



NOAA Technical Memorandum NMFS-NE-316

2023 experimental on-demand lobster fishery in vertical line closures

**US DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, Massachusetts
March 2024**



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Northeast Fisheries Science Center

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Editorial Notes

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GEAR RESEARCH TEAM'S MISSION

Research through Collaboration

The mission of the Gear Research Team is to collaborate with the commercial fishing industry to reduce harmful interactions with marine mammals, turtles, and other protected species by developing and evaluating modifications to fishing gear that enable fishermen to continue fishing while also alleviating gear conflicts with protected species.

INTRODUCTION

The Threat to North Atlantic Right Whales

North Atlantic right whales (NARWs; *Eubalaena glacialis*) are critically endangered. According to the most recent stock assessment, scientists estimate that there are approximately 356 individuals left (Linden 2023). Since 2017, the species has been enduring an ongoing Unusual Mortality Event (UME). Entanglement in fishing gear and vessel collisions are the main threats to the species and the primary causes of the UME (2017-2023 North Atlantic...2023).

NOAA Fisheries continues to collaborate with commercial pot/trap fishers in the Northeast U.S. and other stakeholders to identify solutions that will minimize entanglement risk while also allowing the fishery to continue. The Northeast Fisheries Science Center (NEFSC) Risk Assessment and Mitigation Branch Gear Research Team has established relationships with fishermen, gear manufacturers, and environmental organizations. Together, we are working to develop safe and commercially viable fishing methods that do not involve persistent vertical lines in pot/trap and other fishing gears.

Entanglement Mitigation and the Lobster Fishery

Since 2015, the Massachusetts Restricted Area (MRA) seasonal closure has been implemented by NOAA under the Atlantic Large Whale Take Reduction Plan as recommended by the Atlantic Large Whale Take Reduction Team. This closure is in place to reduce entanglement risk in 3000 square nautical miles of Massachusetts state waters east of Scituate, out to Stellwagen Bank, and southeast of Nantucket. This closure is in place seasonally from February 1 through April 30 and presents a significant economic impact on the lobster fishery and its constituents. In addition to this state waters closure, NOAA implemented a closed area in 2021 south of Martha's Vineyard named the South Island Restricted Area (SIRA) that impacts a significant portion of federal and state waters offshore of Massachusetts and Rhode Island during the same period.

Beginning in 2017, a small group of lobster fishermen from the South Shore of Massachusetts began a search for a tool that would potentially allow them to regain access to the areas otherwise closed to fishing. Working with a local acoustic release manufacturer and the NEFSC Gear Research Team, these fishermen began testing the first on-demand gear prototypes to determine their feasibility in the fishery as well as their potential to significantly reduce NARW entanglement.

Introduction to On-Demand Fishing Technology

On-demand fishing systems, also known as “ropeless” systems, utilize significantly less persistent rope in the water column than conventional gear designs. While traditional fixed-gear fishing methods use a persistent vertical rope to tether bottom gear to a surface-mounted buoy for location identification and retrieval, on-demand fishing systems do not require this persistent gear-to-buoy tether.

All acoustic-based on-demand fishing systems are made up of 4 basic components:

1. the transducer on the vessel;
2. the transceiver on the release unit;
3. the release mechanism; and
4. a graphical user interface on a tablet or mobile device application.

The transducer on the vessel sends a coded signal to the transceiver on the release unit, which then receives the signal and triggers the release mechanism. Depending on the device, the transceiver may send a message back to the vessel transducer notifying the operator the release was triggered. The tablet or mobile device application allows the user to trigger the acoustic release and chart its position.

To improve the commercial viability of on-demand fishing systems and increase testing, the NEFSC’s Gear Lending Library program supports fishermen who are interested in using on-demand gear to regain access to vertical line closures. Permitted fishermen can borrow the gear from the library for testing in their fishery. The borrowers provide feedback on how the equipment operates on their vessel, information on any issues encountered, and suggestions on how to improve the technologies. With assistance and collaboration with environmental and academic organizations, NOAA lends and maintains over 400 on-demand systems from various manufacturers.

2023 Experimental Fishery: Fishing in Vertical Line Closures

Following several years of testing and development, on-demand gear research efforts have accelerated significantly in the Northeast region as an emerging solution to allow fishermen back into the MRA and SIRA while reducing the entanglement threat to whales. However, as outlined in Oppenheim (2022), a number of questions regarding the feasibility of on-demand gear need to be addressed before this technology is widely applied and adopted as a viable option by commercial fishermen and fisheries regulators.

To answer some of these questions, the NEFSC Gear Research Team worked with 12 Massachusetts and Rhode Island lobstermen from February 1 to April 30, 2023, to test on-demand gear (no persistent vertical lines) in the MRA and SIRA (Figure 1). Participants completed a total of 533 hauls, including 334 in the MRA and 199 in the SIRA (Table 1), with 187 completed in Massachusetts state waters (Table 2).

TESTING METHODS

Permits

The NEFSC Gear Research Team operated under two different authorizations for on-demand gear: a Massachusetts Letter of Authorization (LOA) and a NOAA Exempted Fishing Permit (EFP). The LOA allowed 5 participating vessels to test 10 on-demand fishing units in the state waters portion of the MRA and 12 participating vessels operated under the NOAA EFP in the federal waters portions of the MRA and SIRA. The 5 fishermen permitted under the LOA are included in the total count of 12.

Gear

All on-demand units used during the closure were EdgeTech 5112 ropeless fishing units. Each participant was trained on how to use these systems prior to deployment in the closed areas, but some were more experienced than others. Participants were given the option of using the gear either on a single end or on both ends of their trawls. Therefore, participants had the option of setting 5 trawls with 2 acoustic ends, 10 trawls with 1 acoustic end, or anything in between. All of the fishermen were given data sheets to record the positions of their sets, environmental conditions, recovery success or failure information, and other information related to gear operations and catch (Appendix).

GPS Marking

We also evaluated gear marking systems that utilize GPS points for gear marking. Since all of the EFP participants used the EdgeTech 5112 system, they also used EdgeTech's TrapTracker app to set and retrieve gear. The app allows users to chart their trawl locations on a Navionics chart which is linked within the app. Once the user completes a set, the 2 ends are pinned within the chart, a line representing the trawl is drawn between them, and the data are uploaded to a cloud database when connected to the internet. To visualize the gear positions and orientations of trawls, interested mariners could purchase and download the EdgeTech TrapTracker app from the Apple App Store or the Google Play Store using any smartphone or tablet. This application enables users to "see" equipment within 5 nautical miles of the set (Figure 2). This and additional protocols reduced the likelihood of gear conflicts. Vessels participating in this research also flew a distinct flag so other vessels and law enforcement could easily identify them (Figure 3).

Gear Evaluation

In the event that an on-demand unit was not retrieved or hauled as intended, the event was categorized by the following definitions:

- Mechanical: A mechanical aspect of the system was interrupted when activated (e.g., rope snarls, damage due to weather or sea conditions).
- Technological: The technology aspect of the system interrupted a successful haul (e.g., tablet/deck box dead, Bluetooth connectivity issues, app not working).
- Operational: The deployment was interrupted as a result of a user-error issue (e.g., incorrect rigging, recovered incorrect unit on app).
- Acoustic: The acoustic signal was interrupted when activated (e.g., transducer malfunction).

- Environmental: The gear may have worked as intended, but due to environmental circumstances (e.g., dark, fog, tide, currents), it was not retrieved successfully.
- Unknown: It is unknown why the system did not function as intended.
- Mix: A mix of the above malfunctions occurred.
- Lost: The unit was not recovered.

RESULTS

From February 1 to April 30, 2023, 12 collaborating fishermen completed 533 on-demand hauls, 334 in the MRA and 199 in the SIRA. The gear was successfully hauled in 479 of the 533 hauls, a 90% success rate for the 3-month experimental fishery. Fishermen situated in the MRA had more experience using on-demand gear, as seen by a better success rate of 91% compared to the SIRA's success rate of 86% (Table 1).

In Massachusetts state waters, 5 collaborating fishermen completed 187 on-demand hauls, 185 in the MRA and 2 in the SIRA. The gear was successfully hauled in 174 of the 187 hauls, yielding a 93% success rate for the 3-month experimental fishery. These 5 fishermen kept 2,446 lobsters and discarded 1,634 lobsters for a per-haul average of 13 and 9 lobsters kept and discarded, respectively (Table 2).

Gear Efficacy

Out of the 533 hauls completed, there were 59 unsuccessful hauls (11% of total hauls), including 2 units that were not recovered (0.38% of total hauls). Recovery of an on-demand unit that was not retrieved or hauled as intended required grappling for the trawl or retrieval of an alternative on-demand system at the opposite end of the trawl.

Mechanical failures accounted for 30 (51%) of the 59 unsuccessful hauls (11% of the 533 total hauls). This was largely the result of rope snarls within the rope locker of the system. Technological failures occurred in 12 of 59 hauls (20%). The majority of these were identified as Bluetooth connectivity issues that were later resolved, with others attributable to the unit not receiving the acoustic signal.

Operational failures accounted for 5 of 59 (8%) of the total unsuccessful hauls. These occurred when the user either set or hauled the gear incorrectly (2 of 5) or did not replace the batteries in an older unit (1 of 5), resulting in unsuccessful hauls. There were 2 occasions of operational failure where the user selected the incorrect unit on the app to recover, leading them to believe that the unit was not released when, in fact, the unit for the following trawl had been released instead. They only realized their error when the unit was on the surface when they approached the next trawl.

Unknown reasons accounted for 6 of 59 (10%) of unsuccessful hauls. Of these, 2 (3%) were due to several reasons. Both events were due to technological, mechanical, and operational errors. One occurrence was due to the floats being tied incorrectly (operational) as well as Bluetooth connectivity issues (technological), again between the tablet and the deck box. The other occurrence was due to the bridle being fastened to the incorrect side of the trap (operational) and a rope snarl within the rope locker (mechanical).

Lastly, there were 2 units not recovered during the experimental fishery, accounting for about 3% of unsuccessful hauls. These units were marked as "lost." The first unit was lost due to a failed recovery from a rope snarl (mechanical), and upon the grapple recovery, the groundline

parted with 1 trap attached to the on-demand unit. All further grapple attempts to recover the last pot and unit failed, but the coordinates of the lost location were saved. The other missing unit likewise experienced a groundline separation. Two of the trawl's traps and the on-demand unit were lost after unsuccessful grappling attempts. However, the last known position of this unit is recorded. Table 3 depicts a breakdown of the types and number of unsuccessful retrievals.

Comparing Success Rates Over Time

Official open area trials using hybrid on-demand trawls started in 2020, with 81 hauls and a 64% success rate. In 2021, 665 hauls were completed with an 83% success rate, and in 2022, 1,885 hauls were completed with an 88% success rate. As of October 12, 2023, collaborating fishermen had completed 2,567 hauls with a 90% success rate, including the hauls during the MRA and SIRA closures. We anticipate that this number will increase as we continue to receive more data and the newest collaborators gain more experience. Table 4 provides a summary of these metrics.

Whale Sightings

A total of 14 NARW sightings were recorded by participating fishermen in state waters throughout the closure.

Gear Conflicts

No gear conflicts were reported in either closed area period. This includes both fixed-fixed gear and fixed-mobile gear.

App Feedback and Gear Location Awareness

EdgeTech's TrapTracker app performed as expected, allowing all users to visualize any submerged gear within 5 miles of their position, thus preventing gear conflicts between participants fishing in close proximity to each other. While the app worked as intended, we also collected user feedback regarding requested feature changes and more user-friendly functions. Requests such as being able to view the chart when setting gear, larger buttons, and the ability to rename the units (as opposed to a list of serial numbers), were among the top 3 identified issues.

With regard to the EarthRanger platform, after discussions with Division of Marine Fisheries staff, it was determined that the ability to give state enforcement and management agencies separate user permissions to access all locations of gear within their jurisdiction (state waters) will be needed in the future. Furthermore, more work needs to be done to create an EarthRanger mobile application that can be used by anyone but limits the user's viewing distance of the gear to a specified radius.

DISCUSSION

Gear Location Marking

None of the participants in this study encountered any gear conflict between each other or mobile gear fishermen. To address the latter, the EFP targeted rocky bottom where there was limited scallop dredging and fish trawling. Anecdotally, mobile fishermen do not begin to fish until around early to mid-April, which alleviated concerns of gear conflict occurring in February

and March. Regardless, the Gear Research Team has been recruiting mobile fishermen to use TrapTracker by providing them with a tablet and the app subscription to solicit feedback on how the system works for their operation in visualizing and avoiding on-demand gear.

To reduce the burden on mobile fishermen, we continue to work with EarthRanger to support the development of a free, public-facing application that will function in the same manner as TrapTracker (limiting viewing distance to 5 miles). Before more work is completed on integrating on-demand gear positions directly from the cloud into a chart plotter, we believe that working on a free application for on-demand gear visualization is a worthwhile endeavor to start raising awareness, soliciting feedback, and gaining buy-in from mobile gear fleets.

Increase in Success Rates

Over the past 3 fishing seasons, the success rate of on-demand gear hauls has increased significantly. This is likely due to the increase in effort in testing the gear, improvements made to the technologies, and the fishermen having more experience with their systems. This suggests that with sufficient training and monitoring, on-demand technologies could be a viable option for reducing protected species entanglements in vertical lines while simultaneously allowing fishermen to fish in restricted areas.

NEXT STEPS

Ropeless Roadmap

The NEFSC Gear Research Team’s short-term objective is to collaborate with stakeholders to promote the deployment of on-demand gear systems under conditions that minimize the likelihood of gear conflict while allowing fishing to continue in areas that are otherwise closed to vertical lines. For on-demand fishing gear to ultimately meet conservation objectives for protected species, particularly the NARW, and support large-scale fishing, it must move beyond the experimental phase. We are committed to working with fishery participants to develop effective and efficient on-demand systems and with fishery management authorities to evaluate the regulatory changes required to enable the use of on-demand fishing gear without an exempted fishing permit.

NOAA Fisheries issued a draft document in July 2022 titled, “Ropeless Roadmap: A Strategy to Develop On-Demand Fishing.” This draft document described the state of on-demand fishing and laid out a path for increasing adoption of this technology in commercial fisheries in the Northwest Atlantic Ocean. We acknowledge that many collaborators are essential to this process and strategy, and we invite the public and the various stakeholders to provide feedback on this approach and our ongoing research program for on-demand fishing.

Additional Research Objectives

To assist future regulatory actions, we have identified additional research objectives. Areas of consideration include additional time spent waiting for the buoy to surface and associated costs, risks associated with gear conflict and gear loss, and gear durability in the marine environment over time. Dedicated research trials operating without surface buoys and relying solely on acoustic releases to recover gear are necessary to further assess the feasibility and efficiency of fishing with on-demand gear. Some topics to consider when developing additional research trials include:

- Wintertime Use: More data on winter use is required to understand how the systems work in adverse conditions and to continue developing gear upgrades and best practices.
- Gear Location Awareness and Technology Advancements: With currently installed hull-mounted transducers and both current and forthcoming subsurface location functions, this study expands the potential to analyze the capabilities of the available subsurface location functions, boosting gear awareness of both mobile and fixed-gear fisheries.
- Unsuccessful Hauls: Specifics of how and why fully on-demand systems may not be hauled successfully, including but not limited to line snarls, gear breakage, and issues with acoustic responses. This data will be presented back to manufacturers for gear updates. This information is critical to share with manufacturers so they can make improvements to the gear to increase its reliability.
- Gear Movement: Evaluate the underwater unit's movement and stability in various tides, moon phases, and wind to predict potential gear movements during weather events. This information helps researchers determine the correlation (if any) between unsuccessful hauls and movement of the gear during deployment.
- Through Hull vs. Dunking Transducer: Interpret the timing differences between hauling on-demand gear on vessels with through-hull transducers vs. dunking transducers. This information is used to calculate catch per unit effort (CPUE) and other economic models to evaluate the costs associated with increased time to haul on-demand gear compared to traditional buoyed gear.
- Navigation Chart Integration: Ability to access location data, including overlaying on digital charts and demonstrated visibility by enforcement and other ocean users, and how that affects gear conflict with fully on-demand trawls. Fixed-gear and mobile gear commercial fishing industries have identified this as an important next step to reducing gear conflict and improving gear usability.
- Real-Time Gear Positioning: Ability to upload data within coastal cell phone range to a cloud platform (EarthRanger) in order to provide real-time gear position data for both fixed-gear and mobile fleet fishermen. This research is critical, especially in high-density fishing situations, to reduce gear conflict.
- Catch Data: Increased data collection on retained lobster/crab catch by haul for greater comparisons between standard and on-demand hauls. Together with the timing data, this information is necessary to calculate CPUE to factor into economic models.

ACKNOWLEDGEMENTS

The work within the experimental fishery would be impossible without the collaboration between NEFSC, Massachusetts Division of Marine Fisheries, on-demand gear manufacturers, and fishermen. The individuals willing to use and test this gear on their vessels are what make this research possible. We also acknowledge several non-governmental organizations (NGOs) that have contributed to the Gear Lending Library, allowing the collaborating fishermen to use on-demand gear directly. The Conservation Law Foundation (CLF), International Fund for Animal Welfare (IFAW), New England Aquarium (NEAq), PEW Trusts, SeaWorld, Whale and Dolphin Conservation (WDC), and Woods Hole Oceanographic Institution (WHOI) have been instrumental in contributing to the Gear Lending Library.

CONTACTS

For more information on on-demand fishing research, the Gear Lending Library, or other experimental fishing gear, please visit the NEFSC's Gear Research Team website at: <https://www.fisheries.noaa.gov/new-england-mid-atlantic/science-data/protected-species-gear-research>

For general inquiries, contact the Gear Research Team at nec.gearlibrary@noaa.gov

For media inquiries, please contact Teri Frady at teri.frady@noaa.gov

TABLES AND FIGURES

Table 1. Massachusetts Restricted Area (MRA) and South Island Restricted Area (SIRA) data summary; includes data for both state and federal waters. The success rate for hauling on-demand gear within MRA was 90.72%, and the success rate within SIRA was 86.43%, making a total success rate of 89.87% for both closed areas.

Restricted Area	# Vessels	# On-Demand Hauls	Success Rate
Massachusetts Restricted Area (MRA)	6	334	90.72%
South Island Restricted Area (SIRA)	6	199	86.43%
TOTALS	12	533	89.87%

Table 2. Data summary from closed areas within Massachusetts state waters only.

# Vessels	# Hauls	# Hauls Successful	# Unsuccessful Retrievals	Success Rate	# Lobsters Retained	# Lobsters Discarded	Avg. Lob Retained/Haul	Avg. Lob Discarded/Haul	# NARW Sighted
5	187	174	13	93%	2,446	1,634	13.08	8.74	14

Table 3. Categories of unsuccessful retrievals of on-demand gear in both closed areas within state and federal waters.

Category	Number of Events	% of Unsuccessful Retrievals
Acoustic	2	3%
Mechanical	30	51%
Technological	12	20%
Operational	5	8.5%
Unknown	6	10%
Mix	2	3%
Lost	2	3%
Total:	59	

Table 4. Hauls and success rates from 2020 to 2023, including the 2023 restricted areas showing an increase in successful hauls of on-demand gear.

Year	2020	2021	2022	2023 (so far)	2023 (Closed Areas)
# Hauls	81	665	1,885	2,567	533
Success Rate	64%	83%	88%	90%	90%

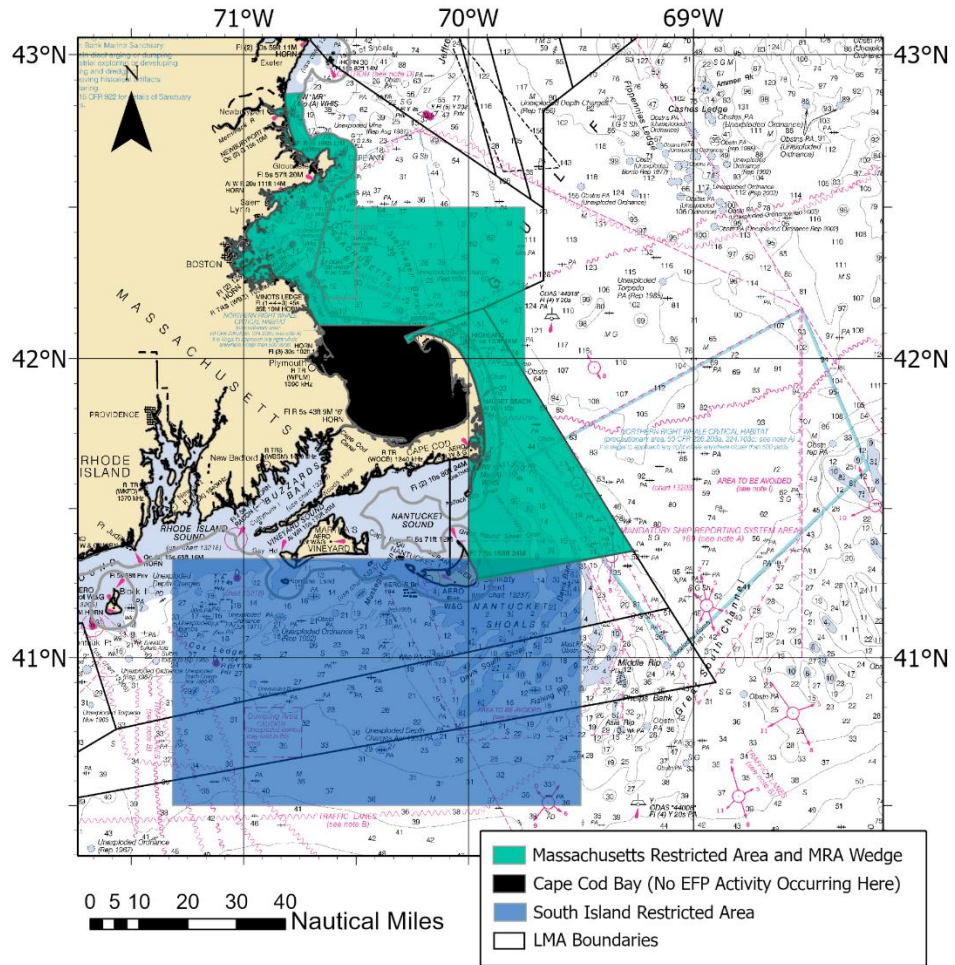


Figure 1. Restricted areas where fully on-demand pot/trap trawls (no persistent vertical buoy lines) were authorized to be tested from February 1 to April 30, 2023.



Figure 2. Screenshot of several collaborators' on-demand trawls in the South Island Restricted Area. The fishermen utilized the Edgetech TrapTracker App to deploy and haul their gear, as well as to be able to see each other's gear in the water since there are no surface markings. The orange icons are trawls belonging to the fisherman using the tablet, and the red icons are trawls belonging to other fishermen using TrapTracker to mark their gear.

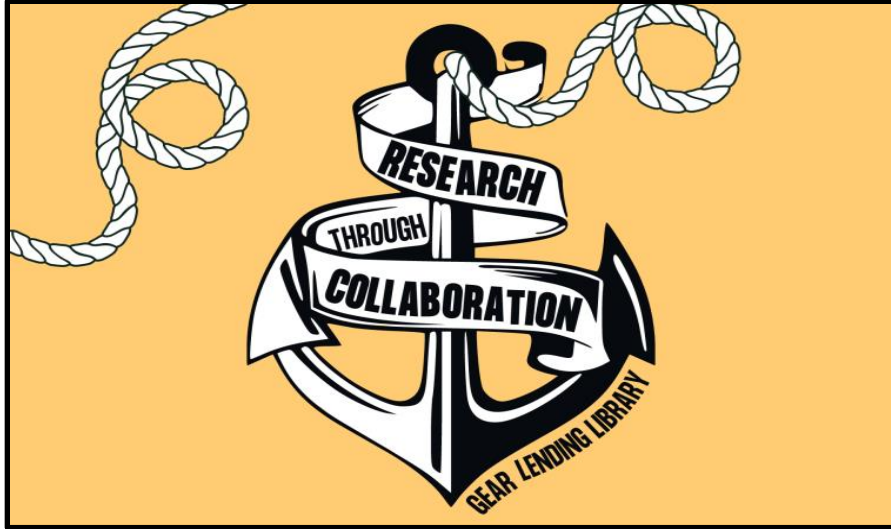


Figure 3. A yellow flag with anchor and slogan “Research through Collaboration” flown by collaborating vessels while participating in the experimental fishery for easy identification by other vessels and enforcement.

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APPENDIX

Figure A1. Closed area data sheet that each participating fisherman filled out after each set, haul, and for any interrupted operations.

Name _____ Vessel _____ Device ID # _____ Trawl # _____ # Traps on Trawl _____

Setting (For Sediment - M = Mud, R = Rock, S = Sand, X = Mixed)

Date	Time	Wind Speed (knots)	Wind Direction	Wave Height (ft)	Sea Surface Temp (F)	Current (knots)	Sediment	Latitude	Longitude	Set Depth (Fa)	Closed Area? (Y/N)	State or Federal? (S/F)	Notes & Additional Gear ID #s (Smart Buoys, Tilt Sensors, Receivers, etc.)

Hauling													Stop Watch Elapsed Time			State Waters Only	
Date	Time	Wind Speed (knots)	Wind Direction	Wave Height (ft)	Sea Surface Temp (F)	Current (knots)	Max Swell During Soak	# Commands to Deploy?	* Retrieval successful? (Y/N)	Buoy to Surface (After Signal Sent)	Buoy to Rail (After Buoy Surfaces)	First Fishable Trap to Rail	Did Trawl Move? (ft)	# Lobsters Kept	# Lobsters Discarded	Whale Sighting?	

* For unsuccessful retrievals, complete back of form

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