it was published. As progress continues, changes to the tasks outlined in this guide are likely. To see the latest in on-demand gear development, please visit our web page.

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The Case for On-Demand Gear

Large Whale Entanglements

Large whales are threatened by a variety of natural and human-caused incidents worldwide. Along the U.S. East Coast, entanglement in commercial fishing gear is a primary cause of documented large whale incidents (which includes mortality, serious injury, and non-serious injury) for humpback, fin, minke, and North Atlantic right whales[1] (right whales). Of particular concern in the Greater Atlantic Region, entanglement in fishing gear is one of the greatest threats to the survival of right whales. NOAA Fisheries and partners estimate that more than 82 percent of right whales have been entangled in fishing gear at least once, and more than 60 percent have been entangled multiple times.[2] Fishing gear can cut into a whale's body, cause serious injuries, and result in infections and death. Even if gear is shed or removed through disentanglement efforts, the time spent entangled can severely harm a whale, weaken it, prevent it from feeding, and reduce its reproductive success.

The East Coast is home to the largest trap/pot fishery in the United States, targeting American lobster and Jonah crab. The fishery deploys trawls of traps along the seafloor connected by groundlines; at the terminal ends of the trawl, mandatory persistent buoy lines and surface marking systems denote the gear's position and provide a means to retrieve the traps. There are also smaller trap/pot fisheries targeting whelk, conch, other crabs, and finfish. Other fixed gear fishermen target a variety of fish by deploying mesh gillnets anchored to the seafloor that are similarly marked with surface marking systems.

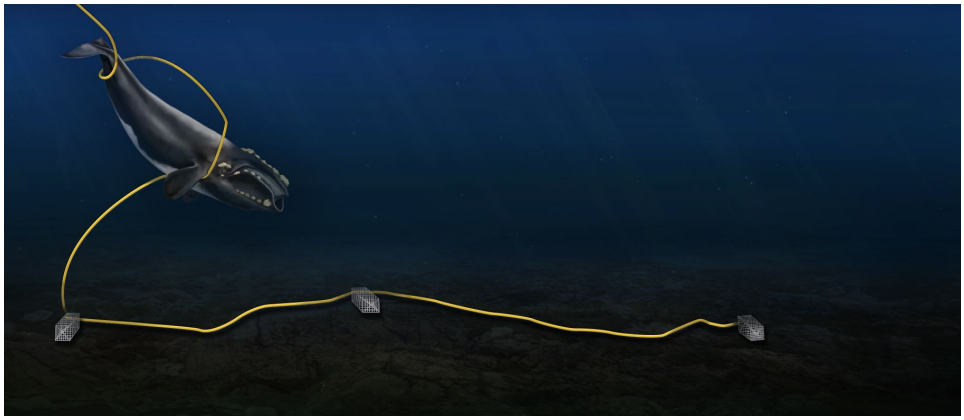

Figure 1. Illustration of whale entangled in a conventional trap/pot persistent buoy line. Credit: Woods Hole Oceanographic Institution/Natalie Renier

[1] https://www.fisheries.noaa.gov/species/north-atlantic-right-whale/conservation-management

[2] Hamilton, P.K., Howe, K.R., Knowlton, A.R., Lockwood, D.J., McPherson, K.D., Pettis, H.M., Warren, A.M., Vance, S.L., and Zani, M.A. 2024. Maintenance of the North Atlantic Right Whale Catalog, Whale Scarring and Visual Health Databases, Anthropogenic Injury Case Students, and Near Real-Time Matching for Biopsy Efforts, Entangled, Injured, Sick, or dead Whales. Final Report to the National Marine Fisheries Service 1305M2-18-P-NFFM-0108

Take Reduction Planning

As required by Section 118 of the Marine Mammal Protection Act (MMPA), NOAA Fisheries implemented the Atlantic Large Whale Take Reduction Plan (Take Reduction Plan) in 1997 to reduce deaths and serious injuries of large whales from incidental entanglement in U.S. commercial fisheries. Section 118 of the MMPA mandates that NOAA Fisheries develop and implement Take Reduction Plans that prevent the depletion, and assist in the recovery, of certain marine mammal stocks that are killed or seriously injured in commercial fishing gear. Pursuant to the MMPA, NOAA Fisheries convenes Take Reduction Teams composed of expert stakeholders to develop recommendations to achieve the short-term goal of reducing deaths and serious injuries of the marine mammals to below each stock's Potential Biological Removal (PBR) level,[3] and the long-term goal of reducing mortality and serious injury to insignificant levels (defined as 10% of a stock's PBR).[4] NOAA Fisheries considers Take Reduction Team recommendations when implementing Take Reduction Plans.

The Atlantic Large Whale Take Reduction Team (Team) was first convened in 1996 to recommend measures to reduce deaths and serious injuries of right, humpback, and fin whales incidental to certain commercial fisheries. Since 1997, the Take Reduction Plan has implemented restrictions on where, how, and what gear can be set; supported research into whale populations, whale behavior, fishing gear interactions and gear modifications; developed outreach materials to inform and collaborate with fishermen and others; and established a large whale disentanglement program. The Take Reduction Plan has been amended more than a dozen times since it was put in place. Nevertheless, incidental deaths and serious injuries in commercial fishing gear continue to exceed PBR for right whales, and compliance with the MMPA requires additional action.

The evidence of a declining right whale population, exacerbated by recent high mortalities, caused NOAA Fisheries to convene subgroups of the Team in early 2018 to investigate the feasibility of additional take reduction measures. A meeting of the full Team was held in October 2018 to develop recommendations for modifying the Take Reduction Plan, followed by a meeting in 2019 to finalize recommendations. The most recent final rule, based largely on the Team's 2019 near-consensus recommendations, was published on September 17, 2021 (86 FR 51970). The amendments to the Take Reduction Plan implemented modifications intended to reduce deaths and serious injuries caused by entanglement in the Northeast American lobster and Jonah crab trap/pot fishery by approximately 60 percent, although updated calculations

[3] The MMPA defines PBR as the maximum number of animals, excluding natural mortalities, that may be removed from a stock while allowing that stock to reach or maintain its optimum sustainable population.

[4] MMPA Section 118(f)(2): The long-term goal of the plan shall be to reduce, within 5 years of its implementation, the incidental mortality or serious injury of marine mammals incidentally taken in the course of commercial fishing operations to insignificant levels approaching a zero mortality and serious injury rate, taking into account the economics of the fishery, the availability of existing technology, and existing State or regional fishery management plans.

indicate that risk was likely reduced by about 47 percent. The 2021 rule focused on the Northeast American lobster and Jonah crab trap/pot fishery because that fishery deploys more than 93 percent of the persistent buoy lines fished along the U.S. East Coast in waters regulated under the Take Reduction Plan.

After implementation of the 2021 rule, right whale deaths and serious injuries continued to exceed the stock's PBR level. NOAA Fisheries reconvened the Team in 2022 to develop additional recommendations for take reduction measures in all East Coast fixed gear fisheries managed under the Take Reduction Plan. Shortly after the 2022 meetings were concluded, Congress passed the Consolidated Appropriations Act, 2023. That Act deemed the 2021 rule sufficient for the authorization of American lobster/Jonah crab trap/pot fisheries to be in full compliance with the MMPA and Endangered Species Act (ESA) until December 31, 2028. The Act also requires NOAA Fisheries to issue ". . . new regulations for the American lobster and Jonah crab fisheries consistent with the [MMPA and ESA] . . . utilizing existing and innovative gear technologies, as appropriate" that "take effect by December 31, 2028." Appropriations have allowed accelerated development and research of on-demand gear in collaboration with fishermen and other partners, and in 2025, NOAA Fisheries will begin working on additional regulations needed to attain MMPA compliance.

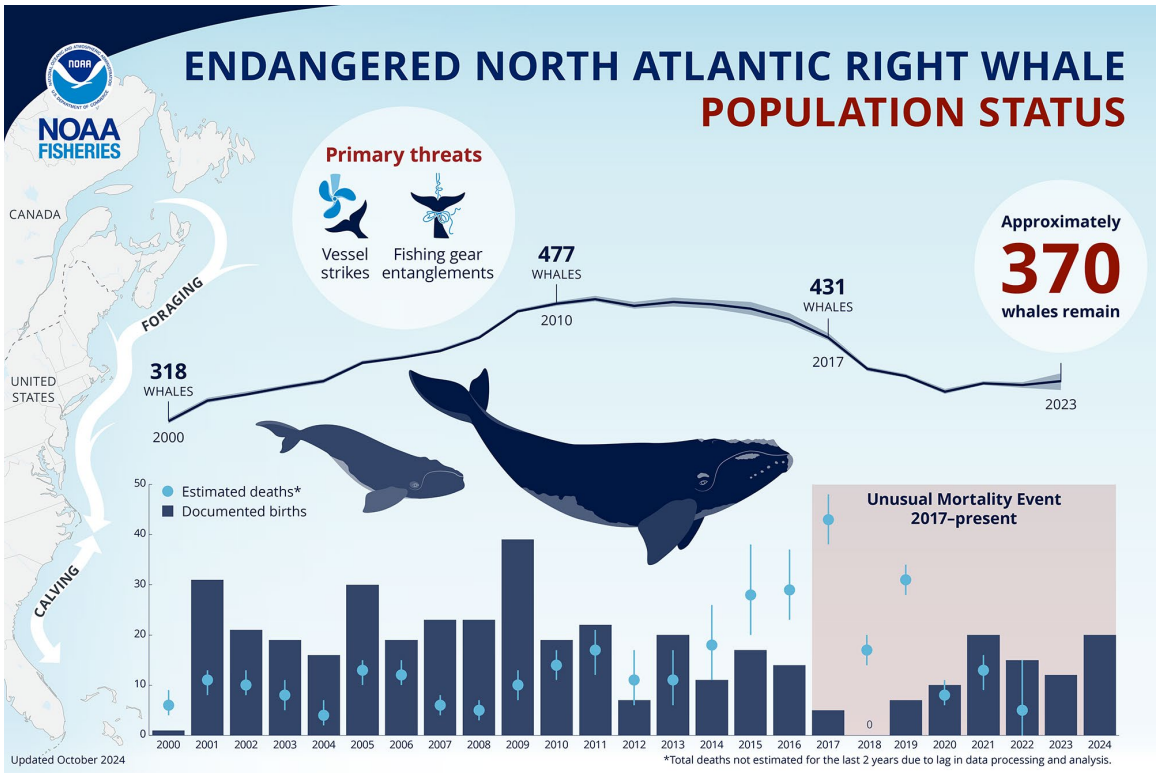

Figure 2: Estimated deaths (blue dots) continue to exceed the MMPA's PBR level of less than one (0.7) human-caused mortality or serious injury to a right whale each year.

Take Reduction Tools

To reduce the risk of deaths and serious injuries due to entanglements in U.S. commercial fisheries, the Take Reduction Plan relies on three strategies: separating whales and lines by prohibiting the use of persistent buoy lines in areas with high co-occurrence of fishing gear and whales; reducing the number of lines in the water column through sinking groundlines and reducing buoy lines; and requiring reduced breaking strength buoy lines to reduce deaths and serious injuries by allowing entangled whales to more easily break free. In addition, increased regional rope markings are required, intended to refine our knowledge of where and in which types of gear entanglements are most common. To find out more about how these tools are currently being used in the Take Reduction Plan, please visit our Take Reduction Plan webpage, and review the compliance guides.

Since its inception, the Take Reduction Plan has required gear modifications in areas of high co-occurrence and has seasonally closed areas to fishing. The 2021 rule changed the Northeast lobster and Jonah crab trap/pot fishery closure language to restrict the use of "persistent buoy lines" to allow for technological innovations (e.g., on-demand gear) that could provide fishermen with continued access to these areas.

As of 2024, the Northeast lobster and Jonah crab fishery is not allowed to fish with persistent buoy lines in 1,030 square miles (2,667 square kilometers) for four months each year offshore of Maine, and in 12,264 square miles (31,664 square kilometers) for three months within three areas offshore of Massachusetts[5]. These are areas of predicted high entanglement risk caused by the co-occurrence of right whales and persistent buoy lines, which currently require removal or relocation of at least 8,400 persistent buoy lines.

Because right whale entanglements continue to exceed the stock's PBR, we anticipate additional buoy line restrictions in the future in areas where and when there is high co-occurrence of gear and whales. In 2022, the Team considered various measures to reduce entanglement risk, including, among other things, seasonal restricted areas or areas where only one endline per trawl or set would be allowed. The Team based these on the information available in 2022, and recommended (by majority, but non-consensus, vote) 16 areas totaling 82,523 square miles (213,735 square kilometers) for closures to persistent buoy lines for between 2 and 12 months. If all areas were implemented, these seasonal restricted areas would have required removal or relocation of up to about 80,000 buoy lines[6], of which we estimate 15-25,000 could potentially be replaced by on-demand units. An additional 5 areas

[5] Right whale risk reduction measures implemented under the Fishery Management Plan (FMP) for the Snapper Grouper Fishery of the South Atlantic Region prohibit black sea bass pot fishermen from fishing with any gear type in 21,966 square miles (56,892 square kilometers) for 6 months each year off the Southeast Atlantic coast.

[6] The number of affected buoy lines should *not* be interpreted as a 1:1 ratio with the number of ropeless units that would be needed to fully support the fishery. Note that 61,200 of these lines are located in Maine Zone A state waters, which is an area where temporary closures based on whale sightings during two months of the year were discussed, and is an area where timed-releases or other ropeless systems may be considered.

totaling 199,811 square miles (517,510 square kilometers) were analyzed under a Team recommendation to allow fishing with one persistent buoy line to reduce the number of lines by half (see Appendix A for a complete table).

The Team's recommended measures were not considered for rulemaking because Congress passed the Consolidated Appropriations Act, 2023, a few weeks after the Team's vote. While we anticipate that future rulemaking will be based on the most contemporaneous whale and fishery distribution and risk data that describe a different risk landscape, we anticipate that seasonal restrictions of persistent buoy lines will be an important component of recommended Plan modifications. Of all the tools NOAA Fisheries has used to try to reduce incidental deaths and serious injuries due to U.S. commercial fishing gear, seasonal restricted areas are the most effective at reducing right whale entanglement risk.

Persistent buoy line restrictions are a solution for whales; on-demand gear is a solution for fishermen. While we recognize that the adoption of technology in any industry brings with it a series of challenges, on-demand fishing has the potential to be an option for fishermen who would like to fish in otherwise closed areas. We plan to operationalize on-demand fishing ahead of the December 31, 2028, Congressionally mandated date to implement new Take Reduction Plan regulations, so it is available as an alternative to current surface gear marking requirements that depend on persistent buoy lines.

About On-Demand Gear

What is On-Demand Gear?

The term "on-demand fishing gear" encompasses a number of technologies and techniques that remove surface marking systems and persistent buoy lines from trap/pot trawls or gillnet strings. We call this mode of fishing "on-demand" because fishermen retrieve gear deployed on the seafloor by triggering a release mechanism that brings the gear to the surface (Figure 3). On-demand fishing gear does not necessarily eliminate the use of line in fishing gear, but minimizes the duration of time line is in the water column, therefore reducing entanglement risk.

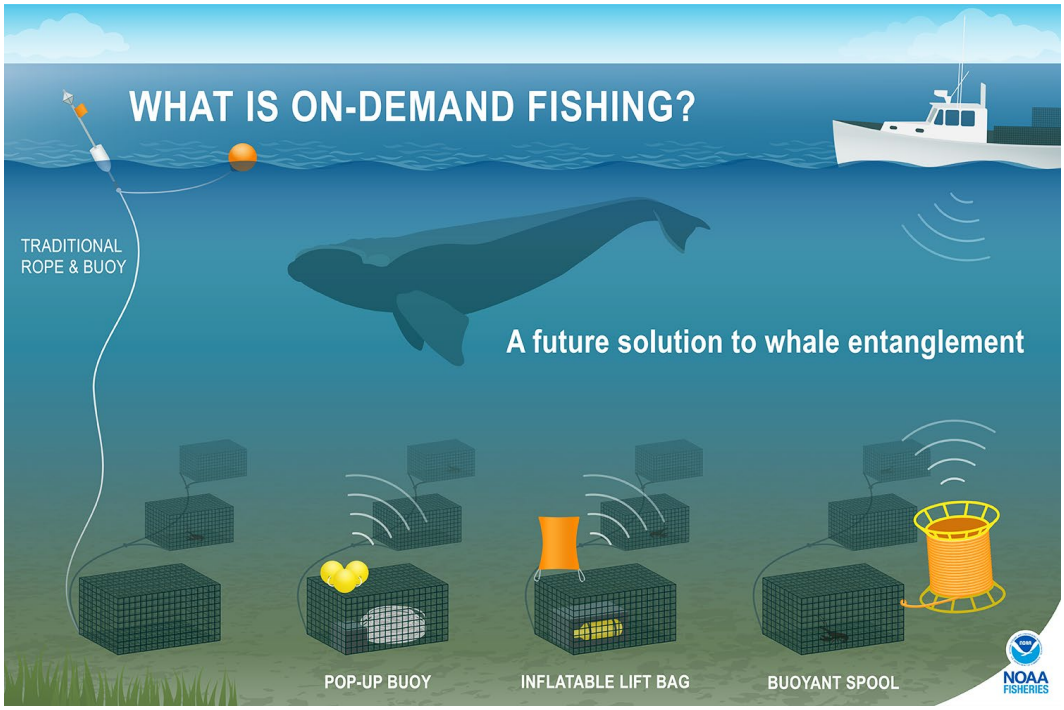

Figure 3. Example of the styles of on-demand gear designs currently available.

Deploying and Retrieving of On-Demand Gear

Fishermen may replace some or all of the buoy lines in a string or trawl with on-demand devices before deploying (setting) gear in much the same way as traditional gear. The retrieval (hauling) mechanisms for on-demand gear vary; for example, gear may be triggered by an acoustic signal, a preset timer, or manually hauled using a grappling hook. Acoustic signals have been used underwater by the U.S. Navy, oil and gas industry, and oceanographic research communities for more than 50 years. Less expensive alternatives, such as timed buoy releases, may be feasible in some areas where there is lower risk to whales and/or where the gear is tended regularly. The use of a grappling hook to recover gear also has potential given that fishermen in many areas are already proficient in this technique. Each of these retrieval methods have trade-offs related to detection, retrieval (including the ability to find lost gear), and redeployment by the fisherman and law enforcement personnel.

Once a device is triggered acoustically or by timer, there are several retrieval mechanisms being tested, including, but not limited to:

- **Pop-up Buoy:** The line is coiled in a cage that is on the seafloor. When a signal is received, it triggers the release of a buoy or buoyant cage top. This floats to the surface, allowing the line to uncoil, providing a means to retrieve the gear.
- **Inflatable Lift Bag**: A deflated lift bag is attached to a cage that is on the seafloor. When a signal is received, the lift bag inflates bringing the cage to the surface, providing a means to retrieve the gear.

- **Buoyant Spool:** Line wrapped around a buoyant spool is tethered to a weight on the seafloor. When a signal is received, the spool is released. As the spool ascends, the line unwinds from the spool and rises to the surface, providing a means to retrieve the gear.

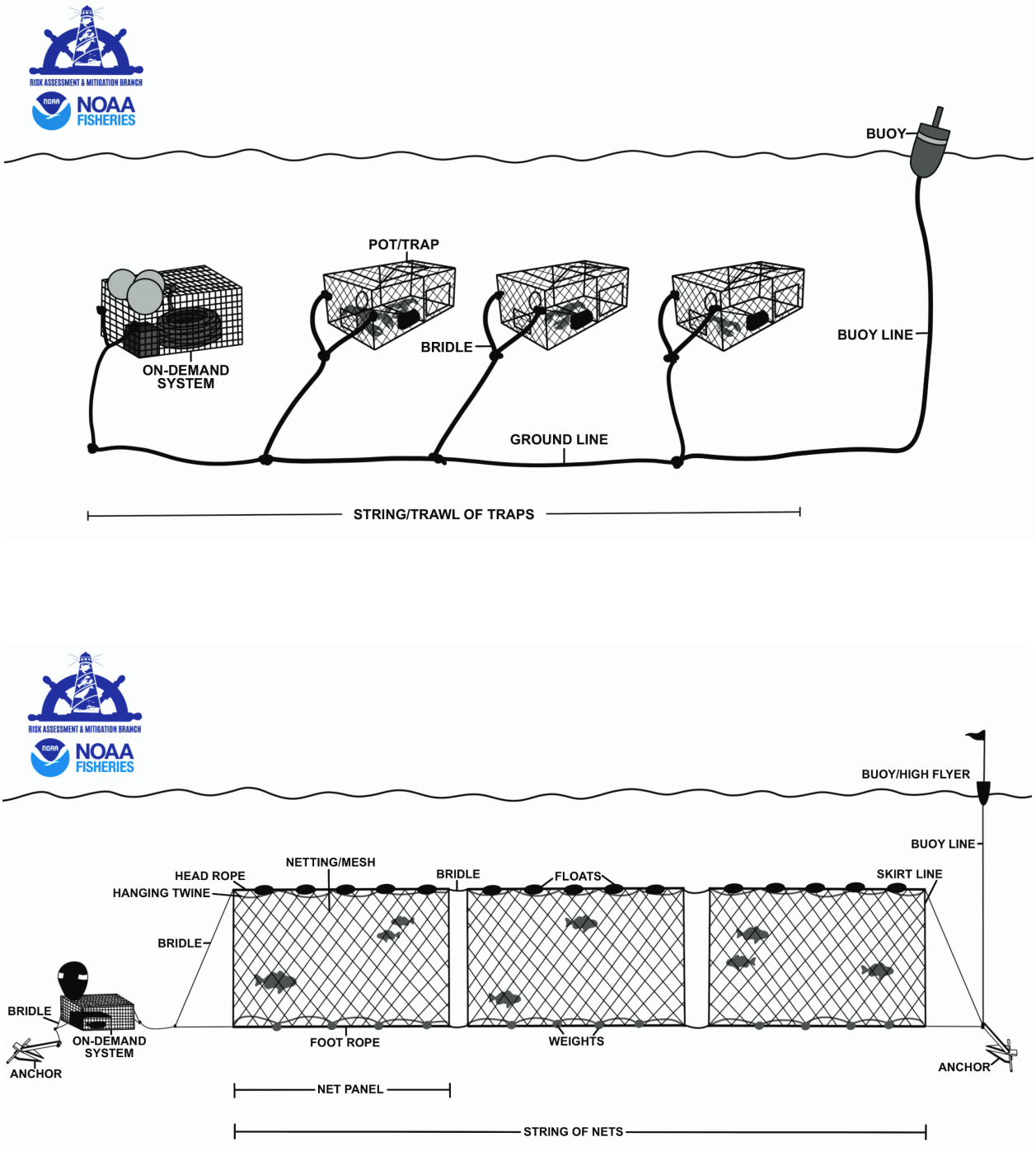

Figure 4. Top: An on-demand device deployed on a trap trawl using hybrid rigging, meaning there is an on-demand device on one end and a buoy line on the other end. Bottom: An on-demand device deployed on a gillnet string using hybrid rigging. Hybrid rigging is also referred to as "one end ropeless." To rig fixed gear without any persistent buoy lines, on-demand devices can be secured to each end or a single on-demand device can be used with no retrieval mechanism on the other end of the string or trawl. Graphic credit: NOAA Fisheries/Megan Amico

Marking and Locating On-Demand Fixed Gear

Currently, most fixed gear is required to be marked with surface buoys, tetrahedral radar reflectors, and/or pennants, collectively referred to as surface marking systems. Fishermen use buoy lines to tether surface marking systems to fixed gear on the seafloor, allowing them to both mark the location of, and retrieve, deployed gear. For all their simplicity, surface marking systems provide a great deal of information and functionality by:

- Alerting other mariners that there is subsurface gear at a distance that varies based on weather, sea conditions, and the components of the surface marking system.
- Communicating roughly where that gear is to avoid gear conflicts with other mariners.
- Providing information about gear set direction and gear length when both ends of a trawl or string can be identified.
- Providing a visible cue to everyone without specialized equipment, except for radar reflectors which require radar.
- Often revealing fishery and ownership information, such as state/federal
- license/permit number, owner identity, and gear type.
- Providing surface connection for hauling gear by the gear user and law enforcement.

On-demand fishing reduces or eliminates surface markings traditionally used in fixed gear fisheries. Therefore, other mariners would need to use an electronic-based virtual gear detection system to inform them of the presence of gear on the seafloor. Technology that allows for gear detection is a critical component of an on-demand system to support fishing, avoid gear conflict, and facilitate law enforcement activities, such that bottom-tending mariners operating in areas where on-demand gear would be allowed can detect gear without surface markings.

In order for virtual gear marking systems to support on-demand fishing and be reasonable replacements for traditional buoyed systems, they may be expected to provide the information and functionalities listed above. Virtual gear marking also offers an opportunity for additional functionality, for example:

- Continual gear detection regardless of weather and sea conditions.
- An underwater map visualization that shows the general orientation and length of gear strings and trawls.
- Alerts to vessel owners when on-demand gear has been displaced.

See Appendix B for current surface marking system performance standards, defined as those functions that current surface marking systems serve that alternative on-demand and gear marking systems may be required to replace. Appendix B also identifies additional functionalities that may be possible using on-demand technology.

Regional On-Demand Gear Research

In 1998, NOAA Fisheries issued its first contract to develop "ropeless" fishing gear to mitigate the risk of right whale entanglement in lobster trap/pot gear. Since then, the concept of on-demand fishing systems has continued to develop. Given the 2017 declaration of a right whale unusual mortality event[7] and subsequent Congressional appropriations and direction (e.g., Inflation Reduction Act, 2022; Consolidated Appropriations Act, 2023), as well as non-governmental organization (NGO) funding, technology development has accelerated along the U.S. and Canadian east coasts.

Since 2018, the NOAA Fisheries Northeast Fisheries Science Center (NEFSC) has housed an on-demand gear lending library and has conducted research with fishermen, manufacturers, and NGOs to develop safe and reliable fixed gear fishing methods that do not rely on persistent buoy lines. In addition to NEFSC-led experimental fisheries, in 2023, the Maine Department of Marine Resources (ME DMR) launched its own gear library and is working with fixed gear fishermen to test acoustic on-demand systems and other technologies. Also in 2023, based on a Congressional appropriation, NOAA provided $18 million to the National Fish and Wildlife Foundation (NFWF) to support the development and use of innovative fishing gear through the New England Gear Innovation Fund[8]. In Canada, parallel efforts are underway, the largest by the Canadian Wildlife Federation. Recently, there have also been successful trials of on-demand fisheries for California Dungeness crab and southeastern U.S. black sea bass. Despite efforts nationally and globally to develop and implement on-demand systems, this guide focuses on NOAA Fisheries' efforts in the Greater Atlantic Region fisheries from Virginia through Maine.

Currently in the Greater Atlantic Region, federal or state laws require that fixed gear fishermen surface mark their gear. To conduct research on fishing methods that reduce persistent buoy lines, NOAA Fisheries and coastal states must authorize on-demand efforts using exempted fishing permits and letters of authorization. Since 2019, NOAA Fisheries Greater Atlantic Region Fisheries Office has issued 10 exempted fishing permits to 6 organizations, including expanding the number of participating vessels from 2 to more than 235. Both the NEFSC and ME DMR have obtained research permits to authorize their activities. Given the present need for authorization to fish without surface marks, gear lending libraries are the most practical option for fishermen to access, train with, and refine on-demand technology. Efforts are underway to expand gear lending capacity to support more fishermen wishing to test on-demand gear.

[7] https://www.fisheries.noaa.gov/national/marine-life-distress/2017-2024-north-atlantic-right-whale-unusual-mortality-event
[8] https://www.nfwf.org/media-center/press-releases/nfwf-announces-nearly-18-3-million-grants-new-england-gear-innovation-fund

Research on Deploying and Retrieving On-Demand Gear

Fishermen within the Greater Atlantic Region, from Maine, New Hampshire, Massachusetts, Rhode Island, and Maryland, have worked with NEFSC testing systems from different manufacturers to investigate the viability of on-demand gear for trap/pot and gillnet fisheries. Fishermen have conducted a majority of the research using hybrid rigging (one persistent buoy line and one on-demand device) in open areas and seasons. In 2023 and 2024, fishermen also tested lobster trawls with no persistent buoy lines in seasons and areas where persistent buoy lines are prohibited. While on-demand devices have become quite advanced and undergone modifications to withstand the rigors of commercial fishing, researchers are continuing to trial new and modified retrieval and gear detection systems as they become available.

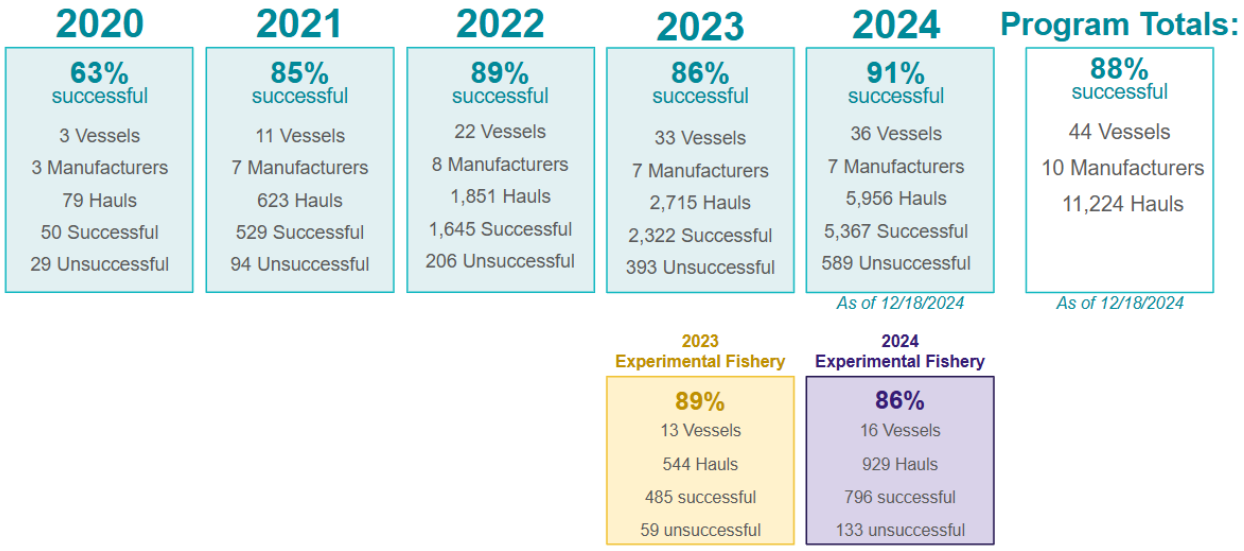

Figure 5. NEFSC's collaborative on-demand research trials. In the top row the total number of vessels, hauls, and success rates are summarized per year and tallied across all years, as of 10/18/24. In the bottom row are statistics related only to fully on-demand fishing in Take Reduction Plan persistent buoy line restricted areas. On-demand gear retrievals are considered successful when the gear is hauled using the on-demand device. Unsuccessful retrievals are all situations where the on-demand device did not surface as expected, including cases of mechanical failure (e.g. rope snarls), technology failures (e.g. drained batteries), or gear conflicts. In the overwhelming majority of unsuccessful hauls, the fishing gear was recovered; there has been one on-demand device lost every 500 hauls, while success rates have been steady between 85-90% since 2021, despite regularly adding new fishermen and new on-demand devices to the program. Experienced fishermen have higher success rates. Credit: NOAA Fisheries

Research on Marking and Detecting On-Demand Gear

To date, two methods have emerged to mark on-demand gear when it is set: the first relies on marks derived from the GPS location of the vessel and the second relies on acoustic communication with the device on the seafloor. On-demand gear marking currently relies on

fishermen using an application on a mobile device to manually hit a "set" button to mark the gear's surface deployment location using GPS. We are investigating technologies that would automatically mark deployment locations, reducing the chance for errant or fraudulent marking, both of which can be problematic for fishermen and for law enforcement. We are also testing the accuracy of surface GPS gear marking relative to where the gear lands on the seafloor.

We are testing two reasonable replacements for surface marking systems to detect on-demand gear locations. The first replacement option relies on a cloud-based platform available to vessels with at-sea internet connectivity. Since 2022, we have been working with fishermen and others to demonstrate the feasibility of using a cloud-based platform to disseminate locations of on-demand fishing gear. To date, we have successfully demonstrated that vessels are capable of sending and receiving gear location information in near real-time using both cellular and satellite internet connections.

The second replacement option relies on acoustic communication with devices on the seafloor. The ME DMR is investigating gear detection using underwater acoustic signaling between on-demand gear and vessels equipped with specialized technology; NEFSC will begin similar work in 2025. This approach focuses on localized gear detection, akin to the line-of-sight detection of traditional surface-marked fixed gear. This acoustic positioning method, without a linked cloud platform, would require paired acoustic devices on each end of a trawl or string to display gear properly on a chartplotter and mobile devices.

In order to **display** on-demand gear, the information derived from either the cloud or acoustic positioning could be displayed on a chart plotter or mobile application. We are working on ways to display data from multiple on-demand device manufacturers directly on chartplotters and mobile devices, and to provide input on data governance and data sharing considerations for the cloud platform method.

Below are examples of the benefits and constraints of the marking and detecting methods that have been researched to date.

- **GPS-based location marks:** This is a simple and readily available method to mark gear; however, it is less accurate than acoustically locating gear on the seafloor and may not be suitable in areas where fishermen are working in close proximity or where gear may move after it's set.
- **Acoustic-based location marks:** This method is more accurate than surface GPS derived gear marks; however, it requires installation and maintenance of acoustic communication technology and would add noise to the ocean soundscape.
- **Cloud-connectivity gear detection (Fig 6A):** This method relies on mariners having reliable internet connectivity at-sea, which may subject vessel owners who are not regulated under the Take Reduction Plan to an additional cost to obtain satellite based internet. Presently, there are limited options for such service. This method would rely on data sharing and privacy protocols designed to replicate the features of current surface marking systems, including detection distances, while providing opportunities for gear awareness in all sea conditions and added value features, such as owners being able to check the status of their gear from shore.

- A**coustic-based gear detection (Fig 6B):** This method requires the installation, use, and maintenance of acoustic communication technology which would add noise to the ocean soundscape and impose costs on both vessel owners who are regulated and those who are not regulated under the Take Reduction Plan. This method requires close proximity to the gear, making it similar to traditional surface marking systems; however, the detection ranges may be smaller than what is possible with current surface markings. While it would alleviate some data sharing and privacy considerations inherent in the cloud-connectivity method, it may require the development of a standardized acoustic communication protocol to detect gear across multiple system brands.
- **Mobile application-based gear display:** Mobile devices are readily accessible and mariners are already using them; however, displaying on-demand gear marks on a mobile application would involve vessel operators referencing an additional screen.

Ultimately, it may be valuable to have multiple methods to mark, detect, and display on-demand gear locations given the breadth of oceanographic conditions and diversity of fishing practices, gear density, and overlap with other fleets across the Greater Atlantic Region and in other regions. Further, systems that couple technologies and/or incorporate auxiliary technologies, for example, smart buoys[9] may be desired by some fishermen to monitor and detect on-demand rigged gear and prevent lost gear, which reduces ghost gear.

[9] https://techpartnerships.noaa.gov/blue-ocean-gear-smart-buoy/

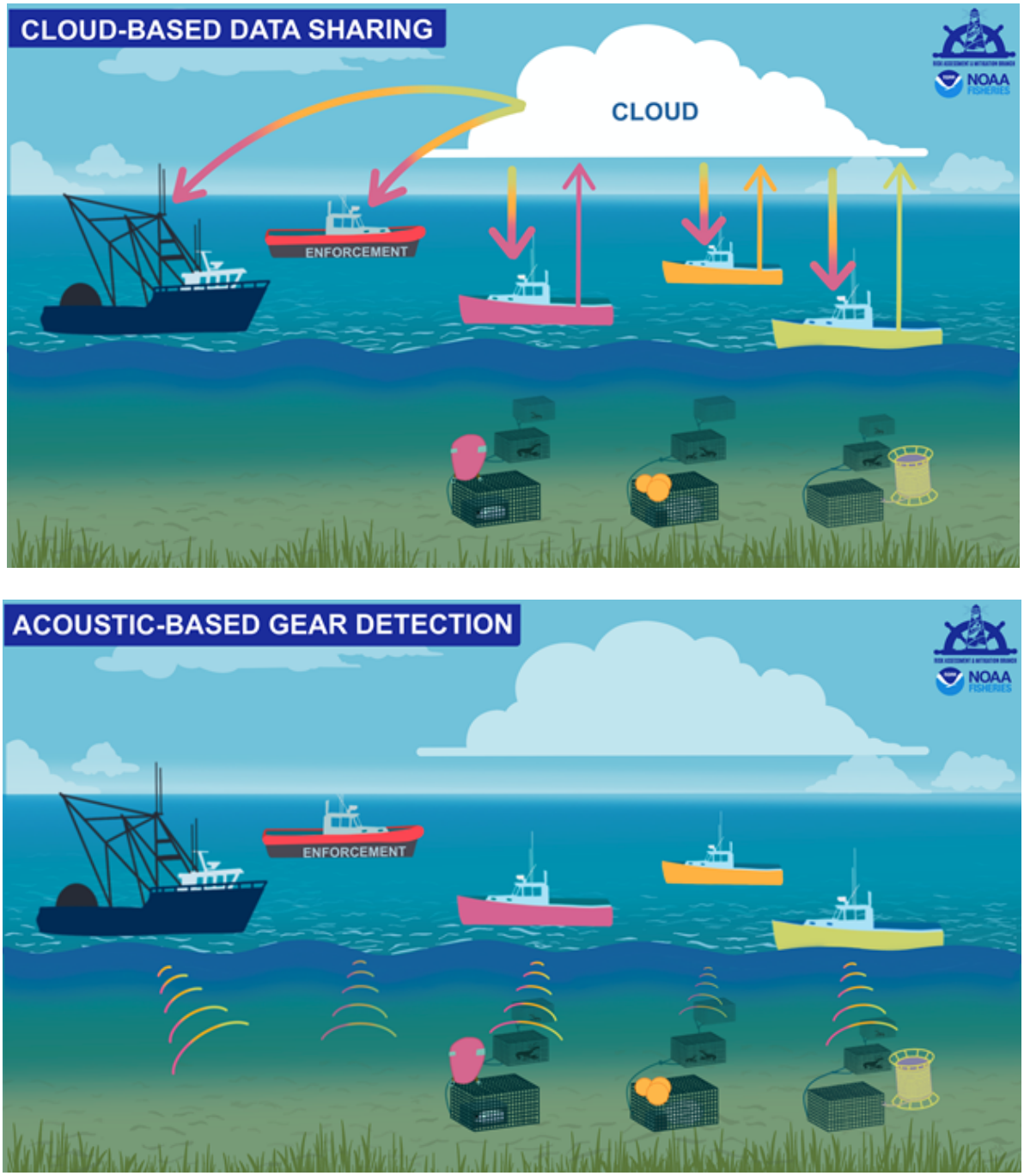

Figure 6. Top: Infographic demonstrating gear detection and dissemination using internet cloud-connectivity. Bottom: Infographic demonstrating gear detection using localized acoustic positioning. Graphic credit: NOAA Fisheries/Megan Amico

Steps Toward Standardization

NOAA fisheries is prioritizing research and development of interoperable on-demand systems while also considering other possibilities. Between 2020 and 2023, gear marking workshops and interviews were held with U.S. and Canadian fishing industry representatives, managers, and enforcement agencies who generally indicated that a standardized marking system is preferable. Such a system would be most useful if it displayed and disseminated the information that is traditionally communicated by a surface buoy, as well as information associated with the on-demand release devices.[10]

In November 2023, NOAA Fisheries convened an On-Demand Interoperability Workshop,[11] composed of experts from NOAA Fisheries, Fisheries and Oceans Canada (DFO), U.S. state agencies, on-demand gear manufacturers, underwater acoustics experts, fishing industry representatives, and other relevant stakeholders to gather input on interoperability considerations, and the utility of standards for acoustic communications and data sharing to support on-demand fishing. Interoperable systems capable of sharing location information across technology brands should minimize disruption to existing fishing and law enforcement practices, while also supporting management needs across jurisdictions and enhancing the resilience of on-demand fishing technologies over time.

In October 2024, NOAA Fisheries convened interested parties to discuss virtual gear marking chartplotter integration and development of a National Electrical Manufacturers Association standard as a means to do so. This meeting built on work already ongoing in the on-demand technology community, which continues to prioritize gear location visualization that is at least as effective as current buoys and other surface system components.

Next Steps to Operationalize On-Demand Fishing

To operationalize on-demand gear as an optional tool for fixed gear fishermen faced with persistent buoy line restrictions, there are six tasks that we envision completing. These tasks define work that is ongoing and build on the four steps outlined in the 2022 Ropeless Roadmap: “expand experimental fishing” (see Task 1), “FMP and TRP regulatory change” (Task 2), “technology development and testing” (Tasks 1 & 3), and “resolving gear

[10] Baumgartner, M., Baumwell, L., Baker, E., Brillant, S. 2021. Workshop on Buoyless Fishing Gear Location Marking Methods: Report on Stakeholder Engagement Meetings. Ropeless Consortium.
Galvez, B., E. Matzen, C. Khan, H. Milliken, J. Goebel, and C. Good. 2023. Fisheries Information System (FIS) Stakeholder Engagement Workshops report: stakeholder input on data fields for an on-demand fishing geolocation cloud database. US Department of Commerce Northeast Fisheries Science Center Technical Memo 309:1-26.

[11] Consensus Building Institute. 2024. On-Demand Interoperability Workshop Report. https://doi.org/10.25923/c1kc-a214

conflict" (Tasks 1, 2, & 3). As on-demand development has proceeded, new tasks have been initiated and it has become clear that, unlike a series of mile markers along the road, development across tasks will continue concurrently, as detailed in the below anticipated timeline (next page).

Operationalizing On-Demand Gear: Remaining Tasks and Timeline	TASK OWNER	PCT OF TASK COMPLETE	2025		2026		2027		2028	
			Jan-Jun	July-Dec	Jan-Jun	July-Dec	Jan-Jun	July-Dec	Jan-Jun	July-Dec
TASK 1: Expand Research										
Continue testing available on-demand systems	NEFSC	**ongoing**								
Expand trials on vessels that complete multi-day trips in offshore areas	NEFSC	**ongoing**								
Evaluate surface GPS gear marking accuracy and acoustic gear marking performance	NEFSC	**25%**								
Test grappling as a retrieval mechanism on marked trap trawls	NEFSC	**0%**								
Encourage mobile gear participation in gear detection technology evaluations	NEFSC	**25%**								
Trial systems in increasingly complex scenarios with geolocation technology	NEFSC	**ongoing**								
Trial new and/or updated on-demand fishing system technologies	NEFSC	**25%**								
Compare the time to haul on-demand vs. traditional gear to inform economic analyses	NEFSC	**50%**								
Collect data to inform device performance standards and technology specification	NEFSC	**50%**								
Issue federal exempted fishing permit authorizations	GARFO	**ongoing**								
TASK 2: Modify Regulations										
Develop ALWTRP regulatory amendment, which could include more restricted areas	GARFO	**0%**	ALWTRT Meetings			Prop Rule		Final Rule		Effective Date
Complete economic analysis and profit optimization model	GARFO	**25%**								
On-Demand Gear Conflict Working Group Provides Report to Councils	MAFMC/NEFMC	**50%**		Lobster Rprt						
Regional fishery management organizations discuss FMP actions	MAFMC/NEFMC/ASMFC	**0%**								
Regional fishery management organizations take final FMP action	MAFMC/NEFMC/ASMFC	**0%**								
FMP Rulemaking to allow for on-demand gear use integrated into ALWTRP	GARFO	**0%**			Prop Rule	Final Rule				
TASK 3: Develop Performance Standards										
Develop minimum safety, reliability, and durability standards for on-demand systems	NEFSC/GARFO	**0%**								
Develop minimum on-demand system supplier standards, if applicable	NEFSC/GARFO	**0%**								
Develop on-demand gear location marking standards	NEFSC/GARFO	**0%**								
Evaluate on-demand acoustic interoperability alternatives and effects on marine life	ST	**50%**								
Develop acoustic communication interoperability standards, if applicable	ST/NEFSC/GARFO	**0%**								
Develop device retrieval and setting interoperability standards, if applicable	ST/NEFSC/GARFO	**0%**								
Task 4: Develop Data Governance, Data Sharing, and Privacy Best Practices and Technical Specifications										
Gather information from interested parties to inform specifications and best practices	GARFO/NEFSC/ST	**50%**								
Convene interested parties to discuss gear marking chart plotter integration	NEFSC/ST	**50%**								
Develop data field and metadata standards for digital gear marking	GARFO/NEFSC/ST	**75%**								
Develop data governance, sharing, privacy, and cybersecurity guidelines	GARFO/NEFSC/ST	**0%**								
Identify data management approach	GARFO/ST	**0%**								
TASK 5: Approve Systems that Meet Performance Standards										
Finalize performance standards across all aspects of on-demand fishing	GARFO	**0%**								
Develop a demonstration and approval process for on-demand systems and suppliers	GARFO	**0%**								
Approve on-demand systems	GARFO	**0%**								
TASK 6: Develop Enforcement Practices										
On-demand gear training for enforcement officers	GARFO/NEFSC/OLE	**25%**								
Guidance distributed to enforcement regarding system use	GARFO/OLE/Suppliers	**0%**								

Task 1: Expand Research

Given increased Congressional funding and growing interest among fishermen to gain experience using innovative gear technology, we are accelerating on-demand research. Research is also expanding under efforts led by others, many in collaboration with fishing communities. For example, organizations funded through NFWF's New England Gear Innovation Fund are working to improve and expand access to on-demand retrieval devices, further develop gear marking and gear detection technologies, and build solutions to support gear conflict avoidance, enforceability and safety. NEFSC will continue to collaborate with organizations to facilitate efficient, non-duplicative, research and the Greater Atlantic Region Fisheries Office will continue to support research through the review and issuance of exempted fishing permits.

In 2024, the NEFSC focused on increasing the number of fishermen collaborators and the amount and diversity of on-demand devices in the gear library. Getting more fixed and mobile gear fishermen involved will allow us to test on-demand fishing technologies at larger scales with increased complexity and refined research goals. The NEFSC currently works with approximately 50 vessels and is authorized to deploy on-demand gear on up to 200 vessels.

NEFSC research goals for 2025-2027 include:

- Continued testing of available on-demand systems to allow fishermen to determine which systems works best for their operation, provide feedback to technology developers, and collect data about the capabilities and limitations of each system when fished in various environmental conditions with various gear configurations.
- Expanding on-demand trials on vessels that complete multi-day trips in offshore areas, fishing long trawls or sets.
- Evaluating surface GPS gear marking accuracy and the performance of acoustic gear marking technology.
- Testing grappling as a retrieval mechanism on marked trap trawls.
- Encouraging mobile gear fisheries' participation in gear detection technology evaluations.
- Trialing on-demand systems in increasingly complex scenarios in concert with gear detection and display technologies.
- Trialing auxiliary technologies that can improve and add value to on-demand fishing systems, such as automatic gear marking and smart buoy integration.
- Comparing the time to haul on-demand versus traditional gear to inform economic analyses
- Collecting data to inform on-demand device performance standards and technology specification.

See the latest research updates here.

Task 2: Modify Regulations

Multiple laws govern commercial fishing in federal waters, including the Magnuson-Stevens Fishery Conservation and Management Act (MSA), Atlantic Coastal Fisheries Cooperative Management Act (ACA), MMPA, ESA, and others. Each of these laws has specific regulations promulgated under these and other statutes that may apply to on-demand fishing. As examples, fishery management plan regulations are governed by the MSA, interstate management plan regulations (such as for the lobster fishery) are governed by the ACA, and Take Reduction Plan regulations are governed by the MMPA. Other regulations may also apply, but this guide focuses on the regulations NOAA Fisheries has the authority to modify to allow on-demand fishing.

2.1 Amendments to the Atlantic Large Whale Take Reduction Plan

The implementation of large seasonal restricted areas to reduce risk to whales is the major driving force in the development of on-demand gear. Congress has directed NOAA Fisheries to work to develop on-demand gear,[12] as noted in the Consolidated Appropriations Act, 2023, which required NOAA Fisheries to implement new regulations for the American lobster and Jonah crab fisheries utilizing existing and innovative fishing gear technologies, as appropriate, by December 31, 2028."[13] In the interim period, Congress appropriated funds for developing and operationalizing those technologies.

For new regulations to be in place on December 31, 2028, we anticipate the following timeline:

- **2025:** Begin scoping and convene the Team via informational webinars and meetings to present the best available scientific information on right whale population estimates, fisheries data, and entanglements that result in serious injury and mortality. Time will

[12] As noted in Senator Angus King's (I-ME) floor statement: "Now, a solution to this crisis is in the bill that we will be voting on tomorrow. It is one that the Maine delegation, myself and Senator COLLINS, Congresswoman PINGREE, and Congressman GOLDEN have been working on since this decision. And it is a compromise that has been negotiated between the various people interested in this issue and this body that leaves in place all of those protective measures that I mentioned—the weak links, the weaker ropes, the ropes out of the water, the marking of the gear. All of those stay in place.

Importantly, it provides funding for two purposes. One is the development of gear that will reduce the risk even further—lobster gear, that is. For example, there is a lot of discussion of something called ropeless fishing, which would be traps on the bottom and a buoy on the bottom that can be released by a radio signal, come to the surface, and then you can pull the traps up. So there is no rope in the water.

Now, that is a great idea. The problem is, it is not ready for prime time. It is being tried. There are experiments going on with it. There are some serious problems with it. For example, currently, if you are a lobsterman, you go out and you see other buoys, and that tells you where other traps are, so you don't put yours down on top of theirs. In this ropeless fishing configuration, until we figure that out, we can't have multiple traps laying on top of each other and becoming entangled.

The other problem is, it is very expensive. We are talking about tens and hundreds of thousands of dollars for the guy that owns this boat. So what the bill provides is funding for research of how to develop this, whether it is ropeless fishing or some other technology that we don't know right now, to mitigate whatever risk there is even further. So that is one funding in the bill."

[13] https://www.congress.gov/117/plaws/publ328/PLAW-117publ328.pdf, see page 6089 et seq.

be provided for Team members to caucus with the stakeholders they represent toward the development of recommendations to modify the Take Reduction Plan.

- **Late 2025, Early 2026:** Team meets to develop and vote on a suite of recommendations.
- **Late 2026:** NOAA Fisheries publishes a proposed rule and Draft Environmental Impact Statement, with a comment period. As was done in the 2021 rulemaking, seasonal restricted areas would restrict the use of buoy lines rather than the harvest of target species; therefore, unless prohibited by FMP or Interstate Management Plan regulations, on-demand fishing would be allowed.
- **2027:** NOAA Fisheries considers public comments, finalizes rule and Environmental Impact Statement.
- **Late 2027/Early 2028:** NOAA Fisheries publishes a final rule, with an implementation date of December 31, 2028, to give industry enough time for compliance.

2.2 Modification of Fishery Regulations Requiring Surface Marking

NOAA Fisheries does not intend to require the use of on-demand gear, however to allow fishermen the option to use this gear to fish in areas closed to persistent buoy lines, changes to current Greater Atlantic Region fixed gear fisheries regulations will be needed to add alternatives to current surface marking requirements.

Fishery management bodies including the New England and Mid-Atlantic Fishery Management Councils (the Councils) and the Atlantic States Marine Fisheries Commission are engaged at various stages in discussing the regulatory modifications that would be needed to authorize alternatives to current surface marking (buoys, radar reflectors, highflyers, etc) requirements. NOAA Fisheries recognizes allowing on-demand fishing in the Take Reduction Plan's restricted areas may impact mobile bottom-tending fisheries not regulated by the Take Reduction Plan and not responsible for incidental takes of right whales. Because these types of changes have the potential to affect all vessels, early and frequent engagement with industry and management partners is important.

The following regulations have been identified as those that would need to be changed to allow Greater Atlantic Region fixed gear fishermen to optionally use on-demand gear:

- Lobster regulations (ACA, § 697.21(b)) require a buoy on trap trawls of three or fewer traps, or a radar reflector and flag or pennant on the westernmost end and radar reflector on the easternmost end of trap trawls of more than three traps. This section of the regulations also has a 1.5 nautical mile trawl length limit (except Lobster Conservation Management Area 3 with a 1.75 nautical mile trawl length limit).
- Groundfish, monkfish (and gear capable of catching groundfish) regulations (MSA, § 648.84(b)) requires bottom-tending gear to be marked at surface with radar reflectors and a flag or pennant. Other fisheries of the Northeastern U.S. regulated under § 648 (fisheries within the Greater Atlantic Region) must also comply with the gear marking requirements § 648.84 (see § 648.14(k)(10)).

- Red crab regulations (MSA, § 648.264(a)(5)) require buoys on trap trawls to be marked with fishery and vessel identification marks, high flyers, and radar reflectors.

Modifications to these gear marking requirements could be made in the near term, in parallel with ongoing research, but would not result in the widespread use of on-demand gear until on-demand gear has been demonstrated to meet any regulated performance standards, an approval process has been developed, and gear has been approved for use.

The New England Fishery Management Council established the On-Demand Fishing Gear Conflict Working Group (ODWG) in 2023, with working group members representing the Councils, the Atlantic States Marine Fisheries Commission, commercial and party/charter fisheries, state and federal resource managers, as well as an NGO representative. The ODWG has developed a work plan and terms of reference, available on their web page, to address issues raised by the potential use of on-demand gear.

The Councils and Commission may, through a future management action, modify surface marking requirements, recommend basic on-demand performance standards and/or provide guidance on a recommended approval process. NOAA Fisheries would consider such recommendations as part of its review of the future management action. If ultimately recommended and implemented in this manner, the Regional Administrator could approve the use of specific systems that meet performance standards following posted procedures as discussed in Task 2.4. We will continue to engage with the Councils and Commission to advance on-demand fishing.

2.3 Evaluate Costs and Describe Economic Challenges of On-Demand Implementation

The socio-economic impacts of any recommended regulatory changes will need to be analyzed by the recommending Council(s) and an economic analysis using best available data will be part of any rulemaking. The use of on-demand gear may also be analyzed in any additional modifications to the Atlantic Large Whale Take Reduction Plan if that option is available to fishermen at the time of such modifications.

While the cost of on-demand gear is expected to drop as production increases and the equipment becomes commercially available,[14] on-demand systems will be more expensive than surface markers and rope. The choice to use on-demand gear, remove gear, or fish elsewhere

[14] Alkire, C. 2022. Decline in on-demand fishing gear costs with learning. Front. Mar. Sci., 17 November 2022; CLF. 2023. Financial Impact of Transitioning Two Sectors of the Northeast Lobster Fishery to On-Demand (Ropeless) Fishing; Oppenheim, N.G. (2022). Assessing the Feasibility of On-demand Gear in New England Lobster Fisheries. Homarus Strategies LLC, Brunswick, Maine, USA. Myers, H. and M. Moore. 2020. Reducing effort in the U.S. American lobster (Homarus americanus) fishery to prevent North Atlantic right whale (*Eubalaena glacialis*) entanglements may support higher profits and long-term sustainability. Marine Policy Volume 118:104017

will be a business decision for each fisherman or fishing company, which will be informed by the cost of losing access to restricted areas versus the benefits of harvesting from these areas during the closed season. The initial investment into on-demand gear could be quite substantial, and gear loss would come at a greater cost. Together, these impacts and business decisions may result in access/equity concerns in some seasonal restricted areas without support for initial gear purchases.

The cost of operationalizing on-demand gear to fishermen regulated under the Take Reduction Plan, as well costs to fishermen not regulated under the Plan that may need to purchase technology to detect on-demand gear is a concern, as is who will bear these costs. Work is underway to estimate the full costs of operationalizing on-demand gear, including costs for the purchase and maintenance of gear and technology, costs of hardware and service plans that can access the internet from sea, and costs to equip and train law enforcement personnel.

NOAA Fisheries and collaborators will continue to work on a profit optimization model that uses fishery related data (e.g., observer trip data and vessel trip report data) to provide fishermen with information on the quantity of on-demand devices they should adopt that could maximize the profit based on their fishing practices and seasons. The goal of this work is to identify key transition points, where challenges or opportunities may arise in the progress toward a fully operationalized on-demand fishery that shifts away from a NOAA-managed gear lending library toward industry, third-party, or other investments.

2.4 Considerations for Regulatory Approaches for Performance Standards and/or Approval Process if On-Demand Gear is Adopted

NOAA Fisheries anticipates that regulations allowing alternative surface markings would detail minimum performance requirements equivalent to current surface marking functions, which allow fishermen to detect from some distance that gear is set on the bottom, haul and reset their own gear, and allow enforcement to inspect and reset gear (see Appendix B, Table 1). Future regulations could require demonstration that on-demand components or systems are compliant with minimum performance standards prior to approval for use by the fishing industry.

Technical specifications related to acoustic signaling, interoperability, data visualization and other elements could also be implemented by regulation. However, stakeholders and gear developers have suggested that overly prescriptive regulations that are not easily modified could prevent innovation. NOAA Fisheries has previously identified minimum performance requirements in regulations, and published guidance regarding minimum technical specifications that must be demonstrated to be approved for use, as well as a list of approved systems, on a NOAA website. This practice allows the rapid adoption of new technology and supports continued innovation. For examples, NOAA Fisheries used this process to approve vessel monitoring systems and electronic vessel trip reporting applications, as well as weak rope and weak insertions for buoy lines, with varying degrees of specificity in the regulations:

- Vessel monitoring systems require type approval, through a process described at 50 CFR Part 600 Subpart Q. Vendors must demonstrate that their devices meet the standards and requirements also described in that part. NOAA Fisheries Office of Law Enforcement reviews applications and devices against these requirements and maintains a list of approved devices on its website.
- Take Reduction Plan regulations at § 229.32(c)(2)(iii) require that rope and weak devices/insertions breaking strength not exceed 1,700 lb (771 kg). NOAA Fisheries staff evaluate and test the breaking strength of ropes/inserts and maintains a list of weak ropes and weak inserts on its website.
- Vessel Trip Reporting regulations at § 648.7(b)(1) require vessels to submit reports using a software application approved by NOAA Fisheries. NOAA Fisheries maintains software development reference information (including technical requirements and the approval process) and a list of approved applications on its website. Staff ensures that applications are capable of submitting the necessary information in the proper format prior to application approval.

Developing technological specifications might also benefit from Council, Commission, and public input, which could occur outside of the regulatory process through a solicitation for public comments. For example, NOAA Fisheries has used this process to establish Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing.

As mentioned earlier, crafting regulations that specify performance standards (See Appendix B for examples) and/or direct the development of an approval process, but do not include technical specifications, would allow for innovation, evolution, and agility. Regulatory performance standards and published technological specifications would also give on-demand manufacturers more certainty about program requirements they could use to refine systems prior to commercial production and distribution, potentially lowering costs. Further, should a yet-to-be-envisioned technology address the needs of an on-demand fishery, limiting regulatory requirements to performance standards could streamline the process of approval for industry use. Under this approach, modifications to fishery management regulations to allow alternative surface markings could be done before the technical specifications have been fully developed

2.5 Potential Modifications to Gear Conflict Regulations

Under Magnuson-Stevens Act regulations, gear conflict means “any incident at sea involving one or more fishing vessels:

(1) In which one fishing vessel or its gear comes into contact with another vessel or the gear of another vessel; and

(2) That results in the loss of, or damage to, a fishing vessel, fishing gear, or catch.”

For the purposes of this document, gear conflicts include interactions between fixed and mobile gear and between fixed gears (e.g., a lobster trap trawl set over a previously set trap trawl). The Magnuson-Stevens Act (see 16 USC 1857(k)) prohibits stealing or negligently tampering with

another person's gear, but it can be difficult to establish intent when reviewing a general gear conflict case. NOAA has prosecuted relatively few gear conflict cases in recent history.

NOAA Fisheries has used multiple strategies to alert vessels of the potential for gear conflicts, including emails and communications via vessel monitoring systems. In some areas, fishermen have been able to come to informal agreements to avoid conflict. Additionally, formal gear separation areas with seasonal, exclusive access for either mobile gear or fixed gear, have been developed and codified in some instances (50 CFR § 697.23). Such agreements may continue to mitigate conflicts between on-demand fishing and mobile gear vessels in the future.

The magnitude of gear conflict in the Greater Atlantic Region is not well understood. Stakeholders have suggested that on-demand gear use could increase the gear conflict that already occurs between fishermen. Given the cost of on-demand systems, conflict that causes gear to be damaged or lost would have increased economic consequences. However, on-demand systems also provide an opportunity to reduce the consequences of gear conflict and other sources of gear loss due to the acoustic signaling that could allow moved gear to be located and retrieved.

However, gear conflict occurs when abundant target species overlap in time and space. In recognition of this, the New England Fishery Management Council amended the Multispecies, American Lobster Fishery, and Atlantic Sea Scallop FMPs to allow framework actions to resolve gear conflict in the Gulf of Maine, Georges Bank, and Southern New England in 1996 (see 62 FR 1403 and the Northeast Multispecies Amendment 8 web page).

The Council identified the measures listed below as those that could be implemented to address gear conflict as part of the framework adjustment procedure:

1. Mandatory monitoring of a radio channel by fishing vessel
2. Fixed gear location reporting and plotting requirement
3. Standards of operation when gear conflicts occur
4. Fixed gear marking and setting practiced
5. Gear restrictions for specific areas (including time and area closures)
6. Vessel monitoring systems
7. Restrictions on the number of fishing vessels or amount of gear
8. Special permit conditions

Because on-demand fishing presents challenges and opportunities related to gear detection and avoidance that could increase or reduce incidences of gear conflict, the ODWG made a consensus recommendation to the New England Council suggesting that the Councils, working through their Enforcement Committees, consider changes to management measures to ensure that the responsibility to avoid gear conflict is clearly spelled out. At the September 2024 meeting, the New England Council passed by unanimous consent a motion by the Chair of the ODWG: "To recommend to task the Enforcement Committee to provide input for the On-demand Gear Conflict Working Group and continue developing recommendations for reducing

gear conflict." The law enforcement committees of the Councils and Commission are expected to provide input on regulations to address the changes to gear conflict brought about by the use of on-demand gear.

Another option could instead require a "duty of care" standard and a regulation that would specify what would be required to meet that duty of care standard; including measures likely to be very similar to the list above. This type of standard could be similar to the gear conflict avoidance regulations regarding the responsibilities of foreign-flagged vessels (§ 600.510 Gear avoidance and disposal).

Task 3: Develop Performance Standards

3.1 Standards for Deploying and Retrieving On-Demand Gear

To provide fixed gear fishermen with fishing access when the use of persistent buoy lines is restricted, on-demand devices may need to meet minimum performance standards related to safety, reliability, and durability. On-demand systems ma also, need to have functionality that allows law enforcement to assess, haul and reset on-demand technology. On-demand gear suppliers may need to meet minimum standards of performance related to providing gear maintenance, training, and customer support.

If minimum performance standards are established, on-demand developers or suppliers may need to demonstrate that on-demand systems are compliant with these minimum performance standards prior to approval for use by the fishing industry (see Task 5).

Below is a list of outstanding questions that NOAA Fisheries is considering for development of performance standards and an approval process. These questions are being informed by on-going research, including the MITRE review discussed further below (see 3.2).

- What success rate would be required to demonstrate device reliability and how would this be demonstrated?
- How would safety and durability be demonstrated?
- How will law enforcement needs be supported through the standards and approval process?
- Will there be minimum performance standards for gear suppliers or will this be left to market forces?
- Will there be a mandatory training component before fishermen deploy gear?

3.2 Standards for Marking and Detecting On-Demand Gear

To avoid gear conflict and allow for gear awareness, on-demand gear deployments should be marked. Gear marking can be manual or automatic and gear deployment locations can be derived from the surface location, using GPS, or where the device is positioned on the seafloor, using acoustic communication. NOAA Fisheries has contracted with MITRE, a not-for-profit

federally funded research and development center, to conduct a comprehensive review of communication approaches to help determine if and where acoustic gear marking may be necessary and where GPS marking may be sufficient. In consultation with NEFSC marine mammal bioacousticians, MITRE is also assessing current systems and drafting recommendations for acoustic signaling ranges that minimize adverse impacts to large whales and other protected species as appropriate. A final report is expected by December 31, 2024.

There is a growing number of on-demand gear manufacturers, many with different, mostly proprietary, acoustic communication protocols for operating, marking, and locating their devices. An interoperable acoustic standard could be beneficial for a number of reasons, including allowing fishermen and law enforcement to use a universal retrieval device and making acoustic location of gear from multiple manufacturers more practical. Should regional interoperability standards be impractical, standards that consider the vast differences in enforcement and fishery needs from the West Coast to the South Atlantic and Greater Atlantic Region should be considered.

Regardless of how on-demand gear is marked and detected, a virtual gear marking system would benefit from a set of standards defining the data elements and metadata associated with how gear is displayed on a chartplotter or mobile application. Standards would ensure that ocean users receive consistent information that effectively replicates the visual awareness they get from surface marking systems, and technology providers have the guidance they need to design and build software and hardware that allows on-demand gear from multiple manufacturers to be displayed consistently.

Below is a list of outstanding questions that NOAA Fisheries is considering related to gear marking, detection, and display.

- Will automatic gear marking be required?
- Will GPS gear marking be allowed in areas or will acoustic-based marks be required?
- Is grappling in combination with virtual gear marking a viable option?
- What gear location and identification data should be shared and how should it be made available and displayed on a chartplotter or mobile application?
- Are there fisheries or areas where mariners do not need access to on-demand gear marking systems in near real time?
- Will interoperability be required or will proprietary systems be approved?

Task 4: Develop Data Governance, Data Sharing, and Privacy Best Practices and Technical Specifications

4.1 Data Governance

Depending on the methods that are ultimately commercialized to mark, detect, disseminate, and display on-demand fishing gear, best practices around data governance, privacy,

cybersecurity, and other elements will need to be resolved. For example, in order for the virtual gear marks from different vendors to be shared via a single cloud platform, decisions will be needed regarding data flow, data management, data governance, and data sharing. Consideration will need to be given to NOAA Fisheries' role, for example, the Agency could serve as the data manager or define standards for a third party data manager.

Data governance recommendations and best practices need to be developed before this method could be operationalized. A proposal was offered at the October 2024 Ropeless Consortium Meeting to have the Consortium convene a workgroup to develop recommendations, however the details of this workgroup are yet to be determined. NOAA Fisheries will consider recommendations from the community and lessons learned from the development of other fisheries electronic technologies as the development process continues.

4.2 Options for Functional Specifications for Virtual Gear Marking

Gathering stakeholder input to inform technical specifications has already begun (see "Steps Toward Standardization" above). Below is an example of virtual gear marking functional specification envisioned by stakeholders during a series of workshops.[15]

Stakeholders identified the following data elements as desirable components of an on-demand gear marking system. The list summarizes the work to date and informs the future development of standards, as needed. Some of these elements replicate current surface marking system performance standards, whereas others represent features that aren't available in traditional fishing, but could be useful, for example that ability for owners to remotely monitor their on-demand gears' status and location. See Appendix B, Table 2 for a breakdown of proposed data access by user permission, access type, and data transmission priority. In all cases, personal identifying information (PII), business information, and trade secrets would be protected in accordance with applicable laws.

- **Device Datetime** - time and date of the initial setting of gear (UTC)
- **Device Datetime (Last Position Update)** - the latest datetime updated acoustically by a passing vessel using certain acoustic systems.
- **Device Health** - describes remaining capacity for release, such as battery percentage or amount of air left, depending on the type of release system being used. This can be interrogated acoustically or can be a physical display on the on-demand device, such as a pressure gauge or indicator light.
- **Device Identification (ID)** - should contain a standardized code for the device manufacturer, year built, model and serial number. For example, the ID could be structured as: first four letters of the manufacturer, the last two numbers of the year the device was manufactured, and the last four numbers of the serial number of the device.

[15] Galvez et al. 2023.

- **Device Location** - decimal degrees (DD) to 5 decimal places. Presence of a location in the marking system would indicate that the device status is "deployed" or "set".
- **Device Status** - device status describes the current status of the device via labels such as "armed" / "ready", "fault" / "error", "deployed", et cetera. "Deployed" devices and associated gear would be viewable on an application's map display or chart plotter, as permissions allow. Other statuses would only be viewable to the gear owner and potentially other users who the device owner chooses to share the data with.
- **Release Notification** - an acoustic message from the device that notifies the device owner that the release command has been received and initiated. This message indicates that the release was successful.
- **Gear Type** - the type of gear the device is attached to (e.g., lobster/fish trap or gillnet)
- **Gear Count** or **Gear Length** - the quantity of traps on a trawl/number of panels on a gillnet string or the length of the trawl or string
- **Owner ID** - unique identification number of an individual user that can be tied to the vessel ID, hull ID, operator ID, permit #, and/or license #, as appropriate under law.

As detailed further below, the transmission of the above data elements fall into two main categories: acoustic communications and cloud (internet) communications. The two types of communication are not mutually exclusive and are determined by function.

Acoustic Communications - The data fields that are currently able to be interrogated acoustically include: Device ID, Device Health, Device Status, and Release Notification, and Location. The release notification is only obtainable via acoustic interrogation, whereas the other data may also be accessed in the cloud, however the cloud could only display Device Health and Device Status from the last time the device was interrogated acoustically.

Cloud Communications - There are currently two viable options available on the ocean for internet connectivity to the cloud - cellular and satellite. Cellular internet service relies on the nearest available cell tower and will work for nearshore internet connectivity in some areas. Satellite internet service provides connectivity without the need for a cellular connection, however it is typically more expensive than cellular service. Therefore, for fishing grounds outside of cellular connectivity range, only data elements identified as priority would be sent using satellite service (see Appendix B, Table 2), while supporting data would be sent when the vessel enters cellular communication range.

Priority data fields may be necessary to minimize gear conflict and comply with law enforcement needs. Those data fields could include Owner ID, Device ID, Device Location, Device Datetime, and Device Datetime (Last Update). Supporting data fields include Device Health, Device Status, Gear Type, and Gear Count. These data would be helpful to the owner and operator for operational awareness and planning. If these data were shared with law enforcement, it would prepare them when hauling gear. If shared with fisheries managers, it would allow them to calculate on-demand fishing effort. If shared with manufacturers, they could use these data to fulfill potential warranty claims.

User Data Permissions - During the Fisheries Information System workshops and as part of the Baumgartner et al. 2021 report, stakeholders identified specific user groups that might benefit from access to specific data elements. Proposed user permissions fall into eight categories with varying levels of access to real-time information about current deployments or to retrospective access about historic deployments. Refer to Appendix B, Table 2 for further details.

As an example, to protect sensitive information, Device Location information would likely be 'geofenced' so that other ocean users would only be able to detect on-demand gear within a defined radius that could be consistent with radar and line-of-sight detection of traditional gear, and the information shared would vary by user type.

Real-time Access - The owner/operator of the gear could have access to all of the proposed data fields. Other fishermen, research vessels, and other mariners within a specified geographic range of the device could be given access to the Device ID, Location, Datetime, and Datetime (Last Update), in order to replicate the visual information conveyed by traditional surface marking systems. Owners may want to give the manufacturer access to many of the data fields for customer service tasks and potential warranty claims. Fisheries managers and researchers/other land-based parties may not need live access to data. Stakeholders had varying opinions on law enforcement access to data fields, ranging from access to all data in real-time to user permissions that replicate the information conveyed by surface markings.

Retrospective Access - Various stakeholders have identified certain users as potentially benefiting from retrospective access to the data. The owner/operator, law enforcement, and manufacturer could be given retrospective access to all of the data fields for maintaining their fishing history, law enforcement purposes, and customer service. Fisheries managers, and researchers/other land-based parties may desire retrospective access to some data for various purposes. To protect privacy and to comply with state and federal laws related to data sharing, users would not be able to access any PII, protected business information, or trade secrets.

Task 5: Approval of Systems that Meet Performance Standards

A system would have to be approved by the Greater Atlantic Regional Administrator before allowing any changes to fishing practices, other than for research purposes. We envision regulations being modified ahead of on-demand systems being approved. Modifications to fishery management plans could also include restricting gear without surface marks to certain areas and/or the development of specific area management protocols such as seasonal rotations or area-specific gear-setting conventions that further reduce the likelihood of gear conflict, etc.

Performance standards that describe what an on-demand system would have to do to replicate the functions of surface markings could be adopted in regulations (Task 2.4). The following checklist enumerates the performance capabilities that the Greater Atlantic Region, in

discussion with stakeholders and partners, has preliminarily identified as necessary to be approved for use in Greater Atlantic Region:

- Allows for consistent deployment and recovery of on-demand systems by fixed gear fishermen.
- Allows other ocean users to detect and visualize gear on the bottom within a specified radius (likely different for state vs. Federal waters) via a chartplotter, mobile device, or other device universally available at a reasonable cost.
- Provides information regarding the gear, vessel, and/or permit information as required by relevant regulations.
- Provides an effective means for enforcement to haul and reset gear as part of normal enforcement operations.
- Meets acoustic communication and interoperability standards, if applicable.

Task 6: Develop Enforcement Practices

6.1 Gear Inspection and Enforcement

Inspecting fixed gear is an important part of NOAA's Northeast Division (NED) Office of Law Enforcement's (OLE) mission. These inspections help verify compliance with regulations (required by MMPA, MSA, ACA, and other laws) that govern gear design, location, quantity, markings, as well as configuration requirements designed to protect marine mammals.

In general, fixed gear inspections are among the more challenging and resource intensive aspects of fisheries law enforcement. Challenges include locating gear, limited availability of enforcement platforms outfitted with gear hauling capabilities, specialized skills and training needed to handle fixed gear, unique gear configurations among fishermen and regions, and the inherent dangers involved in gear hauling and redeploying.

To conduct enforcement in an on-demand fishery, NOAA OLE and their joint enforcement partners (i.e., state fisheries enforcement agencies and U.S. Coast Guard) will have to develop new practices, particularly regarding gear hauling, inspection, and redeployment methods. As we identify system performance standards, we will ensure that there are efficient tools and training plans in place for enforcement to enable hauling, inspection, and resetting. What specific data would be available to law enforcement users needs to be resolved.

6.2 Gear Conflict

Enforcement agencies are involved in on-demand development in a number of ways, for example, through the Councils' and Commission's Enforcement Committees, who have begun to meet to advise on enforcement needs and gear conflict issues. OLE, NEFSC gear researchers, and others hosted a series of gear demonstrations and training sessions for federal and state law enforcement agencies in 2024, with plans to continue these sessions. If new regulations

are implemented to address the changing nature of gear conflict due to the use of on-demand gear, enforcement agencies will be involved in assisting with and monitoring compliance, as well as with enforcement.

Conclusion

Authorization of on-demand fishing as an alternative to current gear marking requirements would allow participating fixed gear fishermen to access areas and seasons where traditional fishing with persistent buoy lines is restricted. Thus, on-demand fishing can support healthy fisheries and their communities while providing needed protections to right whales. While on-demand fishing gear will require both time and investment to fully develop, once operational it could provide many opportunities including:

- Allowing fishermen access to fishing grounds where persistent buoy lines are prohibited to protect species at risk of entanglement.
- Allowing gear to be visualized in all conditions (e.g., darkness, fog).
- Allowing for fishing with gear less vulnerable to current and storm drag.
- Reducing the potential for lost gear as displaced gear can be relocated using acoustics.
- Providing a spatially resilient management solution as both protected species and fisheries shift movement patterns in response to climate change.

NOAA Fisheries and partners will continue to advance the transition to on-demand fishing as an alternative to traditional gear where it is best suited to reduce entanglement risk, while continuing to permit fishing with traditional buoy lines when and where entanglement risk is low. NOAA Fisheries in the Greater Atlantic Region is committed to continuing to work with collaborators to tackle each of the tasks outlined above and follow the direction provided by Congress, namely: “to promulgate new regulations for the American lobster and Jonah crab fisheries consistent with the Marine Mammal Protection Act of 1972 (16 8 U.S.C. 1361 et seq.) and the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.) that take effect by December 31, 2028, utilizing existing and innovative gear technologies, as appropriate….”

For on-demand fishing to become a reality, fishermen, managers, technology experts, and researchers must work collaboratively toward this goal. We will continue to work with all interested fishermen and NGO partners to test new and existing brands and models of on-demand gear and other equipment; work with managers, policy makers, gear developers, and technology organizations to develop strategies around governance, data sharing, and privacy necessary to make on-demand gear operable in the real world; work with gear researchers to identify new areas of investigation and funding opportunities; and work with law enforcement, fishermen, and regional fishery management organizations to develop clear and understandable regulations that will lead to a future where both large whales and fishermen not only survive, but thrive.

Appendix A: Potential Restricted Areas

Table 1. In 2022, the Atlantic Large Whale Take Reduction Team considered measures to reduce entanglement risk, including seasonal persistent buoy line restricted areas and areas where only one endline per trawl or string would be allowed. While these were based on the information available in 2022, 16 areas totaling 82,523 square miles (213,735 square km) were identified for closures to persistent buoy lines for varying lengths of time, each between 2 and 12 months depending on the area, and 5 areas totaling 199,811 square miles (517,510 square km) were identified for fishing with one endline to reduce the number of buoy lines by half. Below is a summary of current and recommended measures. Note that some of the recommended measures overlap with current persistent buoy line restricted areas or overlap with each other, therefore the total areas are not additive.

Region	Fishery	Location	Measure	Total Area (km^2)	Total Area (mi^2)	Period
Current ALWTRP Vertical Buoy Line Measures						
Gulf of Maine (GOM)	Lobster Trap	LMA1 Restricted Area (RA)	No persistent buoy lines	2667	1030	Oct 1-Jan 31
GOM	Lobster Trap	Massachusetts RA	No persistent buoy lines	7475	2886	Feb 1-Apr 30
Southern New England (SNE)	Lobster Trap	South Island RA	No persistent buoy lines	14163	5468	Feb 1-Apr 30
GOM & Georges Bank	Lobster Trap	Great South Channel RA	No persistent buoy lines	8365	3230	Apr 1-Jun 30
GOM & Georges Bank	Gillnet	Great South Channel RA	No persistent buoy lines	7475	2886	Feb 1-Apr 30
Measures Recommended at the 2022 TRT Meetings						
GOM	All Trap/Pot	Maine Zone A - non-exempt waters	Lines out	4431	1711	Jun 1-Jul 31
		LMA1 RA Expansion	No persistent buoy lines	11279	4355	Oct 1-Jan 31
		LMA 1 RA Expansion to Cashes Ledge	No persistent buoy lines	11279	4355	Oct 1-Feb 28

Region	Fishery	Location	Measure	Total Area (km^2)	Total Area (mi^2)	Period
		Jeffreys Ledge	No persistent buoy lines	4119	1590	Jan 1-May 31
		NH state and adjacent federal waters	No persistent buoy lines	307	119	Mar 1-Apr 30
		MA 514 federal waters	No persistent buoy lines	5082	1962	Feb 1-May 31
		Cape Cod Bay east	No persistent buoy lines	609	213	Dec1-May31
Outer Cape Cod	All Trap/Pot	Federal Waters	No persistent buoy lines	2760	1066	Jan 1-May 15
GOM/SNE	Gillnet	West of 70° and North of 42.5°	No persistent buoy lines	5798	2238	Apr 1-May 30
		MA state waters*	No persistent buoy lines			Jan 1-May 30
		South Island RA	No persistent buoy lines	14463	5468	Feb 1-Apr 31
SNE	All Trap/Pot	LMA 2 and LMA 2/3 Overlap	One buoyline per trawl	18042	7105	Year-round
		LMA 2 and LMA 2/3 Overlap	No persistent buoy lines	18042	7105	Jan 15-Apr 30
		South Island RA	No persistent buoy lines	14163	5468	Jan 15-Apr 30
		South Island RA	No persistent buoy lines	14463	5468	Jan 1-Apr 30
		SNE LMA 3 RA	No persistent buoy lines	19916	7690	Dec 1-May 31
Lobster Management Area 3	Lobster Trap	GOM LMA 3 RA	No persistent buoy lines	82787	31964	May 1-Jul 31
		North of the Canyons	One buoyline per trawl	75128	29007	Year-round
		South of the Canyons in depths <100 fa	One buoyline per trawl	14932	5765	Year-round

Region	Fishery	Location	Measure	Total Area (km^2)	Total Area (mi^2)	Period
		South of the Canyons in depths >100 fa	One buoyline per trawl	239363	92419	May 1-Sep 30
Mid-Atlantic	All Trap/Pot	DE, MD, VA state and fed. waters + NC fed. waters within LMAs 4 & 5	One buoyline per trawl	39788	15362	Nov 1-Apr 30
	Smooth Dogfish, Spiny Dogfish, Blue Fish Gillnets	NJ-VA state and federal waters	One buoyline per string	130257	50292	Year-round
Southeast*	Black Sea Bass (BSB) Pots	BSB Pot Prohibited Area	No persistent buoy lines	55347	21369	Year-round
		Snapper grouper FMP Seasonal BSB Pot Prohibition	No persistent buoy lines	45019	17382	Nov 1-30 and Apr 1-30
		Snapper grouper FMP Seasonal BSB Pot Prohibition	No persistent buoy lines	33451	12915	Dec 1-Mar 31

**These recommendations mirror regulations already in place*

Appendix B: Examples of Performance Standards

Table 1. Functions of fixed gear Marking Systems: Current surface marking system performance standards, what on-demand systems may need to do to be considered reasonable replacements, and what additional functionality may be possible using on-demand technology. On-demand gear marking will need to be enforceable to the same performance standards as current gear marking systems.

What a Surface Marking System Does	Minimum Standards Regulating What an On-Demand Marking System Should Do	What an On-Demand Marking System Could Do (if requested by user groups and legally permissible)
Physical presence: Allows detection of subsurface gear by ALL ocean users from about ½ mile away in good conditions.	Alert all ocean users at least ½ mile away from gear, on chartplotter or to vessel.	Alert ocean users or enforcement at any distances - could be based on user type.
Provides accurate information (fluctuations depending on tides/conditions) about subsurface gear location.	Inform ocean users of on-demand gear location via chartplotter or through other existing platform.	Alert gear owners of lost or moved gear and display/share associated information about the gear with other vessels on chartplotters.
In Federal waters, systems have high flyers/radar reflectors and markings for increased visibility and to indicate set direction, visible on radar screen about 4-6 miles away.	In Federal waters, alert ocean users 4-6 miles away from gear in real-time, and indicate set direction if provided by buoy.	Alert ocean users at different distances depending on need for access.
Acts as a standardized non-proprietary identification device that allows everyone equal access to information that gear is below.	Equal access on the water to detect the buoy within a limited radius and display subsurface gear on chartplotter or other existing platforms.	Provide detailed information regarding the gear, vessel, and permit information.
Requirements vary, but buoys often include fishery and ownership info. such as state/federal permit/license number, owner identity, and gear type. Requires buoy retrieval or being very close to read it.	Display any necessary ownership/permit information on chartplotter or other similar device within a comparable distance of information provided by buoy.	Allow the sharing of additional info., such as time of deployment, fishery type, and environmental data from devices on the gear including depth, temperature, salinity, ambient noise, whale calls, etc. Could be accessed from the cloud.
Provides surface connection for hauling gear on the bottom for the fisherman whose gear it is, and for enforcement to inspect gear. Gear can be hauled from either end (except in Maine state waters).	Provide a way to communicate with submerged gear and enable hauling for both the fisherman whose gear it is and enforcement.	Automatically mark gear deployments and recoveries via RFID or other technologies.

Table 2. Draft of functionally critical and beneficial data elements for an on-demand gear deployment as preliminarily identified by various stakeholders within the Northeast U.S. region and Eastern Canada. See Galvez et. al. 2023 and Baumgartner et. al. 2021. The table breaks down data access by user permission, access type, and data transmission priority. Real-time access refers to information that should be sent to the cloud as soon as possible and in some cases, acoustically. Retrospective access refers to access to historical set and haul data.

	Functionally Critical (FC)/ Beneficial (B)	Data Category	Owner/ Operator	Law Enforcement	Other Fishermen	Research Vessels	Other Mariners	Gear Manufacturer	Fisheries Manager	Researcher/ Other Land-Based
	Stakeholder Feedback on Real-Time Access									
Owner ID	FC	Priority	X	X				X		
Device ID	FC	Acoustic/ Priority	X	X	X	X	X	X		
Device Location	FC	Priority	X	X	X	X	X	X		
Device Datetime	FC	Priority	X	X	X	X	X	X		
Datetime (Last Position)	FC	Priority	X	X	X	X	X	X		
Device Health	B	Acoustic/ Supportive	X	X				X		
Device Status	B	Acoustic/ Supportive	X	X				X		
Release Notification	B	Acoustic	X	X				X		
Gear Type	B	Supportive	X	X				X		
Gear Count	B	Supportive	X	X						

	Functionally Critical (FC)/ Beneficial (B)	Data Category	Owner/ Operator	Law Enforcement	Other Fishermen	Research Vessels	Other Mariners	Gear Manufacturer	Fisheries Manager	Researcher/ Other Land-Based
	Functionally Critical (FC)/ Beneficial (B)	Data Category	Owner/ Operator	Law Enforcement	Other Fishermen	Research Vessels	Other Mariners	Gear Manufacturer	Fisheries Manager	Researcher/ Other Land-Based
	Stakeholder Feedback on Retrospective Access									
Owner ID	B	NA	X	X				X		
Device ID	B	NA	X	X				X		
Device Location	B	NA	X	X				X	X	X
Device Datetime	B	NA	X	X				X	X	X
Device Datetime (Last Position)	B	NA	X	X				X	X	X
Device Health	B	NA	X	X				X		
Device Status	B	NA	X	X				X		
Gear Type	B	NA	X	X				X	X	X
Trawl Length	B	NA	X	X					X	X