Financial Impact of Transitioning Two Sectors of the Northeast Lobster Fishery to On-Demand (Ropeless) Fishing

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Conservation Law Foundation

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Acknowledgments

The following organizations and individuals reviewed sections of the financial model and report: Massachusetts Division of Marine Fisheries (DMF); Atlantic Offshore Lobstermen's Association (AOLA); EdgeTech; Dr. Michael Moore, Woods Hole Oceanographic Institution; and Carolyn Alkire, PhD, Economist, NOAA Fisheries.

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We welcome feedback and corrections to this report. Please send any comments to kbreunig@clf.org.

Disclaimer

This report is based on gear prices and assumptions made at the time it was finalized in February 2023. Data on gear configurations may have changed since it was obtained. In addition, regulatory requirements and technological advancements make cost projections difficult and likely to change. Our goal is to provide a sense of (1) the scale of the financial cost of a transition to on-demand fishing gear (using two sectors where data is available), and (2) the decreased costs that could result from increased manufacturing and decreased gear loss. We hope it provides a basis for discussion and welcome all feedback, corrections, and additional data.

Cover photo: Ecophotography

Executive Summary

North Atlantic right whales (*Eubalaena glacialis*) face extinction due to human causes.[1] Accidental entanglement in commercial fishing gear is the primary threat to the survival and recovery of the species.[2] Approximately 83 percent of the population has been entangled at least once in the rope, or static vertical line, that runs from anchored fishing gear on the seafloor (such as lobster traps or gillnets) to the surface marking buoys at or near the surface.[3] If a whale cannot break free, it may drown immediately or die slowly of injuries, infections, or starvation. Chronic entanglements have resulted in sublethal impacts to the species that include smaller whales, fewer calves, and longer intervals between calves.[4]

"On-demand" fishing gear (also known as ropeless, buoyless, or pop-up gear) offers a solution that would allow fishing to continue while nearly, if not entirely, eliminating entanglement risk. This gear uses acoustic signals to retrieve traps on the seafloor without the static vertical lines in the water column that cause most entanglements.[5] As NOAA Fisheries noted in its recent draft Ropeless Roadmap, "on-demand fishing represents the best solution to separate rope and right whales in areas of highest risk."[6] The cost of such systems, and who will foot those costs, is explored here.

Recent events in Congress have changed the funding landscape. On December 29, 2022, President Biden signed H.R. 2617, the Consolidated Appropriations Act, 2023 into law. This bill set aside $20 million dollars in fiscal year 2023, and potentially another $500 million over the next ten years, for the funding of innovative fishing technologies that reduce "lethal and sub-lethal effects of human activities on North Atlantic right whales." This report attempts to show the cost of making a transition of on demand fishing a reality by looking at two sectors of the Northeast US lobster fishery, one nearshore off the Massachusetts coast and one far offshore.

The Atlantic States Marine Fisheries Commission (ASMFC), the interstate agency charged with developing the Fishery Management Plans for American lobster and Jonah crab ("lobster

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[1] *See* IUCN, "The IUCN Red List of Threatened Species 2020—*Eubalaena glacialis*," January 1, 2020.
[2] *See* NOAA Fisheries, "2017–2022 North Atlantic Right Whale Unusual Mortality Event," December 8, 2022.
[3] *See* Knowlton et al., "Monitoring North Atlantic right whale *Eubalaena glacialis* entanglement rates: a 30 year retrospective," *Marine Ecology Progress Series*, October 2012.
[4] For additional information on the impact of entanglements on the survival of the North American Right Whale, *see* Knowlton et al., "Fishing gear entanglement threatens recovery of critically endangered North Atlantic right whales," *Conservation Science and Practice*, August 2022.
[5] For purposes of this report, the term "ropeless" is not used as the systems are not truly ropeless. Not only is there groundline connecting traps in a trawl, but certain systems such as EdgeTech use a vertical line and floatation device to bring a release unit to the surface upon retrieval. While these lines are not "static" in the water column except during retrieval, they are still rope; further, in the deepest areas where lobstering occurs there can be as much as 1.75 miles of groundline connecting traps in a trawl.
[6] Northeast Fisheries Science Center, "Draft Ropeless Roadmap A Strategy to Develop On-Demand Fishing," July 3, 2022.

fishery"), has divided the Atlantic seaboard into seven Lobster Management Areas (LMAs). Regulations differ among LMAs and even within LMAs with respect to gear markings, gear configurations, trap limits, and gear restricted areas.[7]

This report offers cost estimates for transitioning two areas of the commercial fishery where permit and gear configuration data was readily available: (1) Massachusetts state permitted vessels fishing in nearshore LMA1 with boats 30 feet or longer (assuming smaller boats fishing close to shore may not be required to transition) and (2) federally permitted vessels operating in LMA3 fishery far offshore. These two sectors present different challenges. The MA LMA1 fishery modelled in this report operates nearshore in an area seasonally closed due to the high density of right whales. The LMA3 fishery operates well offshore and poses risk due to heavy gear (thicker lines and longer trawls). Both areas are impacted by regulatory closures to fishing with static vertical lines.

In estimating costs, a conversion rate, or percent of the fishing vessels in a fleet converted entirely to on-demand fishing, was modelled at 20, 50, and 100 percent, an acknowledgement that in some areas only those vessels of a certain size, or a certain distance from shore, or operating in high density whale habitat in a certain season, will likely be required to transition.

The report also estimates potential economies of scale if manufacturing volume is increased and potential net financial gains if gear loss is reduced. The best available data suggests that gear loss in the fishery is currently around 12 percent annually. In the absence of available data on just how much less gear will be lost if vessels fish are fishing with on-demand gear and interoperability and geolocations challenges have been solved, we modelled a theoretical halving of gear loss to 6 percent annually.

While several manufacturers are producing on-demand fishing systems, our cost estimates are based on the current pricing of the EdgeTech 5112 Ropeless Fishing System using a hull mounted transducer. EdgeTech has a large manufacturing facility, potentially able to ramp up production more readily than others, and the EdgeTech 5112 system represents a reasonable midpoint in price. Our report is not an endorsement of this manufacturer, however, and there are several others with promising systems in production.

Based on available data, our modeling of current and future costs suggests the following:

Massachusetts LMA1 Nearshore Fishery and Vessels 30 feet or longer:

- The approximate cost of fully equipping a commercial lobster fishing vessel 30 feet in length or greater, fishing in state and/or federal waters in LMA1, and permitted and

[7] *See* NOAA Fisheries, "Minimum Traps/Trawl for Northeast Lobster/Jonah Crab Trap/Pot Fisheries," updated October 21, 2021.

landing in Massachusetts ("MA LMA1"), with on-demand systems at current list prices, ranges from approximately **$227,000** (scenario for a 30-35 foot vessel fishing 500 traps (2019 median), using 11 traps per trawl (2019 average), with one release per trawl) to **$460,000** (scenario for 40-45 foot vessel fishing 800 traps (2019 median), using 17 traps per trawl (2019 average), with two releases per trawl);

- The estimated cost of fully equipping all MA LMA1 vessels 30 feet or more in length with on-demand systems at current list prices is an estimated **$128 million**.

The LMA3 Far Offshore Fishery:

- The approximate cost of fully equipping a federally permitted commercial lobster fishing vessel fishing in LMA3 with on-demand systems (scenario where a vessel fishes 1594 traps (current average), using 45 traps per trawl, with two releases per trawl) is an estimated **$344,000**; and
- The estimated cost of fully equipping all 70 active commercial lobster vessels in offshore LMA3 with on-demand systems at current list prices is estimated at **$24 million**.

On-demand gear costs could come down by as much as half if economies of scale are realized, assuming a 95% learning rate (*see* "Impact of Economies of Scale," pgs. 15-18). Recognizing that scale economies will not be achieved right away and that the number of units manufacturers will build is uncertain, the following provides a general sense of the potential reduction in cost:

Cost Reductions if Economies of Scale are Realized:

- Under the scenarios above, if 20 percent of the MA LMA1 fleet fully converted to on-demand gear, the increased volume of gear required (deck box, transducer, cages, and releases) could bring per vessel costs down from **$227,000** to **$123,000** (scenario for a 30-35 foot vessel fishing 500 traps (2019 median), using 11 traps per trawl (2019 average), with one release per trawl), and from **$432,000** to **$232,000** (scenario for a 40-45 foot vessel fishing 800 traps (2019 median), using 17 traps per trawl (2019 average), with two releases per trawl), a reduction in price of 46 percent;
- Under the scenarios above, if 50 percent of the active LMA3 fleet fully converted to on-demand gear, the increased volume of gear required could bring per vessel costs down from **$344,000** to **$193,000**, a reduction in price of 44 percent; and
- Further cost savings would be realized if other portions of the lobster fleet and/or other fisheries (e.g., gillnet) converted, requiring even higher volumes of gear.

Net Financial Impact if Gear Loss is Reduced:

A potential benefit of on-demand systems is a reduction in gear loss during storms or conflicts with other vessels where gear is dragged away from its original placement. It is estimated that lobstermen lose on average 12 percent of their gear annually,[8] a rate that varies based on many factors including a captain's experience, area fished, seasonal storms, and length of trawl. If current geolocation and data interoperability issues are resolved, there is reason to believe gear loss could be reduced. The model estimates the theoretical net financial impact over an assumed 15-year useful life of an on-demand system if the gear loss rate were cut in half, from 12 to 6 percent, where net financial impact represents the potential savings from reducing the need to replace lost traditional gear (traps only), less the replacement cost of any lost gear.

- In MA LMA 1 the net financial impact over the 15-year period of cutting gear loss in half is a modest loss or gain. These vessels tend to fish with fewer, smaller, and less expensive traps, less line, and fewer traps per trawl than LMA3 vessels. Using the estimated cost of on-demand releases at 20 percent fleet conversion rate, the net financial impact of cutting gear loss in half could range from **a loss of $13,000 to a financial gain of $44,000** over 15 years based on vessel size.
- In contrast, in LMA3 there could be significantly positive net financial impact over the 15-year period if gear loss is cut in half, as vessels generally fish an average of over 1,500 larger and more expensive traps with 45 traps per trawl. Using the estimated cost of on-demand releases at a 50 percent fleet conversion rate, the net financial impact of cutting gear loss in half could be **a gain of $491,000** over 15 years, more than offsetting the upfront cost of equipping the vessel with on-demand gear and representing a payback period of 6 years.

Future regulatory decisions and technological advances will change these cost estimates. The scope of regulatory restrictions on vertical lines will impact the volumes of gear required and potential economies of scale. Likewise, technological advances may have a positive or negative impact on cost, and improved sharing of gear location data will have an unknown but positive impact on reducing gear loss. Despite the significant costs to transition relevant parts of the lobster fishery to on-demand fishing, there are past examples of gear transitions that have received public and philanthropic funding (included in this report) and recent Congressional appropriations look promising. For example, the cost estimated here of transitioning the LMA3 fleet, fishing in an area of high risk to right whales, would represent just five percent of the funding authorized by Congress for "innovative gear technology."

[8] 12 percent is the average of gear loss rates cited by seven sources. The range was 1.44 percent to 25.00 percent. *See* Sawicki, "Ropeless is Real: A Solution for Fishermen and the North Atlantic Right Whale," May 2020, p. 34.

I. Introduction and Scope of Project

The North Atlantic right whale (*Eubalaena glacialis*), one of New England's most iconic species, is listed as *endangered* under the Endangered Species Act[9] with fewer than 340 animals remaining.[10] According to the International Union for Conservation of Nature, the species is *critically endangered* or one step away from extinction.[11] The primary threat to the long-term survival of the right whale population is human activity – specifically accidental entanglement in fishing gear and vessel strikes.[12] Scientists are clear, however, that right whales are a long-lived and resilient species that can recover if humans stop killing them.

With the urgent need to reduce the number of entanglements of right whales, the recovery of this species hinges, in part, on the broad-scale use of on-demand fishing gear to eliminate static vertical lines when and where right whales are at risk of entanglement.[13] Recovery is especially important because of the ecological role that large whales, such as right whales, play in the marine ecosystem – transporting nutrients, fertilizing phytoplankton, and sequestering carbon.

As part of its broader right whale campaign, CLF set out to better understand the financial impact of converting two representative sectors of the Northeast lobster fleet to on-demand fishing gear where data was obtainable. Limited but relevant data on gear configurations were available for (1) lobstermen fishing in LMA1 (state and/or federal waters) and landing their catch in Massachusetts (hereafter "MA LMA1"), and (2) federally permitted lobstermen fishing in LMA3. We acknowledge that data gaps remain and welcome input from the industry, regulators, and others to improve the report with additional data or insight.

A transition to on-demand fishing will come at a significant financial cost. While it is not currently expected that individual lobstermen will shoulder the costs, it would benefit advocates, policymakers, legislators, funders, and the industry to better understand the financial impact of such a transition. This report provides preliminary estimates at both the individual vessel and fleet-wide level, recognizing these estimates will change as technology

[9] NOAA Fisheries 5-year review of the species' status, 16 U.S. Code § 1533(c)(2), concluded the status of the right whale's recovery has declined since the last 5-year review was completed in 2017 and therefore recommended the classification for the North Atlantic right whale remain *endangered*. *See* National Marine Fisheries Service Greater Atlantic Regional Office, "North Atlantic Right Whale (Eubalaena glacialis) 5-Year Review: Summary and Evaluation," November 2022. *See also* 50 C.F.R. § 17.11; 35 Fed. Reg. 8,495 (June 2, 1970).

[10] *See* New England Aquarium, "North Atlantic right whales' downward trend continues as updated populated numbers released," October 24, 2022.

[11] *See* IUCN, "The IUCN Red List of Threatened Species 2020—Eubalaena glacialis," January 1, 2020.

[12] *See Id.*; *see also* NOAA Fisheries, "2017–2022 North Atlantic Right Whale Unusual Mortality Event," updated December 8, 2022.

[13] "On-demand fishing offers the greatest potential for a lasting solution to this challenge by allowing fishing to occur within habitats used by [right] whales . . . with minimal risk of entanglement." NOAA Fisheries Science Center, "Draft Ropeless Roadmap A Strategy to Develop On-Demand Fishing," July 29, 2022.

and regulatory requirements evolve. This report also analyzes economies of scale that could bring gear costs down if larger volumes of gear are manufactured and deployed. And finally, it looks at the net financial impact of reducing gear loss rates relative to the cost of on-demand systems.

There are several manufacturers developing solutions for both gear retrieval and geolocation marking, as well as partnerships combining components from different manufacturers. There are also efforts underway to create interoperability standards across manufacturers so that a fishing vessel (another lobsterman or a member of the mobile fleet such as a scalloper or bottom trawler) operating in the same area can "see" all systems from all manufacturers on one device (ideally an existing chart plotter). Given the rapidly evolving nature of this industry, we have noted areas for additional consideration as progress could impact future costs and effectiveness.

This report also looks at how similar fishing gear transitions have been funded in the past and suggests areas for additional research and analysis that could be useful but are beyond the scope of this report.

II. Terms Used in this Report

The term ***on-demand system*** refers to a vessel-based ***deck box*** connected to a ***transducer*** (over-the-side or hull-mounted) that sends an acoustic signal to a ***release*** system on the seafloor, triggering an action that brings gear to the surface for retrieval. As shown below in Figure 1, there are three types of systems currently in trial: (1) a stowed rope and buoy(s), (2) an inflatable lift bag, and (3) a buoyant spool.[14]

[14] Examples include stowed rope and buoys (EdgeTech, Ashored Rope on Command (ROC), Desert Star Ropeless Fisher); inflatable lift bag (SMELTS Lobster Raft, Ropeless Systems Inc. Ropeless RISER); and buoyant spool (Fiomarine Fiobuoy, Devocean ropeless fishing system, experimental system from Woods Hole Oceanographic Institution (WHOI)).

Figure 1: Three Types of On-Demand Systems. (NOAA Fisheries)

On-demand systems also require a gear marking or ***geolocation*** system that allows fishermen deploying gear to mark the location of the gear where it is dropped or on the seafloor. An interoperable geolocation system that allows other lobstermen, other fisheries, and law enforcement to "see" all gear is critical to the success of on-demand fishing. In its absence, other lobstermen could set their trawls on top of this gear and other fisheries using dredges or trawls could tow through this gear, leading to increased gear conflicts.

At this time, EdgeTech uses a GPS based system that provides positional coordinates where gear is placed, with additional ranging capabilities on the horizon. Other companies such as Teledyne broadcast acoustic gear location in real time. Emerging technologies, such as EarthRanger, may provide an interoperability solution that uploads both GPS positional data and acoustic location data from multiple manufacturers into a cloud system and back onto a chart plotter, available for observation.

Most lobstermen deploy ***trawls*** – a string of traps secured together using groundline. Traditionally, at least one, if not both, ends of the trawl is connected to a static ***vertical line***, which connects gear on the bottom to surface markings (buoys and/or high-fliers) necessary to mark, locate, and haul gear. To reduce the number of static vertical lines, state regulators and

NOAA Fisheries require a minimum number of traps per trawl that varies by management area.[15]

The Atlantic States Marine Fisheries Commission (ASMFC), the interstate compact agency charged with developing the Interstate Fishery Management Plan for American Lobster, has divided the Atlantic seaboard into seven ***Lobster Management Areas (LMAs)*** (Figure 2). Each LMA, and even within an LMA, can have varying regulations regarding, among other things, gear marking and configuration requirements, trap limits, and gear restricted areas. A map of these LMA boundaries is shown below (the entirety of LMA1 is shown in teal and LMA3 in orange).

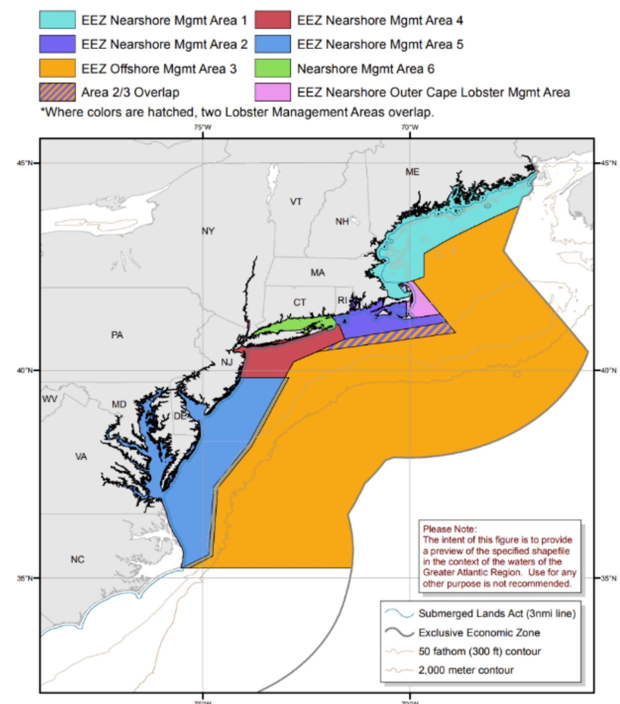

Figure 2: Map of Lobster Management Areas (LMAs). (NOAA Fisheries)

This report provides a scenario-based analysis built on (1) 2019 gear configuration data provided by the Massachusetts Division of Marine Fisheries (MA DMF) for Massachusetts permitted lobstermen fishing in LMA1 (state and/or federal waters) and landing their catch in Massachusetts ports; and (2) gear configuration data provided by the Atlantic Offshore Lobstermen's Association (AOLA) and publicly available federal permit data and trap per trawl requirements from the 2021 amendments to the Atlantic Large Whale Take Reduction Plan (ALWTRP) for lobstermen fishing in LMA3. We recognize that this is not a lateral comparison, but such a comparison is difficult given data gaps.

[15] *See* NOAA Fisheries, "Minimum Traps/Trawl for Northeast Lobster/Jonah Crab Trap/Pot Fisheries," updated October 21, 2021.

III. Assumptions

Consistent with relevant regulations, a lobsterman may vary the number of traps fished, trawl configurations (including number of traps on a trawl), and fishing locations over the course of the season and even across seasons. These variances make precise costs estimates of the transition challenging. Therefore, several simplifying assertions and assumptions were made:

Total Traps Fished and Traps per Trawl: To estimate conversion costs of vessels fishing in MA LMA1, the model uses the 2019 median number of traps fished during the season and the average number of traps per trawl during the season for four vessel size classes, as provided by MA DMF. This configuration data is derived by MA DMF from Massachusetts Supplemental Reports, LMA Permit Declarations, Massachusetts Monthly Harvester Reports, and federal Vessel Trip Reports (VTR) as of 11/24/2021. The year 2019 is the most recent year for which these data were available.[16]

For LMA3, the model uses a scenario based on the average number of traps fished (1594) by 70 active LMA3 lobstermen in 2022, as provided by the Atlantic Offshore Lobstermen's Association (AOLA). The model also assumes most LMA3 vessels fish 45 traps per trawl, which is reflective of the 2021 minimum trawl length requirements in the northeastern portion of LMA3.

Number of on-demand releases necessary per trawl: For MA LMA1 projections, the model scenarios assume a user will place one on-demand release on trawls with 15 traps or less. The model assumes two releases, one on each end, for scenarios with trawls of 15 traps or greater. Note there are no regulatory requirements at this time regarding the number of releases necessary for a given trawl length.

For LMA3, due to the length of the trawls, the model assumes two releases are necessary on all trawls. This allows fishermen to approach the trawl from either end and retrieve the nearest or safest end based on oceanographic conditions. Similarly, two releases provide redundancy in the unlikely event that a release did not work and could make it easier to find lost gear.

Only MA LMA1 Vessels 30 Feet or Longer Included: For MA LMA1 fishermen, the model excludes vessels less than 30 feet in length. We assume these vessels are less likely to transition to on-demand systems in the near term; they also tend to fish closer to shore with fewer traps and lighter lines, presenting less lethal risk to whales. According to MA DMF, vessels over 30 feet in length or longer represent more than two-thirds (69 percent) of the 593 commercial lobster fishing vessels fishing in LMA1 and landing in Massachusetts in 2019.[17]

Use of EdgeTech 5112 on-demand system for pricing: All model scenarios are based on current

[16] Personal communication with MA DMF on October 3, 2022.

[17] Personal communication with MA DMF on November 23, 2021.

list prices for EdgeTech's 5112 Ropeless Fishing System using a deck console box and a hull mounted transducer. Fishermen prefer this configuration over portable deck boxes and "over the side" dunking transducers which take more time and require the boat to be stopped before a signal is sent. According to the manufacturer, EdgeTech's pricing is the same for nearshore and offshore applications, although additional costs are associated with the larger cages used in the offshore fishery.

A simplified depiction of the EdgeTech system is shown in Figure 3.

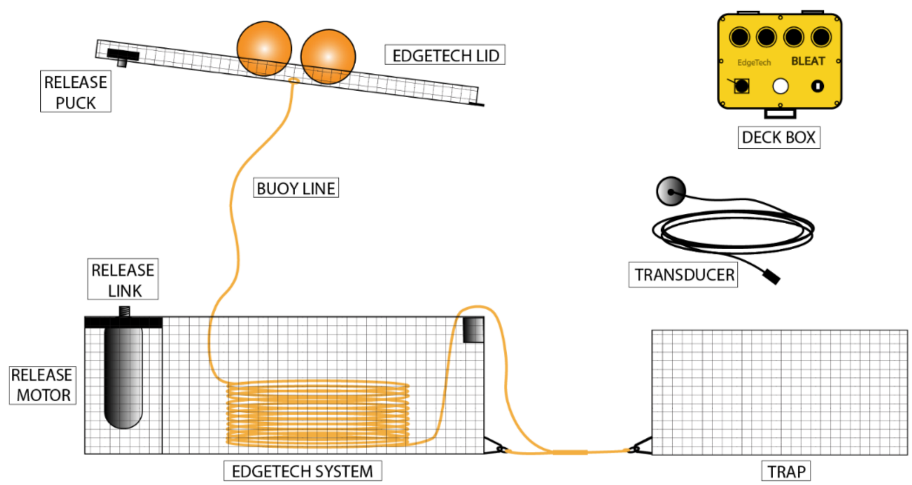

Figure 3: EdgeTech 5112 System. (CanFish Gear Lending Library)

For illustrative purposes, the current model uses EdgeTech's 5112 for cost estimates because it represents a reasonable midpoint in pricing compared to other manufacturers. (*See* Figures 4 and 5 below). EdgeTech represents the midpoint for both a deck box with hull mounted transducer and per release pricing, although it should be noted that some of the higher priced products in these figures may include additional features such as real time gear location tracking.

EdgeTech's use of GPS surface marking and storage of location data in a cloud database may be sufficient for areas of low gear density and low risk of gear conflict. In areas of high density, however, self-location of gear using directional ranging, with or without a connection to the cloud, may be needed. Thus, it is possible that the model may underestimate the transition costs for some LMA1 vessels fishing in areas of high density.

One vendor, Sub Sea Sonics, offers a low-cost ($600) acoustic release suitable for nearshore fishing using single traps. However, as currently designed, lift capacity is limited and approximately 15 minutes is required to trigger a release, making it an unlikely solution for the larger commercial fishing vessels modeled in this report.

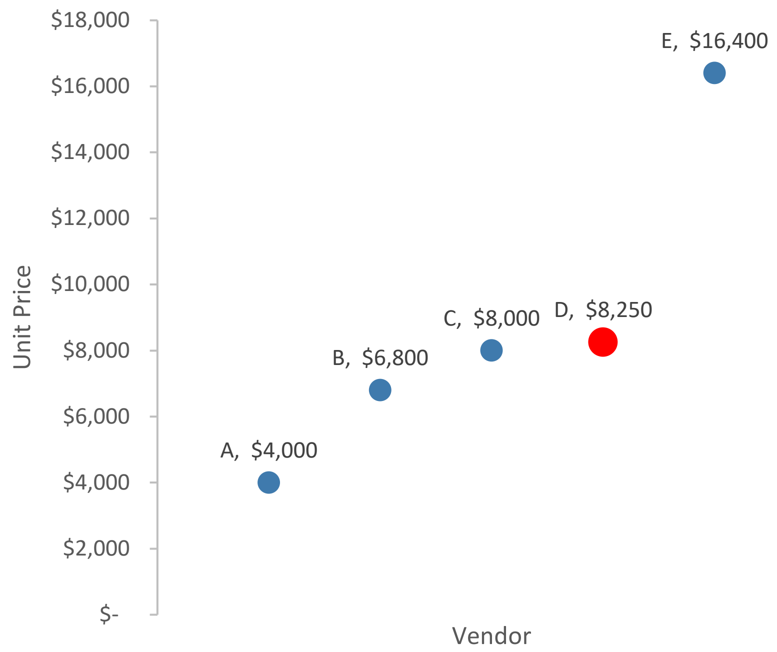

Figure 4: On-Demand Deck Box + Hull Mounted Transducer List Price from Five Manufacturers (EdgeTech 5112 System represented in red)

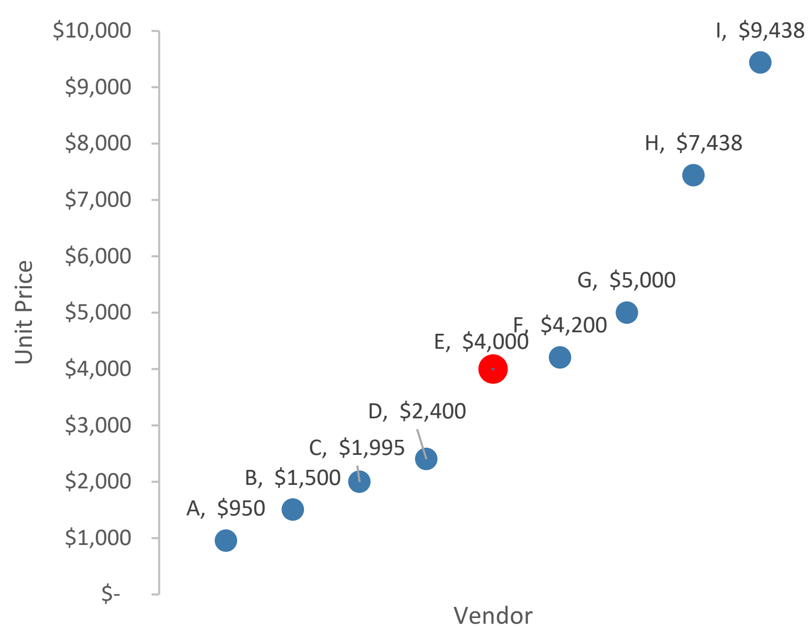

Figure 5: Per Release On-Demand Prices Across Nine Manufacturer Products (EdgeTech 5112 System represented in red)

Installation costs of hull mounted transducer: Installation costs will vary depending on hull type (e.g., steel, wood, or fiberglass) and whether the vessel needs to be hauled out or is already hauled out for another reason. The model uses a midpoint of costs between when a vessel is already out of the water ($2,000 - $2,500) and when it would need to be hauled out solely to install the transducer ($4,600), based on communications with fishermen that have installed transducers (limited number). As more transducers are mounted and as additional data is gained, we expect the accuracy of these cost estimates to improve.

Costs included in this model: Cost estimates are based on the EdgeTech 5112 console deck box, hull mounted transducer, transducer installation cost, release system and cage (24-inch cage for MA LMA1; 48-inch cage for LMA3), Trap Tracker software and Navionics software (used to mark and release gear).

Costs not included in this model: Many varying and unpredictable costs are not included in this model. These costs include training (currently covered by NOAA Fisheries and manufacturers while in gear trials), the cost of an iOS or Android tablet necessary to run software, the cost of upgrading a vessel's communications equipment with a satellite phone and/or relevant data plan, the cost of carrying one or more "spare" release systems, the cost of strobe lights and/or smart buoys (required in certain situations), and the regular maintenance costs of servicing on-demand gear (such as replacing batteries or worn components). These costs will vary by manufacturer, vessel, area fished, and equipment already in use.

IV. Cost of transitioning to on-demand systems in two areas

The primary objective of this report is to obtain some preliminary estimates of the cost of transitioning a commercial lobster fishing vessel or a portion of the fleet to on-demand systems based on a variety of factors.

A. Massachusetts LMA1

LMA1 includes both state and federal waters, as shown in Figure 6 below (state waters are inside of 3 nm as shown in grey plus additional boundary waters shown in purple). MA DMF issues permits for MA state waters and NOAA Fisheries issues permits in federal waters (teal green and eastward). Some fishermen have dual permits allowing them to fish in both state and federal waters.

Massachusetts DMF further divides nearshore and offshore areas into Statistical Reporting Areas (SRAs), as depicted in Figure 7. SRAs 1-14 are comprised primarily of state waters, while SRAs 15-25 are comprised primarily of federal waters. For LMA1, MA DMF provided data from the following SRAs: SRA 1-8, 19, and 20, and to a lesser extent portions of SRAs 18 and 21.[18] According to MA DMF, approximately two-thirds of the MA LMA1 fishermen landing in

[18] Discussion with MA DMF on September 26, 2022.

Massachusetts only fish in state waters; the remainder have a dual permit.[19] MA DMF also noted that they do not have 100 percent compliance with reporting requirements and therefore some data is unavoidably missing.

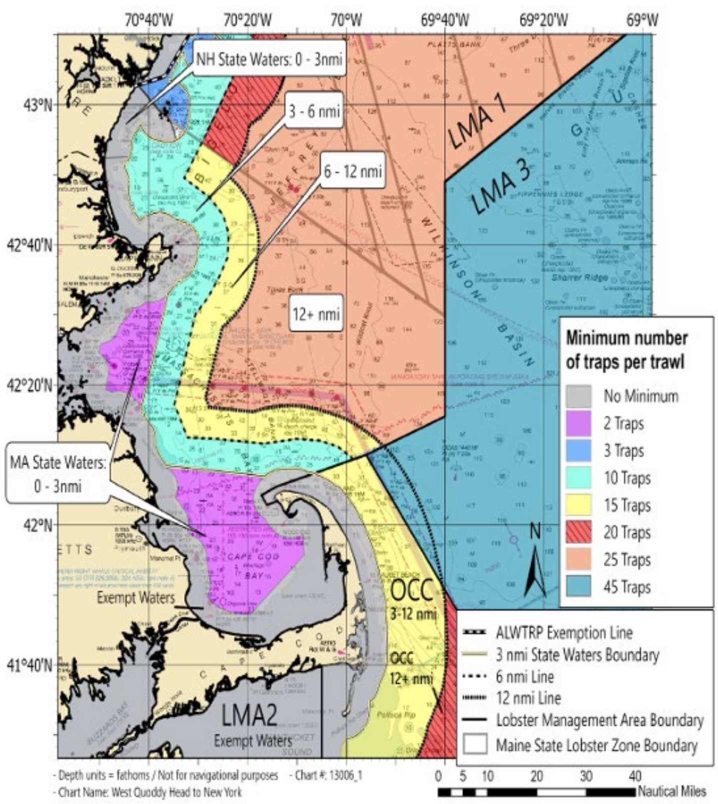

Figure 6: Map showing state waters and federal boundaries within LMA1.
(NOAA Fisheries)

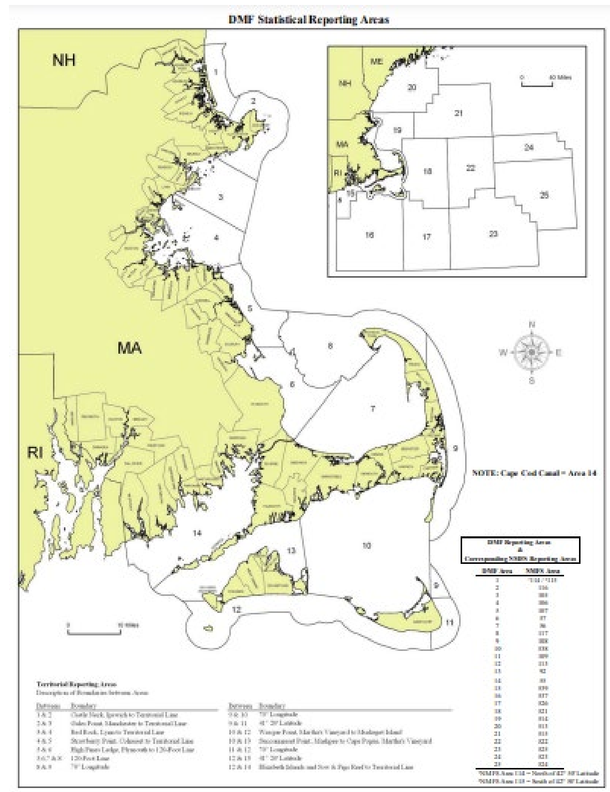

Figure 7: Map showing MA DMF Statistical Reporting Areas (SRAs).
(MA DMF)

To estimate the financial impact of the transition to on-demand gear on varying fishing operations, the model uses four scenarios based on vessel size, median number of traps fished, and average traps per trawl in 2019 (the most recent data available).

Based on 2019 gear configurations, the approximate cost of equipping a MA LMA1 commercial lobster fishing vessel 30 feet or greater with on-demand systems using current list prices, ranges from approximately **$227,000** (scenario for a 30-35 foot vessel fishing 500 traps (2019 median) with 11 traps per trawl (2019 average) using one system per trawl) to **$460,000** (scenario for 40-45 foot vessel fishing 800 traps (2019 median) with 17 traps per trawl (2019

[19] Discussion with MA DMF on September 26, 2022.

average) using two systems per trawl).

Costs are largely driven by the number of traps fished and traps per trawl, which in turn determines the number of on-demand releases required. As shown in Figure 8, there are some anomalies associated with using the MA DMF 2019 data to predict future costs of transitioning parts of the fleet. The shorter average trawl length reported for the 40–45-foot vessel class results in more trawls, and therefore more releases required, than for the 45–50-foot class, resulting in higher costs for the 40–45-foot class. This is not a function of the vessel length, and this anomaly may be unique to this one year of data.

Figure 8: Upfront Per Vessel On-Demand Gear Costs by Configuration Scenario – MA LMA1 at Current Prices

The estimated cost of fully equipping all MA LMA1 vessels 30 feet or more in length with on-demand systems at current list prices and using 2019 gear configurations is an estimated **$128 million.**

Assumptions behind the calculation of per vessel and per fleet estimates are provided below in Figure 9.

LMA1 Vessels 30 Feet and Over (Massachusetts LMA1)						
Gear Configuration Assumptions						
Vessel Size (feet)	**30-35'**	**35-40'**	**40-45'**	**45-50'**		
Median # of Traps Fished 2019*	500	800	800	800		
Average Traps per Trawl Reported 2019*	11	14	17	18		
Calculated Number of Trawls per Vessel (rounded up to next whole number)	46	58	48	45		
Assumed Acoustic Releases per Trawl (1 or 2 ends)	1	1	2	2		
Required # of Acoustic Releases per Vessel	**46**	**58**	**96**	**90**		
Upfront Gear Costs per Vessel (EdgeTech) - Current List Price						
Console Deck Box with Hull Mounted Transducer Cost (1 per vessel)	$ 8,297	$ 8,297	$ 8,297	$ 8,297		
Transducer Installation Cost - estimated^	$ 3,300	$ 3,300	$ 3,300	$ 3,300		
Cost of Releases	$ 184,000	$ 232,000	$ 384,000	$ 360,000		
Cost of Compatible Cages (22 inch)	$ 31,050	$ 39,150	$ 64,800	$ 60,750		
Total Costs per Vessel	**$ 226,647**	**$ 282,747**	**$ 460,397**	**$ 432,347**		
Upfront Gear Costs for Fleet - Current List Pricing					**Totals**	
Vessels Reporting by Size Class 2019*	159	128	105	17	**409**	deck boxes
Total Acoustic Releases Required	7314	7424	10080	1530	**26,348**	releases
Total Costs for Fleet	**$ 36,036,857**	**$ 36,191,603**	**$ 48,341,675**	**$ 7,349,897**	**$ 127,920,032**	
Grand Total					**$ 127,920,032**	

Figure 9: MA LMA 1 Gear Configuration Assumptions and Cost Model

As discussed later, we expect these costs, based on list price, to come down as a higher volume of on-demand gear is manufactured due to economies of scale.

In addition, fishing behavior and trawl configurations, in federal waters especially, may have changed after implementation of the 2021 ALWTRP final rule. Massachusetts permitted fishermen fishing 12 miles or more from shore are now required to fish a minimum 25 traps per trawl, a number higher than the 2019 configuration averages modeled. **While we cannot model**

the fleet transition under the new rule without additional data, the model estimates that fully equipping a 45–50-foot vessel fishing the minimum 25 traps per trawl would reduce the per vessel cost of an on-demand system to from $432,000 to $311,000 due to fewer average trawls needed (32) and fewer required on-demand releases (64).

B. Lobster Management Area 3

All fishing vessels in the relevant part of LMA3 for this report (north of 50 fathom line on the south end of Georges Bank) must fish a minimum of 45-50 traps per trawl under the 2021 ALWTRP final rule.[20] Trap limits are based on individual vessel permits and can go up to a maximum of 1,945 traps in 2022 under current regulations.[21]

The model estimates that the approximate cost of fully equipping a federally permitted LMA 3 commercial lobster fishing vessel with on-demand systems under a scenario where the vessel fishes the current average number of traps (1594) with 45-traps per trawl and two on-demand systems per trawl is estimated at **$344,000**.

The estimated cost of fully equipping all 70 active commercial lobster vessels in offshore LMA3 with on-demand systems at current list prices is estimated at **$24 million**.

Assumptions behind the calculation of per vessel and per fleet estimates are provided below in Figure 10.

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[20] *See* NOAA Fisheries, "Minimum Traps/Trawl for Northeast Lobster/Jonah Crab Trap/Pot Fisheries," updated October 21, 2021.
[21] *See* NOAA Fisheries, "American Lobster," updated November 18, 2022.

LMA3		
Gear Configuration Assumptions		
Vessel Size (feet)	**50+**	
Average Traps Fished*	1594	
Average Reported Traps per Trawl*	45	
Calculated Number of Trawls per Vessel	35	
Assumed Acoustic Releases per Trawl (1 or 2 ends)	2	
Required # of Acoustic Releases per Vessel	**70**	
Upfront Gear Costs per Vessel (EdgeTech) - Current List Price		
Console Deck Box with Hull Mounted Transducer Cost (1 per vessel)	$ 8,297	
Transducer Installation Cost - estimated^	$ 3,300	
Cost of Releases	$ 280,000	
Cost of Compatible Cages (48 inch)	$ 52,500	
Total Costs per Vessel	**$ 344,097**	
Upfront Gear Costs for Fleet		
Active Permits 2021*	70	deck boxes
Total Acoustic Releases Required	4900	releases
Total Costs for Fleet	**$ 24,086,783**	
Grand Total LMA3		**$ 24,086,783**

Figure 10: LMA 3 Gear Configuration Assumptions and Cost Model

V. Sensitivity Analysis

A. Impact of economies of scale

Manufacturing costs for a given product generally come down as volume goes up. This phenomenon is called economies of scale. One way to project economies of scale uses the learning curve theory. Learning curve theory was originally based on how quickly a worker could learn a task. The faster a worker could master a task, the more quickly production efficiency would be improved. Learning curve theory is commonly used in manufacturing to project future costs and improvements in productivity.

A key component of learning curve theory is the learning rate, which can vary by company and industry. The learning rate represents the speed at which unit cost will decline with every doubling of volume of goods produced.[22] For example, an 80 percent learning rate means that cost or time will decline 20 percent (or be 80 percent of the previous cost) with every doubling of volume. To calculate scale economies in this report, we use a conservative 95 percent learning rate because it is often achieved in electronics manufacturing where relatively little labor is needed to create each unit.[23] Installation costs for the hull mounted transducer are projected to remain fixed and not subject to scale economies.

The charts below depict the potential sensitivity of cost to volume for EdgeTech 5112 on-demand gear.[24] The model uses price as a proxy for unit cost, since manufacturing costs are proprietary. However, it is reasonable to assume that prices will decline along with costs. The current list price of a deck box and hull mounted transducer (not including software and installation) is $8,250. The current list price is $4,675 for a release and 22-inch cage and $4,750 for a release and 48-inch cage. As Figure 11 demonstrates, under normal circumstances most of the learning effect occurs early in the product lifecycle as different production approaches and materials are tested.

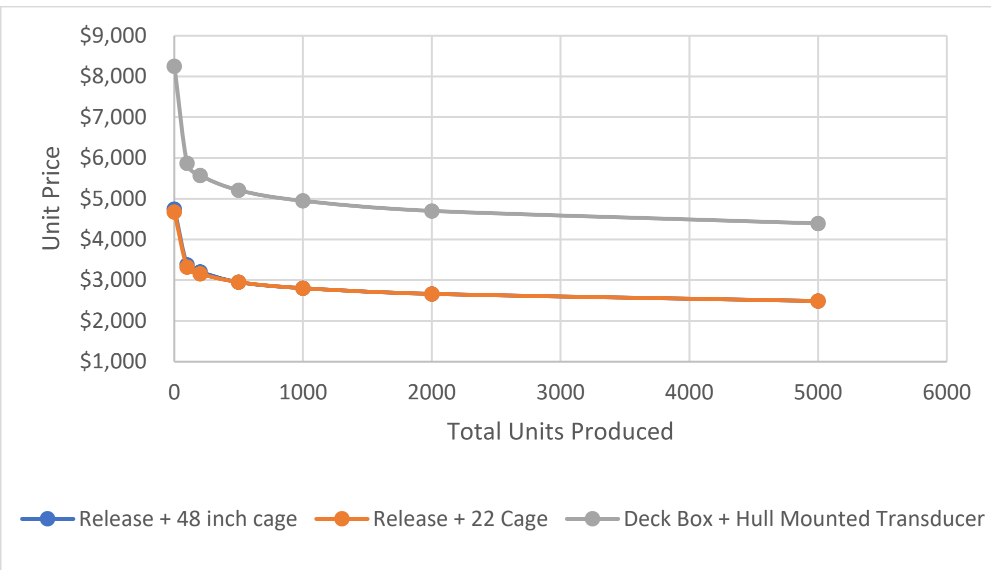

Figure 11: Economies of Scale for EdgeTech 5112 System at a 95 Percent Learning Rate

[22] This cumulative average formula is also known as the Wright model. A guide to learning curve theory can be found on the Valamis Learning Hub. *See* Valamis, "Learning Theories: Learning Curve," updated December 14, 2022.
[23] Historical learning rates by industry can be found on NASA's Learning Curve Calculator. *See* NASA, "Learning Curve Calculator," updated May 25, 2007.
[24] A recent analysis estimated the learning curve impact on the cost of on-demand gear for all federal waters, based on the lower price point of Desert Star equipment. *See*: Alkire C., "Decline in on-demand fishing costs with learning," *Front. Mar. Sci*, November 2022.

It is difficult to predict the exact volume of on-demand fishing gear that will be manufactured, or the degree to which vertical lines will be restricted in fishing areas, so the model projects costs associated with transitioning 20, 50, or 100 percent of the fleet fishing in MA LMA1, and 50 or 100 percent of the fleet fishing in LMA3. Costs may ultimately vary from the model in the marketplace based on competition, vendor designs and suppliers, and manufacturer specific learning curves. Although the model assumes that EdgeTech has not yet benefited from economies of scale (starting with a single unit produced) because design modifications based on fishermen feedback are continuing to this day, we acknowledge that it may be further along the learning curve than what is modelled here. Conversely, the model does not include the likely scenario where a significantly greater volume of gear is manufactured to meet additional needs within several fixed gear fisheries in the U.S. and Canada, or even globally, which could push costs down further.

Learning effects are most pronounced early in the manufacturing learning process. As shown in Figure 12, in the case of MA LMA1 vessels, costs could come down dramatically, by approximately 46 percent, even if only 20 percent of the fleet converts, requiring 82 deck boxes and 5,270 releases. However, it is unlikely that all these components would be manufactured at once or come from the same vendor, potentially reducing the scale effects.

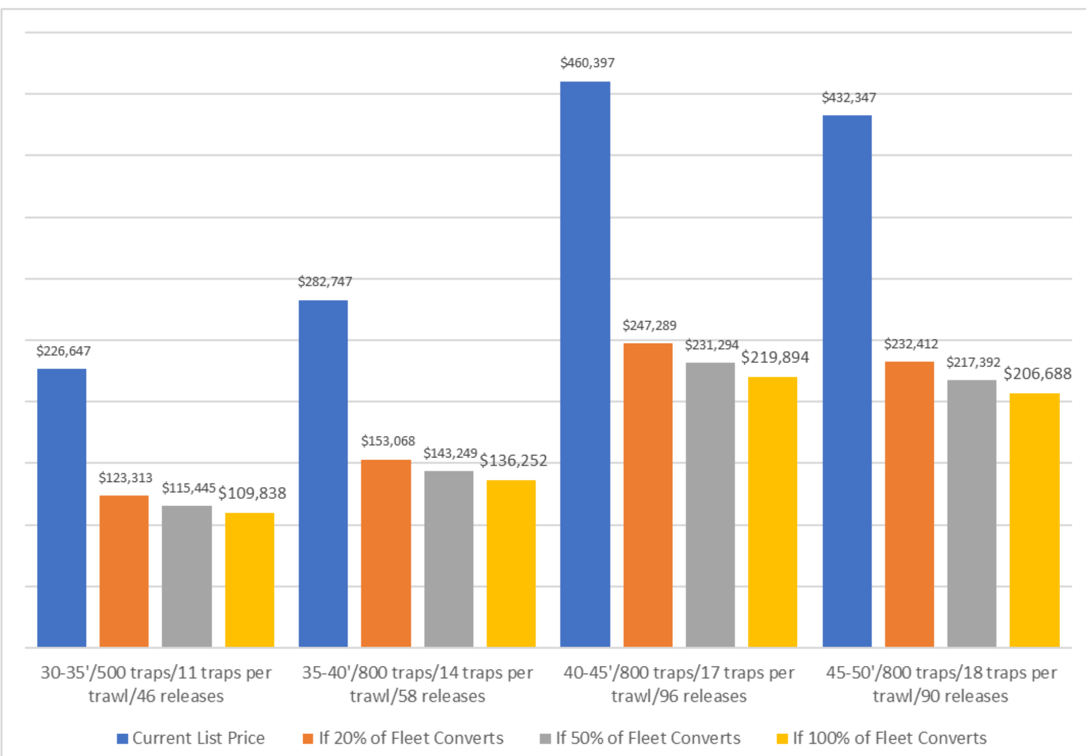

Figure 12: Upfront Per Vessel On-Demand Gear Costs by Configuration Scenario - Fishing in MA LMA1, with Economies of Scale by Fleet Conversion Rate

A similar phenomenon occurs for LMA3 at a 50 percent fleet conversion rate (see Figure 13), which would require 35 deck boxes and 2,450 releases. Again, it is unlikely that all these components would be manufactured at once or come from the same vendor, potentially reducing the scale effects.

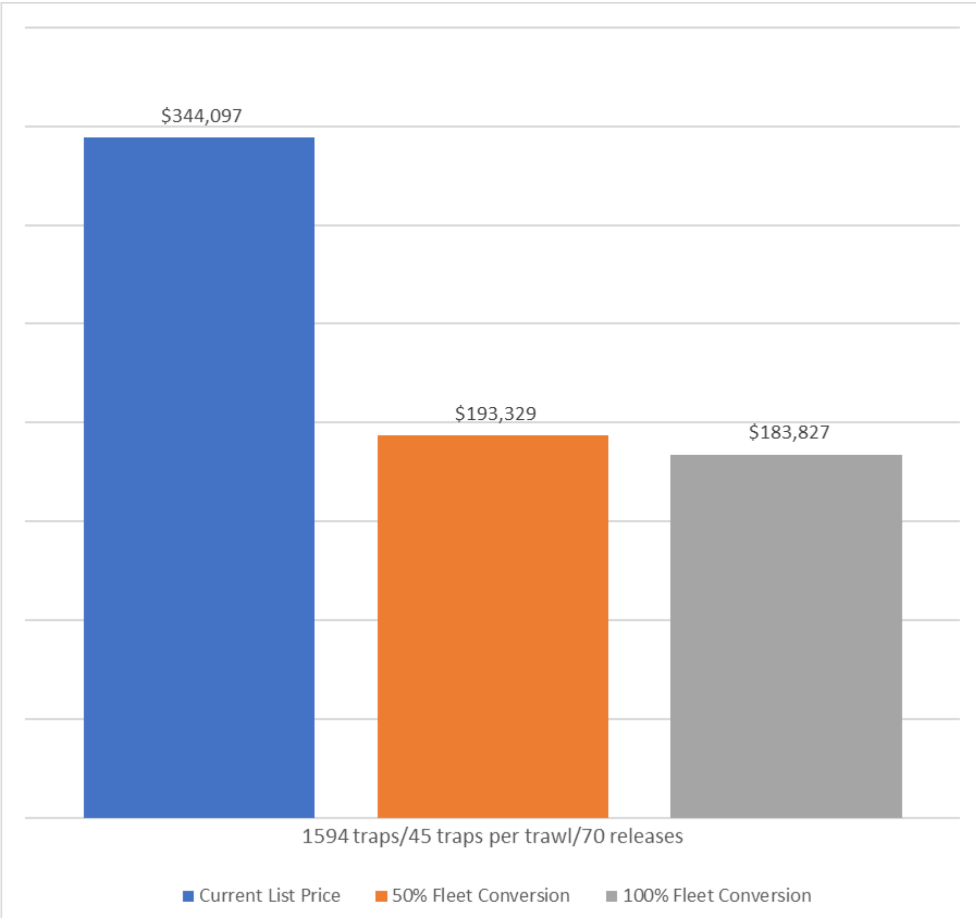

Figure 13: Upfront Per Vessel On-Demand Gear Costs - LMA3 with Estimated Economies of Scale by Fleet Conversion Rate

Limitations of the learning curve model: Learning curve theory assumes a continual increase in the volume of production. Based on early discussions with EdgeTech, they predict that production will be in batches, with pauses between batches, rather than a continuous ramp up of volume. Also, because of the relatively low volume of the electronic components necessary to build on-demand systems, compared to high volume electronic products like mobile phones, significant volume discounts from third-party manufacturers of chips and microprocessors used in on-demand systems are unlikely. A change in the regulatory requirements, however, could dramatically influence assumptions about production.

B. Net financial impact of reducing gear loss

Based on limited data collected during major storms in the Northeast over the last three years, it appears that on-demand systems may move less than traditional gear in a storm due to the absence of high-flyers (or other surface buoys) and static vertical lines that can be dragged by currents or swells. If this assertion proves true, on-demand fishing systems could reduce the annual average gear loss attributed to storm activity.

Trawls are also moved when another fishing vessel interacts with and drags it from its original location. Emerging gear marking systems that acoustically broadcast the location of on-demand systems and allow it to be downloaded from a central location to a platform that is available to all fishing fleets will reduce the likelihood of gear conflicts and increase the probability that such gear can be located if moved.

For discussion purposes, the model estimates the net financial impact of cutting gear loss in half by using on-demand gear, where net financial impact represents the potential savings from reducing the need to replace lost traps, less the cost of replacing any lost on-demand gear. **For this analysis, the model assumes an interoperable database showing location data for all on-demand systems will be available to other lobstermen as well as the mobile fishing fleet and that, if such gear is detected, fishing behavior will be altered to avoid such gear.**

In LMA1, the model assumes a 20 percent fleet conversion rate to calculate gear costs to reflect economies of scale, with assumption that more fishing in LMA1 occurs in state waters, where the gear is lighter, and the risk of lethal entanglement is lower. Otherwise, it uses the same gear configuration scenarios that the upfront gear cost estimates used.

To estimate the net financial impact of reduced gear loss for MA LMA1 vessels deploying on-demand gear, the model makes the following additional assertions and assumptions:

- Relevant vessels are fishing exclusively with on-demand gear.
- The annual gear loss rate is cut in half (from 12 to 6 percent).
- Gear loss is based on the percentage of traps lost.
- The replacement cost of a trap is $200 (a slight overestimate to account for associated lost line and surface markers).
- The useful life of the on-demand system is 15 years, based on input from EdgeTech.
- The cost of both lost traps and lost on-demand releases are included.
- The estimated number of on-demand releases lost is based on the loss of one end of 6 percent of trawls per year over 15 years.

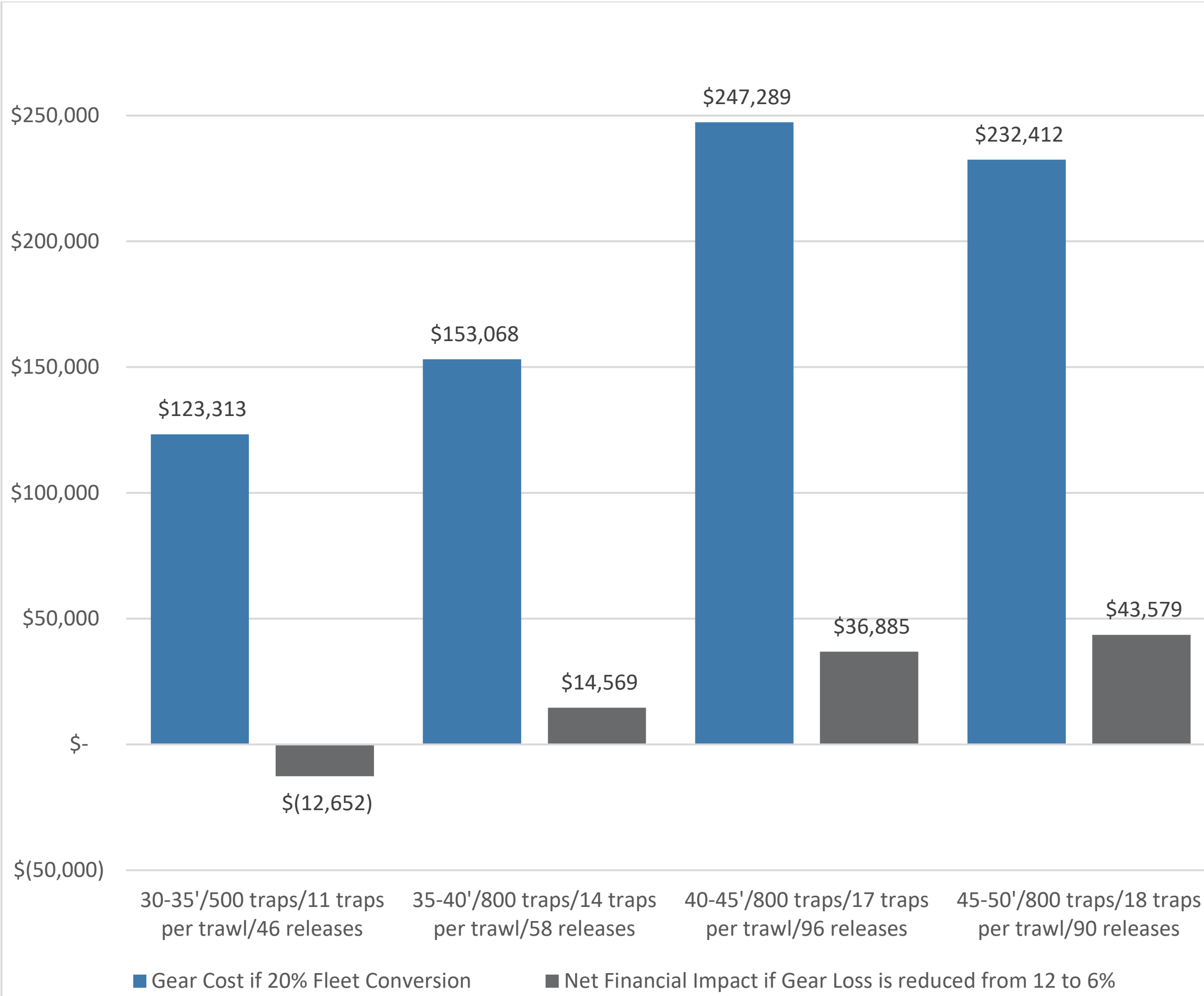

Figure 14: Upfront Per Vessel On-Demand Gear Costs by Configuration Scenario in MA LMA1 if 20 Percent of Fleet Converts vs. 15-Year Net Financial Impact of Reducing Gear Loss by 50%

As shown in Figure 14, in MA LMA 1 there may be a modest negative to positive net financial impact over the 15-year period if gear loss is cut in half (from a 12 percent to a 6 percent annual rate). These vessels tend to fish with fewer, smaller, and less expensive traps, less line, and fewer traps per trawl than LMA3 vessels. Using the estimated cost of on-demand releases at 20 percent fleet conversion rate, the estimated net financial impact of cutting gear loss in half could range from an **additional cost of $13,000 to a savings of $44,000** over 15 years. These calculations are shown in Figure 15. Note that these results only reflect replacement costs of lost gear; in a full deployment of on-demand gear, fishermen will realize additional savings by no longer needing to purchase surface buoys and potentially fewer vertical lines.

Net Financial Impact of Reducing Gear Loss by 50% Using On-Demand Gear Over 15 Years in MA LMA1				
Vessel Size (feet)	**30-35'**	**35-40'**	**40-45'**	**45-50'**
Average traps per Trawl	11	14	17	18
Value of Trawl				
Cost per Trap	$ 200			
Current Annual Gear Loss Rate	12%			
Current Average Traps Lost / Year (rounded)	60	96	96	96
Current Average Annual Value of Lost Gear per Vessel	$ 12,000	$ 19,200	$ 19,200	$ 19,200
15-Year Current Value of Gear	**$ 180,000**	**$ 288,000**	**$ 288,000**	**$ 288,000**
15-Year Savings per vessel by reducing gear loss by 50%	$ 90,000	$ 144,000	$ 144,000	$ 144,000
Less: Number of on-demand releases lost on one end of 6% of trawls over 15 years	41	52	43	41
Less: Value of on-demand releases lost over 15 years @ 20% conversion rate	$ 102,652	$ 129,431	$ 107,115	$ 100,421
Net Financial Loss/Benefit of Reduced Gear Loss Over 15 Years Using On-Demand Gear	**$ (12,652)**	**$ 14,569**	**$ 36,885**	**$ 43,579**

Figure 15: Net Per Vessel Financial Impact of Reducing Gear Loss by 50% in MA LMA1

In LMA3, the model uses a 50 percent fleet conversion rate on the assumption that the risk of lethal entanglement in this offshore area is higher. Otherwise, it uses the same gear configuration scenarios that the upfront gear cost estimates used.

To estimate the potential savings from reducing gear loss in LMA3, we make the following additional assumptions and assertions:

- Relevant vessels are fishing exclusively with on-demand gear.
- The annual gear loss rate is cut in half (from 12 to 6 percent).

- Gear loss is based on the percentage of traps lost.
- The replacement cost of an offshore trap is $400 (an overestimate to account for associated lost line and high-flyers).
- The useful life of the on-demand system is 15 years based on input from EdgeTech.
- The cost of both lost traps and lost on-demand releases are included.
- The estimated number of on-demand releases lost is based on the loss of one end of 6 percent of trawls per year over 15 years.

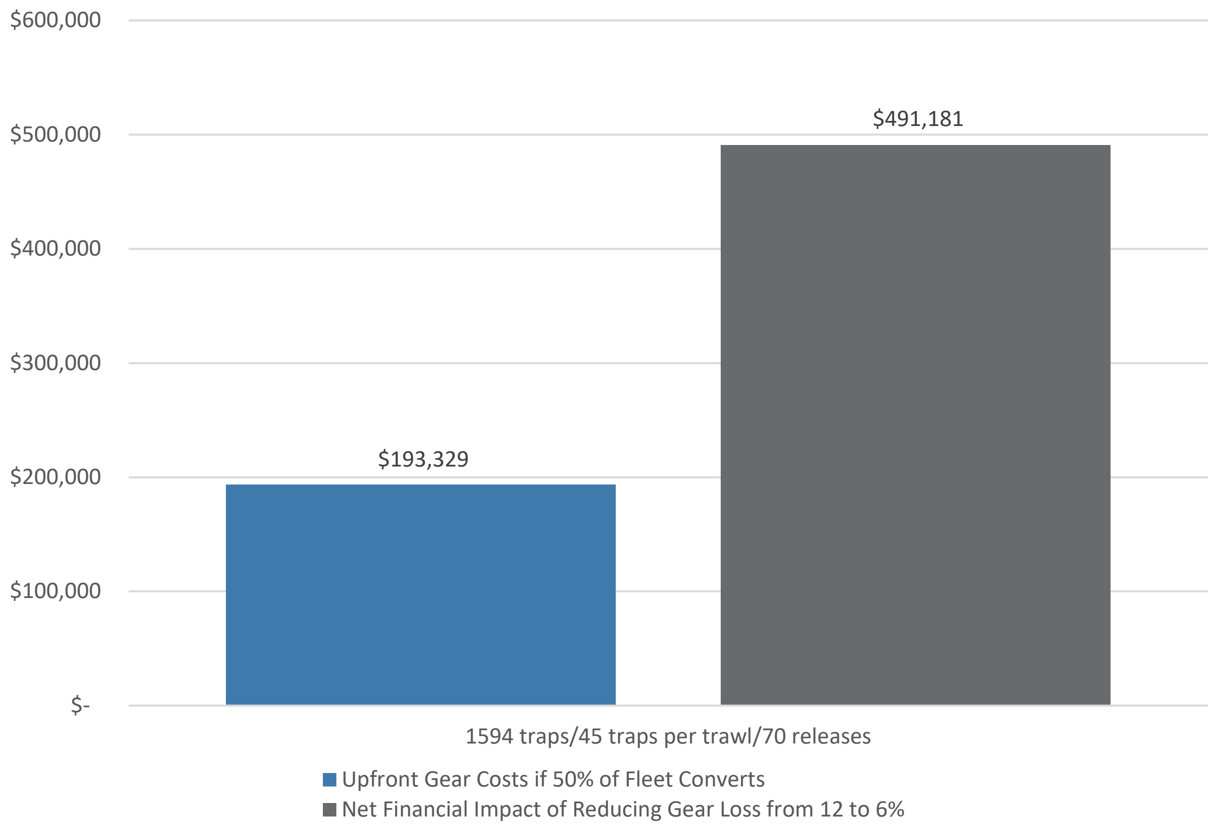

Figure 16: Upfront Per Vessel On-Demand Gear Costs if 50 Percent of LMA3 Fleet Converts vs. 15-Year Net Financial Impact of Reducing Gear Loss by 50 Percent

As shown in Figure 16, in LMA3 there could be a positive net financial impact over the 15-year period if gear loss is cut in half (from 12 percent to 6 percent annual rate), as vessels generally fish an average of over 1,500 larger and more expensive traps with 45 traps per trawl. Using the estimated cost of on-demand releases at 50 percent fleet conversion rate, the net financial impact of cutting gear loss in half could be **a gain of $491,000** over 15 years. Such savings, if realized, would more than offset the upfront cost of on-demand gear, and represent a payback period of 6 years. Calculations are shown in Figure 17. Note that these results only reflect replacement costs of lost gear; in a full conversion to on-demand, fishermen will realize additional savings by no longer needing to purchase highflyers and vertical lines.

Net Financial Impact of Reducing Gear Loss by 50% Using On-Demand Gear Over 15 Years	
Average Traps Fished	1594
Value per Trap	$400
Current Annual Gear Loss Rate	12%
Current Lost Traps per Year	191
Current Average Annual Value of Lost Gear per Vessel	$ 76,512
15-Year Current Value of Lost Gear	**$ 1,147,680**
15-Year Savings per vessel by reducing loss by 50%	$ 573,840
Less: Number of on-demand releases lost on one end of 6% of trawls over 15 years	32
Less: Value of on-demand releases lost over 15 years @ 50% conversion rate	$ 82,659
Net Financial Benefit Over of Reduced Gear Loss Over 15 Years Using On-Demand Gear	**$ 491,181**

Figure 17: Net Per Vessel Financial Impact of Reducing Gear Loss by 50 Percent in LMA3

VI. Additional Considerations Not Included in Analysis

A. Availability of On-Demand Gear for Testing

Currently, on-demand fishing gear is manufactured by a small number of companies at low volumes. In the Northeast, most (but not all) of the on-demand fishing gear used in trials today is supplied through NOAA's Northeast Fisheries Science Center's (NEFSC) Collaborative Gear

Lending Library. As of summer 2022, the Gear Library managed 160 on-demand units, available for fishermen to test, and had worked with 24 New England-based vessels.[25] While the Gear Library will acquire additional units and continue to work with additional vessels in the coming years, it is likely that other Gear Libraries will be created (especially likely in Maine) to supply necessary gear.

B. Supply Chain Issues

As the on-demand systems manufacturing industry has grown, it has encountered supply chain challenges that do not appear to be going away in the short term. The COVID-19 pandemic created well-documented shortages of materials and components across many industries, and on-demand fishing was no exception to challenges in sourcing key components. For example, EdgeTech representatives noted that supply chain disruptions were severe as of August 2022 and disruptions due to labor shortages were expected to continue for at least the next two years. To compensate for long lead times to source key electronic components, EdgeTech has been forced to carry additional inventory, which in turn has increased costs.

As the industry evolves toward broad-scale adoption, manufacturers will need to ensure reliable supply chains for key components to adequately meet the growing demand within the New England lobster fishery and beyond.

C. Gear Location Marking and Data Interoperability

The ability for fishermen to easily mark and locate their on-demand gear for retrieval, and for other vessels to "see" that gear to avoid gear conflicts and reduce gear loss will be critical to the adoption of this technology. Industry, government agencies, and researchers have been investigating ways for on-demand systems to determine and broadcast their location in real time, and for location data to be easily shared with other lobster vessels, the mobile fishing fleet, and law enforcement. Which technologies ultimately prove to be effective, and who pays for the development effort to create a single, interoperable database of location data integrated with a wide variety of chart plotters, will drive the ultimate costs of the transition. Interoperability extends to the need for fishermen to be able to operate with a single hull-mounted transducer that communicates with a wide range of ropeless systems to avoid gear conflict and to law enforcement that will need to retrieve traps using on-demand systems from multiple manufacturers.

A white paper developed as part of a series of stakeholder interviews to document requirements on gear location marking methods identified four options. Each varies in terms of

[25] Northeast Fisheries Science Center, "Draft Ropeless Roadmap A Strategy to Develop On-Demand Fishing," July 2022, p. 7.

detection distance, accuracy, data sharing, battery life, and environmental impacts.[26] The technologies identified include:

- **GPS marking** (used by the EdgeTech system): the GPS location of each end of a trawl is recorded when the gear is deployed, and this location is transmitted to a centralized database and made available to other fishermen. Fishermen need real-time access to this data to "see" the stored location data. If the gear is moved, its new location will be unknown.
- **Ranging**: a transponder on a vessel emits a signal, and a transponder on a trap returns a signal. The speed of this two-way communication is used to calculate the distance between vessel and trap. The vessel will need to survey multiple points around the trap transponder to calculate its position, a time-consuming process. All vessels in an area, including the mobile fishing fleet, would need a hull mounted transponder to avoid gear conflict.
- **Directional Ranging**: this system improves on the ranging model by using a directional transponder that can detect the bearing of the trap transponder. This method requires only a small number of two-way communications, reducing the time required to establish the position of the trap. All vessels in an area would need a hull mounted transponder to avoid gear conflict.
- **Self-localization** using successive acoustic receive time (SART): a modem on a vessel's hull mounted transponder continually sends the vessel's GPS location. A trap modem can use this information and the speed of transmission to calculate its surface deployment location. Once the trap transponder communicates with a second vessel it can calculate its true position on the seafloor and broadcast it to other vessels. Because identifying information is stored in the trap system, no real time communications to shore is required.

It is beyond the scope of this paper to evaluate these technologies at this time, but this area should be monitored as it will impact the cost of the transition to on-demand gear.

Given that different gear marking methods may be used by different manufacturers, creating a centralized database of gear location data will be important to making sure all mobile and fixed gear fishermen have access to the same data. This will be particularly valuable if the data can be viewed in current chart plotters and eliminate the need for all vessels in an area, including mobile fishing vessels, to have hull mounted transponders. Two efforts are underway to address this issue. NOAA is partnering with the Earth Ranger team at the Allen Institute for

[26] Baumgartner et al., "Workshop on Buoyless Fishing Gear Location Marking Methods Report on Stakeholder Engagement Meetings," August 2021.

Artificial Intelligence to pilot a cloud-based, interoperable location database.[27] A separate industry effort organized by the Ropeless Manufacturers Workgroup is working on a virtual interoperable gear marketing solution to be offered at low or no cost.[28]

There is some risk that fishermen using GPS-based location marking will accidentally forget to mark their gear as it goes into the water, or that some might mark locations to "hold ground," creating an appearance of fishing in an area. Emerging technologies like Radio Frequency Identification (RFID) could allow a smart tag attached to a trap to be scanned during gear deployment and retrieval, and automatically update a location database. Such a system would also have ancillary benefits for enforcement and the discouragement of illegal fishing.

D. Potential funding sources based on prior fishing gear transitions

In transitioning to on-demand fishing gear, we do not anticipate that fishermen will be asked to fund the initial purchase of on-demand fishing gear. It is more likely that the transition to on-demand fishing will be subsidized through a variety of public and private programs. Some such sources have already come online to support early on-demand gear testing and related technology development. These funding mechanisms may lead to fishermen owning or leasing on-demand gear, depending on their needs.

With this in mind, we have provided some examples of funding sources used to support prior gear transitions in the fishing industry. Even within the lobster fishing industry, there are several precedents for government and private subsidies in support of the transition to weak rope, sinking ground line, and the development and testing of on-demand fishing gear.

In looking across these examples and beyond, we see roles for both public and private funding mechanisms in accelerating the transition toward environmentally sustainable technologies. These models include local, state, and federal government grants; government bonds and tax credits; philanthropic funding; Fisheries Improvement Projects (FIPs);[29] revolving loan funds and bank financing; venture capital; and other innovative financing strategies.

While this is an area where future exploration is needed, the summaries below, organized by category, provide a basic outline of historical funding strategies, which may provide useful models for funding the further development and adoption of on-demand fishing gear.

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[27] Northeast Fisheries Science Center, "Draft Ropeless Roadmap A Strategy to Develop On-Demand Fishing," July 2022, p. 18.

[28] *See* Sustainable Seas Technology, "The Ropeless Gear Manufacturer's Workgroup on Virtual Gear Marking," last accessed December 29, 2022.

[29] *See* Marine Stewardship Council, "Fishery Improvement Projects," last accessed December 29, 2022.

Federal Government Funding:

Direct Subsidy for Implementing the 2021 Rule amending the Atlantic Large Whale Take Reduction Plan[30]

- $12 million in the federal FY23 Omnibus spending bill above FY22 levels to Atlantic States Marine Fisheries Commission to assist states in defraying the cost of compliance with the 2021 rule, for a total of $26 million.[31]
- $17.1 million included in federal FY22 Omnibus spending bill to support the U.S. lobster industry, including:
  - $14 million to help industry comply with new Large Whale Take Reduction Plan,
  - $765K for planning to "preserve the industry in the face of burdensome right whale-related regulations,"
  - $2 million for Sea Grant lobster and right whale-related research, and
  - $300K to study right whale migration patterns.

Federal Support for Required Offshore Lobster Vessel Tracking[32]

- Congress appropriated funds allowing the ASMFC to distribute funds to states or re-grant those funds to eligible vessel holders.

Groundline Exchange Program[33] (aka "Bottom Line Program")

- Funding provided by NMFS, administered by Gulf of Maine Lobster Federation.
- $3M provided to partially offset the cost of the transition 2006-2009.
- Transition was expected to cost $10K per fishermen; fishermen were compensated $2 per ton of rope.
- Massachusetts ran a pilot exchange in 2004 through a grant by the National Fish and Wildlife Foundation's National Whale Conservation Fund.

NOAA Bycatch Reduction Engineering Program (BREP)[34]

- Provided funding for Sub Sea Sonics to design a low-cost digital release timer for on-demand applications costing ~$70/unit.
- Lobster Lift received $185K in FY21 to design and test systems interoperable with other

[30] *See* Angus King, Press Release, "Maine Delegation Secures $17.1 Million to Support Jobs in Maine's Lobster Industry," March, 11, 2022.
[31] *See* COMMERCE, JUSTICE, SCIENCE, AND RELATED AGENCIES APPROPRIATIONS ACT, "Explanatory Statement," p. 23, 2023.
[32] *See* Massachusetts Division of Marine Fisheries, "Lobster Vessel Trackers to be Required in 2023," June 23, 2022.
[33] *See* Laurie Schreiber, "Groundline Exchange Scheduled For Maine," Fishermen's Voice, April 2006.
[34] *See* NOAA Fisheries, "Bycatch Reduction Engineering Program," updated December 15, 2022.

manufacturers. Received $200K in FY20 to develop and test on-demand gear.

- The New England Aquarium received $125K to test whale release ropes to reduce bycatch by lobster industry.
- $2.4 million available in FY22.

State and Local Government Funding:

Pingers for Gillnets[35]

- Program in 2013 allowed fishermen to upgrade existing pingers (used to deter marine mammals from gillnets) to LED-based pingers which allowed confirmation that units were working.
- Fishermen paid a $15 copay per unit; typical cost was $70-80 per unit.
- $330K program led by Gloucester Fishing Preservation Fund; $100K provided by Gear Conservation Engineering and Demonstration Network (GEARNET) and the New Hampshire Coastal Economic Development Corporation (CEDC) and Regional Economic Development Center of Southern New Hampshire (REDC).

Public/Private Partnerships:

Drift Gillnet Buyback Program[36]

- California swordfish fishermen receive $110K to retire their drift gillnet gear; state law requires all drift gillnet gear be eliminated by 2024.
- Oceana and State of CA each contributed $1M to the program. Oceana received individual contributions and foundation support.

Fisheries Innovation Fund,[37] National Fish and Wildlife Foundation

- Provided grants[38] of $200K to Mass DMF's "Developing a Framework for On-demand Fishing in New England" project and $300K to Blue Planet Strategies for "Reducing Entanglements of Critically Endangered Marine Life with Gear Tracking" in 2020.
- Major funding provided by NOAA, the Walton Family Foundation, and the Kingfisher

[35] *See* Saving Seafood, "Gloucester Fishing Community Preservation Fund Paves the Way for New Technology Pingers and Protecting Harbor Porpoise," November 12, 2013.
[36] *See* Steve Bittenbender, "Oceana provides USD 1 million to California gillnet buyback program," SeafoodSource, September 17, 2020.
[37] *See* NFWF, "Fisheries Innovation Fund," last accessed December 30, 2022.
[38] NFWF, "NFWF Announces $500,000 in New Support to Help Conserve North Atlantic Right Whales," November 16, 2020.

Foundation. Mitigation funds received through NFWF's Recovered Oil Fund for Wildlife have also supported the program, with grantee organizations and additional public and private funders providing matching funds.

Private Funding:

Ocean Stewardship Fund,[39] Marine Stewardship Council (MSC)

- MSC directs 5 percent of its royalties into this fund. $3.2 million in grants to date from MSC and third-party funders.
- Mostly funds projects, including Fishery Improvement Projects (FIPs), in fisheries outside the U.S. and Canada.
- Goal to raise an additional $10M from third party donors by end of 2022.
- Includes a $1.2M Innovation Fund to improve at-sea monitoring.
- Walton Foundation funding a $1M loan guarantee program for sustainable practices.

Schmidt Marine[40] / Schmidt Family Foundation

- Supports projects that reduce by-catch and improve sustainability.
- Funded Blue Ocean Gear (developer of Smart Buoys).

Conservation International Ventures[41]

- Invested $250K in SafetyNet, a UK company that uses LED lighting attached to fishing gear to repel unwanted bycatch species.
- Funded by Mustard Seed Impact and Althelia Sustainable Ocean Fund (now called Mirova Natural Capital[42]).

VII. Areas for Future Analysis and Research

A. Establishing Geolocation and Establishing Interoperability Standards

There is a heavy focus on these issues by government and non-governmental organizations. We fully support these efforts, however, given their status the costs were not modelled and it is not the focus of this report.

[39] *See* Marine Stewardship Council, "Ocean Stewardship Fund," last accessed December 30, 2022.
[40] *See* Schmidt Marine, "Schmidt Marine Technology Partners," last accessed December 30, 2022.
[41] *See* Conservation International, "Safetynet Technologies Ltd," last accessed December 30, 2022.
[42] *See* Mirova, "Natural Capital," last accessed December 30, 2022.

B. Commercial Lobster Fishing in Maine

Maine has the largest lobster fishing fleet in New England (more than 5,000 permit holders). Currently, there is insufficient publicly available gear configuration data to model the cost of gear transition in Maine, but that may change in the coming year and CLF welcomes opportunities to collaborate.

C. Need for Private Capital and Public/Private Partnerships

While the transition to on-demand fishing is likely to require public and private subsidies, it is possible that innovative impact investment capital could play a future role in accelerating gear trials, funding innovative (and lower cost) on-demand technologies and addressing funding shortfalls should public funding prove inadequate.

D. Additional Manufacturers

There are several manufacturers developing and improving on-demand gear. As the industry evolves, pricing from additional manufacturers could be modelled. As noted earlier, each vendor's approach to on-demand release technology and gear location marking could impact the cost of the transition.

Current manufacturers of on-demand fishing gear include:

- Ashored
- Desert Star
- Devocean
- EdgeTech
- Fiomarine
- Ropeless Systems Inc.
- SMELTS
- Sub Sea Sonics

VIII. Resources

The following resources provide additional information on the state of development in the on-demand gear industry:

- NOAA Fisheries, "Developing Viable On-Demand Gear Systems"

- Woods Hole Oceanographic Institution, "Ropeless Consortium," last accessed December 30, 2022.
- Moore et al., "On-Demand Fishing – A Status Report to the Ropeless Consortium," January 14, 2022.