A Pilot Project to Modernize Pot Fishing for the Black Sea Bass (BSB) Fishery Using Acoustic Subsea Buoy Retrieval Systems

Date of Application: 04/21/2020

Extent of Time EFP needed: May 1, 2020 - September 30, 2020

Applicant's name, mailing address, telephone number, e-mail, and fax number, if available:

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Identification of Problem:

Acoustic Subsea Buoy Retrieval Systems (ASBRS), are an example of innovative gears which store buoys and their retrieval devices at depth. These systems exist in the water column for minutes instead of hours or days as they are activated via acoustic releases only when fishers are present. Currently vertical end lines and buoys, such as those utilized in the Black Sea Bass (BSB) pot fishery, present an entanglement risk to the critically endangered North Atlantic right whale, a species which migrates and calves off the coast of Georgia in the winter months. Adaptation of Acoustic Subsea Buoy Retrieval Systems (ASBRS)[1] or "ropeless" systems for this style of pot fishing could remove nearly all risk to these whales and other marine animals that suffer entanglements. These systems have been utilized in other fisheries and in many other marine applications world-wide for over twenty years and are currently being tested nationwide in a multitude of locations that suffer time area closures due to the presence of endangered cetaceans. For fisheries management to determine if these devices could be relied upon in an exempted area, a detailed performance analysis is required that examines the refinement and successful use of ASBRS in the BSB pot fishery.

Objectives:

This pilot project seeks to examine the potential usefulness of these gears in the BSB pot fishery while minimizing impacts to protected species, **the research described in this EFP application specifically seeks this exempted fishing permit to determine:**

[1] Acoustic Subsea Buoy Retrieval Systems are also known as "ropeless, lineless, pop-up, and on-demand" fishing systems. For the purpose of the application, the all-inclusive term ASBRS will be used to offer clarity and continuity for all devices.

- If the ASBRS gear will show a greater than >99% successful deployment and retrieval rate.
- If ASBRS gear significantly increases time or expense for retrieval and recovery versus the current fishing method such that it might affect profitability.
- If ASBRS gear significantly increases time or expense for repacking of gear for redeployment versus the current fishing method such that it might affect profitability.
- If bycatch rates for a modified BSB pot design ("4by") are greater than the traditional single pots

We will engage other stakeholders in a meaningful fashion; Marine Extension and GA Sea Grant (GASG) for outreach and education to consumers and fishers, Southeast Regional Office Protected Species Branch for considering measures to mitigate impacts to NARW, and South Atlantic Fishery Management Council for sound management of this fishery.

Data will be collected during two testing cycles (May-July 2020 (with ropeless devices and then in August-September 2020 if issued an EFP) in the GA BSB pot fishery through an ongoing and collaborative effort of different ASBRS manufacturers, our fisheries industry partners, and Marine Extension and GASG. The first will be in May and June and will be to familiarize the fisher with ASBRS gear, using mock-up traps (with no entrances for fish) as allowable by law. This will yield basic data about the ease of adaptation to the experimental buoy designs and success of acoustic deployments and retrievals, as well as to gain valuable information on the accuracy of virtually marking the gear with both a chart plotter as well as the GPS enabled- gear marking software that accompanies the various systems. These initial test traps will be tested with safety lines in place (traditional rope and buoy as described by law) These configurations have been used successfully in other regions of the United States and Canada. (Shester, 2018) Camera and film recordings of fish, trap, ASBRS, and participant behavior will be utilized to ensure safety of both intended target catch and sub-legal species as well as nearby marine animals and participants.

The second cycle would be after receiving the EFP. The selected styles of ASBRS gear and pot configurations can be seen in Table 1 and figures 1-3 and are detailed later in the EFP. (See Table 1 and Figures 1-3). Any gear modifications or alterations in rigging will be made through consultation with regional & federal management agencies and in collaboration with individual fishers and industry partners. Fishers participating in this initiative are self-funding the trial and to ensure coverage under the MMPA by the Marine Mammal Authorization Program, will keep and sell all legal catch so that it meets the definition of a commercial fishery. We will consult with NOAA Fisheries to ensure the pilot design is in line with NARW conservation measures currently in place.

BSB pots will be fished as singles with a traditional configuration* in both the inshore and the offshore areas*; this will be done in August and September 2020.* The control pots will yield data relative to the time expended to retrieve and rebait traditional traps per current regulations. Experimental configurations of BSB pots will be fished without vertical buoy lines on live bottom near control pots with traditional configurations.

Virtual gear marking (marking of gear deployment location with chartplotters, GPS, and manufacturer-provided software) will be utilized and evaluated, with analysis of the

interoperability of systems being shared with fishery management partners. These systems have to date, been extremely reliable (>99%) in tests done internationally. (Shester, 2018; Terhune *et al.*, 2018; Baker and Specialist, 2019; Flagg, 2019; Morris and MacEachern, 2019; Stevenson, 2019) (See Appendix 2.)

To accurately address our research questions, our research group will require exemptions from the following regulations:

I. 50 CFR §622.189 (g) Restrictions and requirements for sea bass pots-line marking 4

II. 50 CFR §622.177 (4) Gear identification, unmarked pots or buoys.....4

III. 50 CFR §229.32 (b) (1-3) Gear marking requirements 4

IV. CRF 50 §622.189 (b) Configuration restriction. 4

V. 50 CFR § 229.32 (C) (1) (i) Buoy line floating at the surface.....5

VI. 50 CFR § 229.32 (C) (vi) (D & E) Buoy line free of objects 6

Statement of Work

I. 50 CFR §622.189 (g) Restrictions and requirements for sea bass pots-line marking
II. 50 CFR §622.177 (4) Gear identification, unmarked pots, or buoys
III. 50 CFR §229.32 (b) (1-3) Gear marking requirements

50 CFR 622.189 (g) Sea bass pot buoy line marking requirement. In addition to the gear marking requirements specified in 50 CFR 229.32(b), 50 CFR 229.32(f) 50 CFR 229.32(c)(6) and (9)

50 CFR 622.177 (4) Unmarked sea bass pots or buoys. An unmarked sea bass pot or a buoy deployed in the EEZ where such pot or buoy is required to be marked is illegal and may be disposed of in any appropriate manner by the Assistant Administrator or an authorized officer.

50 CFR 229.32 (b) (1-3) Areas, Markings, Color Code

The two technologies that utilize lift bags and buoys are unable to be line-marked as they do not incorporate line or rope into their design. These gears will otherwise be marked according to all federal and regional regulations.

All buoy lines on gears that use line will be marked in accordance with the most recent requirements per the ALWTRP and the SAFMC regulations, and will have a maximum breaking strength of 600 lbs. *These systems that incorporate line will only be fished during the second testing periods in the inshore area.*

IV. CRF 50 §622.189 (b) Configuration restriction
V. CRF 50 § 648.144 (b) (2) Black sea bass gear restrictions

Restrictions and requirements for sea bass pots.

CRF 50 §622.189 (b) Configuration restriction. In the South Atlantic EEZ, sea bass pots may not be used or possessed in multiple configurations, that is, two or more pots may not be attached one to another so that their overall dimensions exceed those allowed for an individual sea bass pot. This does not preclude connecting individual pots to a line, such as a "trawl" or trot line.

CRF 50 § 648.144 (b) (2) All black sea bass traps or pots must have two escape vents placed in lower corners of the parlor portion of the pot or trap that each comply with one of the following minimum size requirements: 1.375 inches by 5.75 inches (3.49 cm by 14.61 cm); a circular vent of 2.5 inches (6.4 cm) in diameter; or a square vent with sides of 2 inches (5.1 cm), inside measure; however, black sea bass traps constructed of wooden laths instead may have escape vents constructed by leaving spaces of at least 1.375 inches (3.49 cm) between two sets of laths in the parlor portion of the trap. These dimensions for escape vents and lath spacing may be adjusted pursuant to the procedures in § 648.140.

Because trawls are not allowed in this region from November 15-April 15, we have elected to connect four of the regulation-sized pots together with wire connecting clips or zip ties so that only one ASBRS gear device is needed to retrieve four pots (4BY), thus simulating conditions that

we would propose to test in the future. We also propose to test a four pot trawl of standard BSB gear to determine if catchability is better in one configuration versus another.

Each pot will have the standard single entrance and will possess one back panel with 2" uniform mesh. We have included a few photos of a model trap to illustrate how this would look, as well as one with an ASBRS device mounted to the top. (See figures 1 and 2) The four traps will test both 1 and 2 single entrances (on adjacent sides of single traps to replace the allowable 2 opposite entrances) to four regulation-sized trap interiors and will otherwise adhere to all requirements for BSB pots in the SAFMC region. *It is critical to note that the interior dimensions of these configurations ore the same as required by law. These 4BY traps are not chevron-style fish traps, they are simply standard BSB traps connected to adjacent standard BSB traps.*

The goal of this modification is to examine ways to reduce procurement and implementation costs associated with the number of required ASBRSs to fish 35 pots.

Figure 1 Modified BSB Pot Configuration

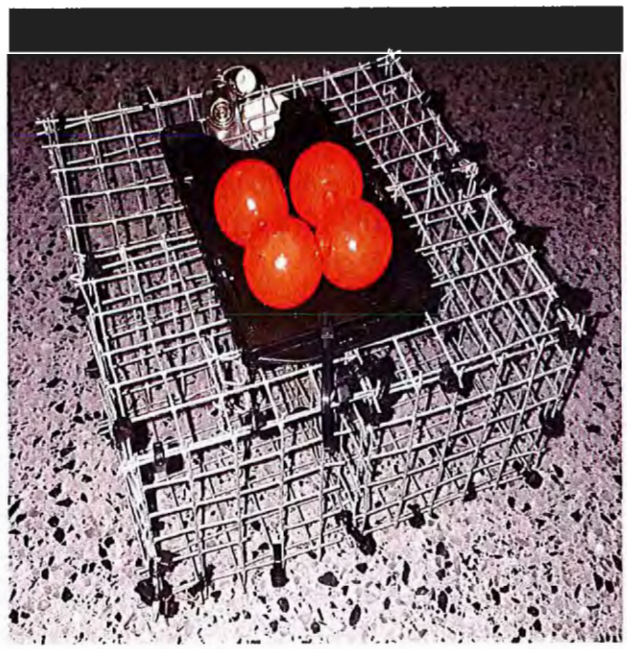

Figure 2 Modified BSB Pot Configuration with ASBRS Device

VI. 50 CFR § 229.32 (C) (1) (i) Buoy line floating at the surface

50 CFR § 229.32 (C) (1) (i) No buoy line floating at the surface. No person or vessel may fish with trap/pot gear that has any portion of the buoy line floating at the surface at any time when the buoy line is directly connected to the gear at the ocean bottom. If more than one buoy is attached to a single buoy line or if a high flyer and a buoy are used together on o single buoy line, floating line may be used between these objects.

Four of the ASBRS devices require floating line to return the buoy or buoys to the surface for retrieval. Currently, the average time for appearance of buoys at greater than 100ft is approximately three minutes. Retrieval generally takes less than 120 seconds, which means that

floating rope would be at the surface for less than five minutes total, during which time the vessel would be within 20-30 feet of the line at all times.

Two of the devices do not incorporate line longer than ten feet in the design, and two use a harness that clips to the trap. The remaining devices use less than 150' of rope which will be stowed inside either a trap (See MOBI, 5112), a bag (Desert Star), or on a spool (FioBuoy). (See Figure 3)

VII. 50 CFR § 229.32 (C) (vi) (D & E) Buoy line free of objects

50 CFR § 229.32 (D) The entire buoy line must be free of objects (e.g., weights, floats, etc.) except where it attaches to the buoy and trap/pot

50 CFR § 229.32 (E) The buoy line is made of sinking line.

Four of the ASBRS devices require floating line to return the buoy or buoys to the surface for retrieval. Currently, the average time for appearance of buoys at greater than 100ft is approximately 3 minutes. Retrieval generally takes less than 120 seconds, which means that floating rope would be at the surface for less than five minutes total, during which time the vessel would be within 20-30 feet of the line at all times. Sinking line cannot be used for this application as it will create a negatively buoyant strain on the buoys and not allow for their return to the surface.

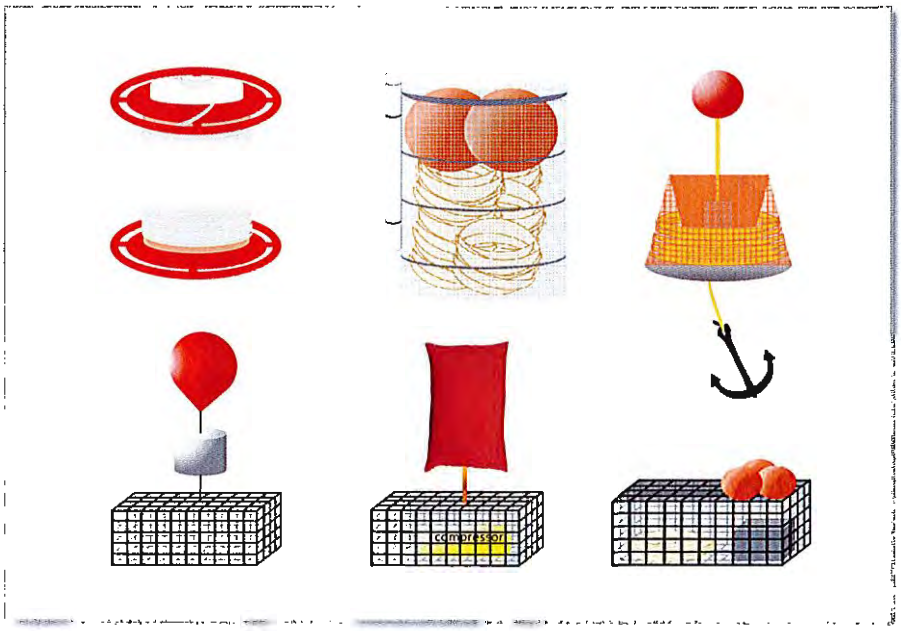

Figure 3 ASBRS Gears to Be Tested (from l to r Fiomarine-FioBuoy, Desert Star Systems ARC-1, Ashored-MOBI, LobsterLift, SMELTS-Lobster Raft, EdgeTech 5112) Credit: Annika Toth, 2019

All of the gears with a rope storage system will need to be attached between the trap and the buoy. Several of the gears might require a small anchor or weight to be attached between the trap and rope-storage device or buoy in areas with higher current to keep them from fouling in

the trap, as well as to ensure they are not dragged from their deployment area. We are requesting the use of these devices only if necessary. For lift bag and buoy systems, the actual systems will be secured between the trap and the buoy/bag. Please see figure above.

Six of the eight currently available devices require the use of a rope for retrieval that is contained and stored at depth by a rope management system. The two other devices do not use line, but instead, utilize the inflation of either a lift bag or inflatable buoy to pull a lead trap to the surface. The styles of line management vary with device design that includes square, rectangular, domed, circular, and conical cages, oyster mesh bags, canisters, and spools. These have been successfully used in trials and testing in a variety of active fishing operations in California, Massachusetts, Australia, Canada, and Scotland.

An overview of each product's gear type, working method, and development status is presented in Table 1.

Manufacturer	Gear type	Status	Field-tested	Web site
Fiomarine	Spool Design	Mature design 20+ yr. product	Yes	http://fiomarine.com
Desert Star Systems	Rope Release Bag	Mature design 20+ yr. product	Yes	http://www.desertstar.com
EdgeTech	Cage System	Mature design – 1965	Yes	https://www.edgetech.com
Lobster Lift	Inflatable Buoy	Solid Prototype	Yes	https://www.lobsterlift.com
SMELTS	Inflatable Lift Bag	Solid Prototype	Yes	https://www.smelts.org
Ashored	Cage Design	Solid Prototype	Yes	https://ashored.ca

Table 1. Summary of current ropeless systems available

Spool Design (Fiobuoy®)

Manufacturer:	Fiomarine
Product Name:	Fiobuoy
Gear Type:	Spool device
Field Tested:	Yes
Available for Purchase:	Yes
Website:	http://fiomarine.com
Video Demonstration:	Spool design

The Fiobuoy® is an integrated smart buoy system comprised of a spool of rope, acoustic modem, floatation, and release mechanism affixed to a subsea object (Figure 4). Each unit has a unique identification code to allow security to the fleet and provide an integrated system management capability for enhanced fisheries operations and oversight. The code management capability can be configured to allow only the buoy to operate in areas open for fishing. If there were an attempt to launch the system within a closed zone, the release jaws would not close on the surface. This system capability prevents the deployment of the system when configured for this functionality. The Fiobuoy mechanical release is activated upon receiving an acoustic command from the surface vessel, a master code for enforcement personnel is also designed into the system. There are also two failsafe release backups in the Fiobuoy; a time/date trigger and a low battery trigger. Once the mechanical jaws are released, the Fiobuoy floats to the surface as the line unspools. Recovery operations remain the same as traditionally marked surface float fixed gear traps. This configuration removes the surface float and the vertical line in the water column until a release is triggered. This device will not require weight to be added to the trap unless fast moving currents are present.

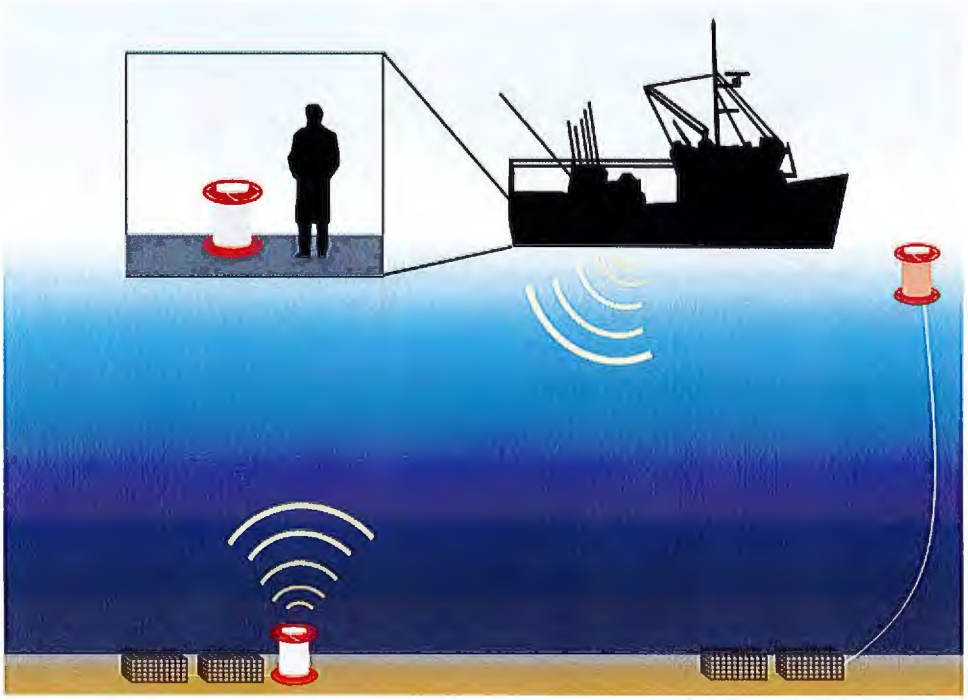

Figure 4. Fiobuoy © 2019 Annika Toth

Desert Star ARC-1 with Rope Release Bag

Manufacturer:	Desert Star Systems
Product Name:	Desert Star ARC-1
Gear Type:	Rope Release Bag
Field Tested:	Yes
Available for Purchase:	Yes
Website:	http://www.desertstar.com
Video Demonstration:	Release Bag

The Desert Star ARC-1 is a modular acoustic release system produced by Desert Star Systems that can be paired with any rope management systems (Figure 5). As seen in Figure 5, the buoys and rope are contained in a mesh bag with an acoustically triggered release mechanism attached to the side, which is placed with the rest of a fisherman's regular gear. The release mechanism is a small magnesium wire that disintegrates when it receives an acoustic command. Once released, the buoys and line ascend out of the bag and are available for retrieval at the surface. The gear is then hauled as normal, and the line is repacked for another deployment. The rope storage method can and has been customized to fishermen's needs according to their geographic regions. This release system has existed and been in use by fishermen in New South Wales (Australia) for many years and is available for purchase on Desert Star Systems' website. This device will require weight to be added to the trap to fully submerge the bag.

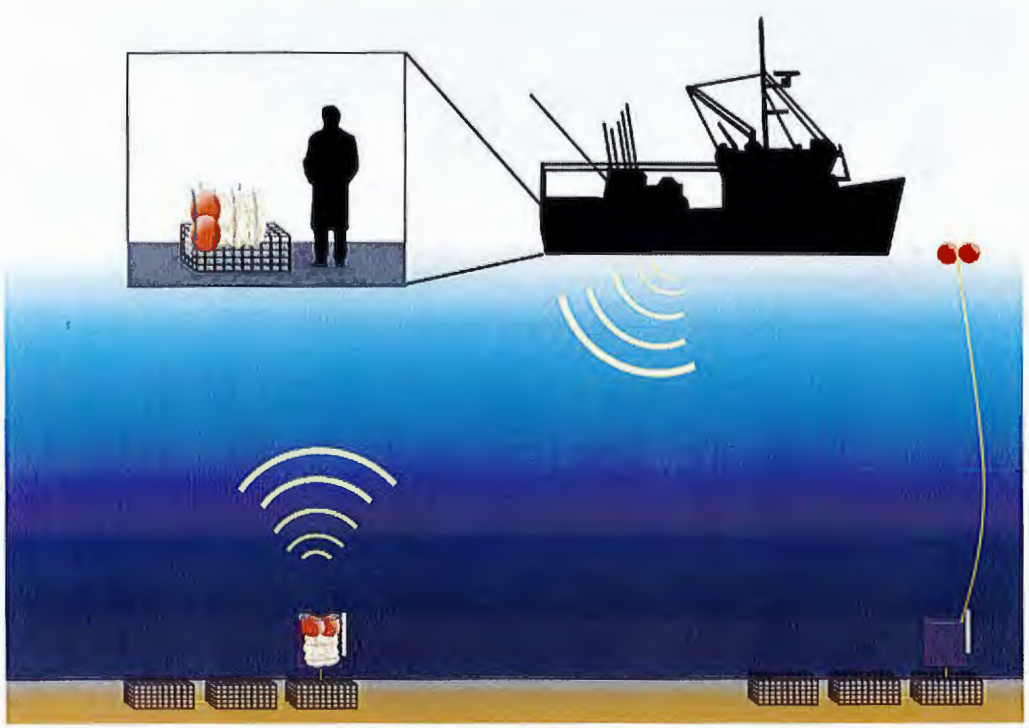

Figure 5. ARC-1 with Rope Release Bag © 2019 Annika Toth

Cage System (EdgeTech 5112)

Manufacturer:	EdgeTech
Product Name:	EdgeTech 5112
Gear Type:	Cage System
Field Tested:	Yes
Available for Purchase:	Yes
Website:	https://www.edgetech.com
Video Demonstration:	Cage System

The EdgeTech 5112 system is an acoustic command and control system developed by EdgeTech. The system consists of a modified lobster trap, which comes in a variety of sizes and rugged acoustic release (Figure 6). The release cage has two sections and a top cover with flotation. One section holds up to 650 feet of ⅜ line, and the other section contains the acoustic release. The top cover includes the floatation that detaches and floats to surface when the acoustic release is actuated. It is deployed like any other lobster trap but without the need for surface rope and buoy. The unit can be deployed in water depths down to 500 meters and handle a load of 500 pounds (release load 250 pounds) while enduring underwater for up to one year (two years on lithium batteries). The acoustic release is constructed of nickel aluminum bronze alloy that protects against corrosion. When communicating with one of the 5112 deck boxes, the system will provide shipboard operators information such as battery life status, tilt information, and release information and confirmation. This system was designed from the ground up with the input of lobster fishermen and is available for purchase on EdgeTech's website. This device will not require weight to be added to the trap.

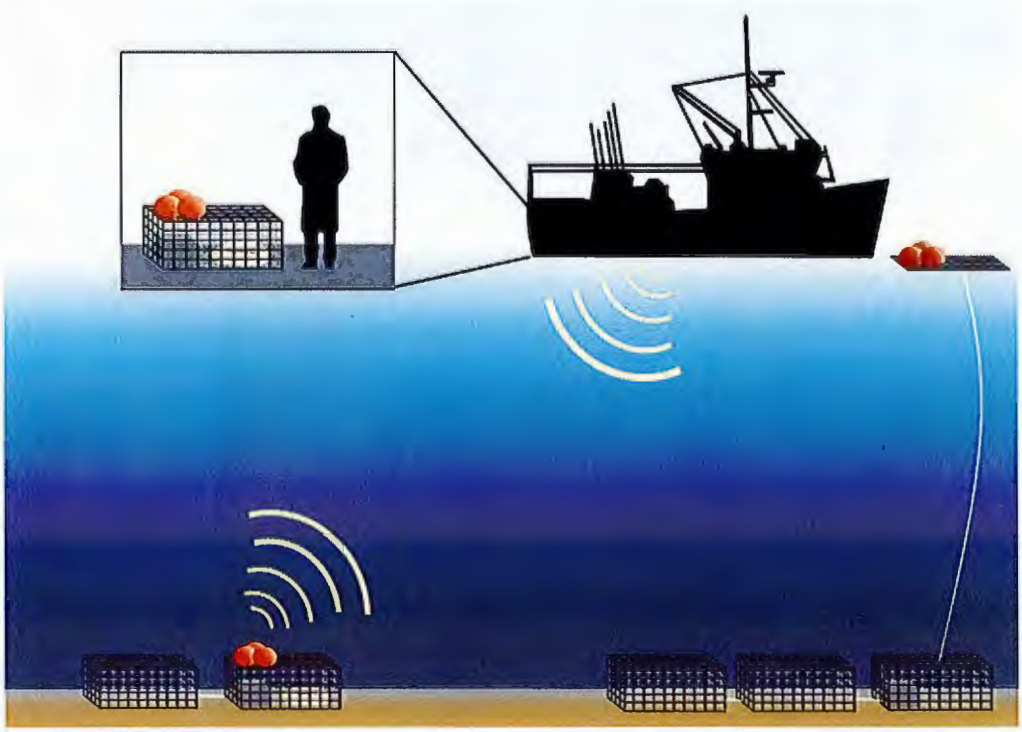

Figure 6. EdgeTech 5112 © 2019 Annika Toth

Lift Buoy (Lobster Lift)

Manufacturer:	Lobster Lift
Product Name:	LobsterLift
Gear Type:	Inflatable Buoy
Field Tested:	No
Available for Purchase:	No – solid prototype
Website:	https://www.lobsterlift.com
Video Demonstration:	N/A

LobsterLift is a lineless, self-surfacing modular lobster trap retrieval system. Traps utilizing LobsterLift technology sit on the seafloor and are raised when needed, either through acoustic signal or through GTR (Figure 7). To retrieve a trawl, a fisherman sends an acoustic signal from the boat to a module attached to the trawl. Alternatively, the unit can be fitted with a GTR, which would allow the release of nitrogen from a tank to inflate an attached buoy. The buoy increases in size until it can float the trap to just below the surface (4-8 ft. below the waterline). The buoy is then hauled, the traps are retrieved, removed of their catch, and re-baited. This method uses no vertical endline but does use rope between traps and would require slight modification to work with GTR to protect catch, animals, and gear. This device will not require weight to be added to the trap.

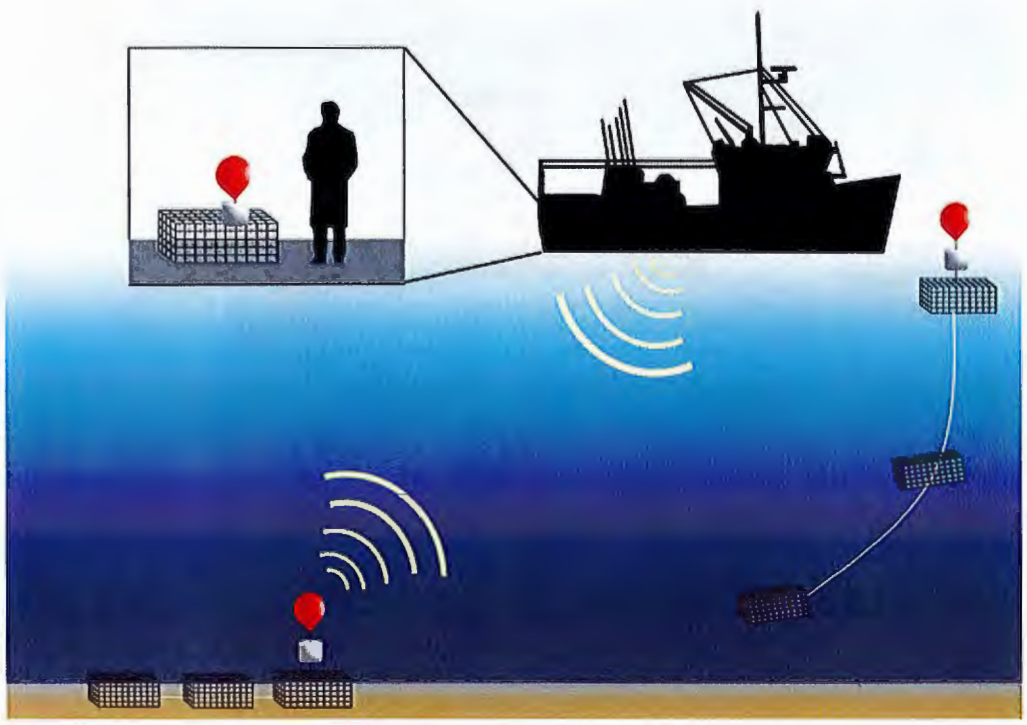

Figure 7. Lobster Lift © 2019 Annika Toth

Inflatable Lift Bag (Lobster Raft)

Manufacturer:	SMELTS
Product Name:	Lobster Raft
Gear Type:	Inflatable Lift Bag
Field Tested:	Yes
Available for Purchase:	No – solid prototype
Website:	https://www.smelts.org
Video Demonstration:	Lobster Raft

The non-profit Sea Mammal Education Learning Technology Society (SMELTS), located in Washington State, has developed a lift bag retrieval system that is operated remotely using a WHOI acoustic modem. The SMELTS lift bag does not employ any vertical line; instead, an acoustic modem, release electronics, and a compressed air cylinder are contained within a standard lobster trap (Figure 9). When the release system receives an acoustic signal, the compressed air cylinder fills the lift bag on top of the trap with air to bring the trap and groundline (which attaches the lift trap to the rest of the trawl) to the surface. Depending on the depth fished and the volume of the air cylinder, SMELTS estimates that the system can deploy six to 50 times without replacing the air cylinder. The SMELTS lift bag system has gone through engineering trials in Cape Cod Bay and Stellwagen Bank and will be used in commercial fishing tests in Massachusetts and the southern Gulf of St. Lawrence during 2019 (Myers *et al.*, 2019). This device will not require weight to be added to the trap.

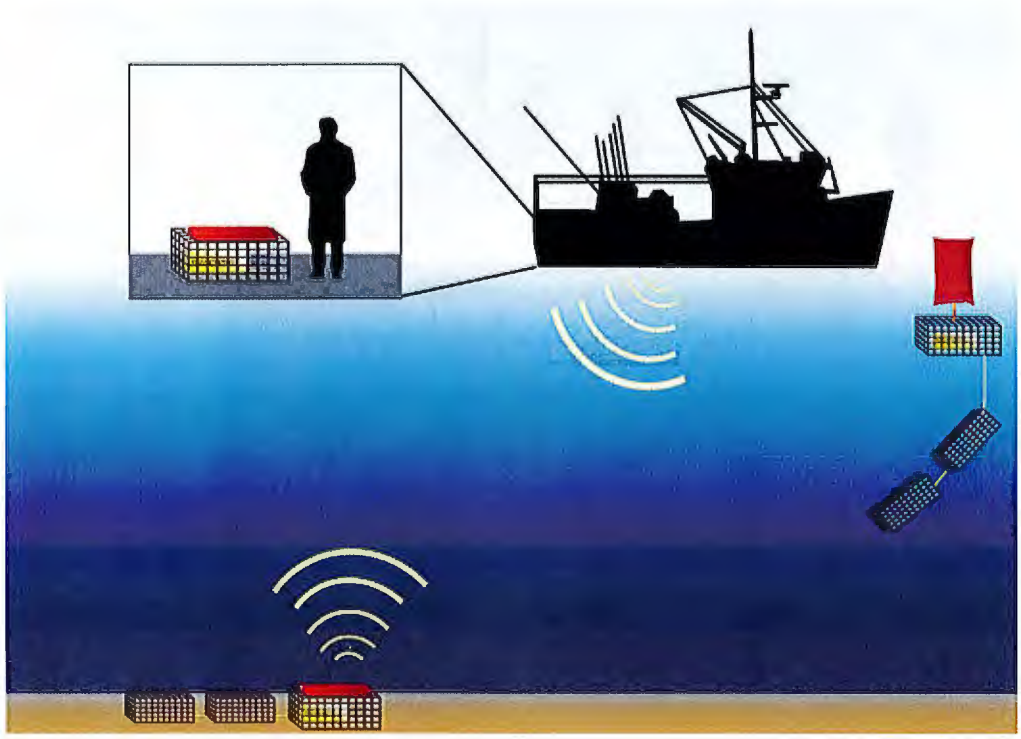

Figure 8. Lobster Raft © 2019 Annika Toth

Cage Design (MOBI)

Manufacturer:	Ashored
Product Name:	MOBI
Gear Type:	Cage Design
Field Tested:	Yes
Available for Purchase:	No – solid prototype
Website:	https://ashored.ca
Video Demonstration:	Cage Design MOBI

MOBI by Ashored is an electronically activated underwater release system that consists of a conical cage that stores line as well as a buoy, anchored on the seafloor until activation (Figure 10). The release mechanism consists of a t-bar connected to a drive shaft allowing for circular motion. This t-bar is coupled with a lid plate that has a specific slot to slip over the t-bar for arming. The t-bar then spins 90 degrees over the lid plate to complete arming and holds the lid in place until released. The release is initiated either by a remotely transmitted acoustic signal or from the internal time-clock backup. The t-bar spins another 90 degrees in the same direction and realigns with the slot in the lid plate, enabling separation/release of the instrument. Ashored's MOBI could be relatively easily adapted to work with a GTR and used as a rope management system. The rope cages feature a stackable design to mitigate deck space consumption and arrives at the surface with the buoy for simultaneous respooling as the buoy line is hauled aboard. This device will not require weight to be added to the trap but will require weight to be added to the bridle, which lies between the trap and the storage cage.

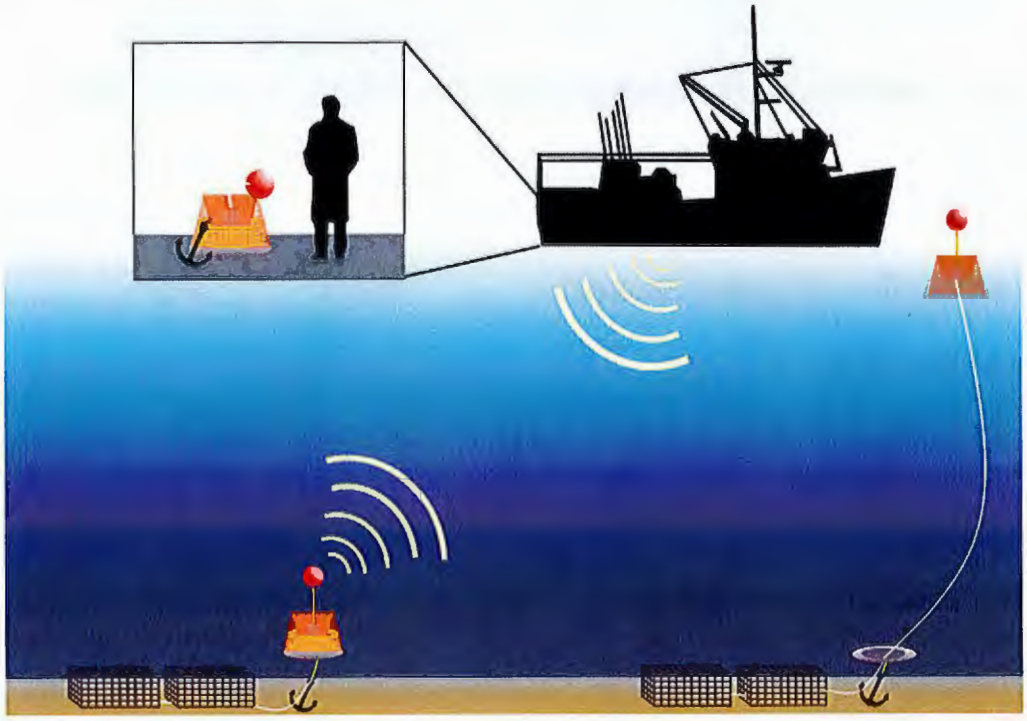

Figure 9. MOBI device © 2019 Annika Toth

The species (target and incidental species must be clearly differentiated) expected to be harvested and/or discarded under the EFP

Target Species: Centropristis striata, Black Sea Bass

Incidental Catch Species: Centropristis striata (Sub-legal conspecifics), and possibly a small number of marketable octopus.

The number or weight, by species, of such harvest and/or discard anticipated to occur during the exempted fishing, regardless of whether or not it is retained for sale.

Black Sea Bass: We expect to harvest a total of approximately 10,000 WW pounds per exempted fishing period for a total of 10,000 WW pounds.

Incidental species (octopus) will be harvested if allowable by law and is expected to be less than 10% of total catch, or 1,000 WW pounds over the two periods of exempted fishing time. For those non-permitted or non-exempted fish that show signs of barotrauma, we will use decompression techniques including descending gear devices and/or venting prior to being returned to the water.

The expected disposition of all regulated species harvested under the EFP (e.g., what will be done with the fish once it is caught).

It will be sold.

Any anticipated impacts on fisheries, marine mammals, endangered species, or Essential Fish Habitat.

No detrimental impacts are anticipated.

The following anticipated effort information for vessel:

Type and size of gear to be used:
Black sea bass pots, with a uniform back panel mesh size of 2 inches or greater, and a uniform all over mesh size on remaining sides of 1 ½ inches or greater. We will also be fishing four BSB pots of regulation size mesh greater than 2 inches connected together with metal retaining clips to test the feasibility of targeting a large group of BSB at one time to reduce the number of ASBRS devices needed to haul gear in winter in the inshore area to investigate improving return on investment for ASBRS gear. (see Figures 1 & 2)
Amount of gear to be used: 35 total pots
Number of gear hauls: <300
Average soak time: 90-120 minutes per configuration
Testing months/time of year: 10 days between 2 cycles in May-June and then in August and - Sept 30 of 2020.

Testing locations (including depth): The Requested Testing Area has an approximate perimeter of 87 nm and an area of 501 nm. Inshore and Offshore, we will fish in waters between 10 and 30 meters per the map below. The offshore area is that approximate area outside the Time Area Closure, but within the noted pentagonal shape in Figure 11.

The following coordinates are approximate but represent the intended area of targeted testing. We will not fish in Special Management Zones (SMZs) or the North Atlantic Right Whale Critical Habitat Area or those areas listed in CRF 50 §622.182 Gear-restricted areas ((a)(1)(i) through (li)). (See Figure 10)

Waypoint 1: 31°20'4.86"N 80°26'42.58"W
Waypoint 2: 31°20'27.67"N 80°48'8.33"W
Waypoint 3: 31°30'36.47"N 80°58'10.48"W
Waypoint 4: 31°44'34.14"N 80°42'28.16"W
Waypoint 5: 31°33'34.59"N 80°21'17.00"W (See Figure 12)

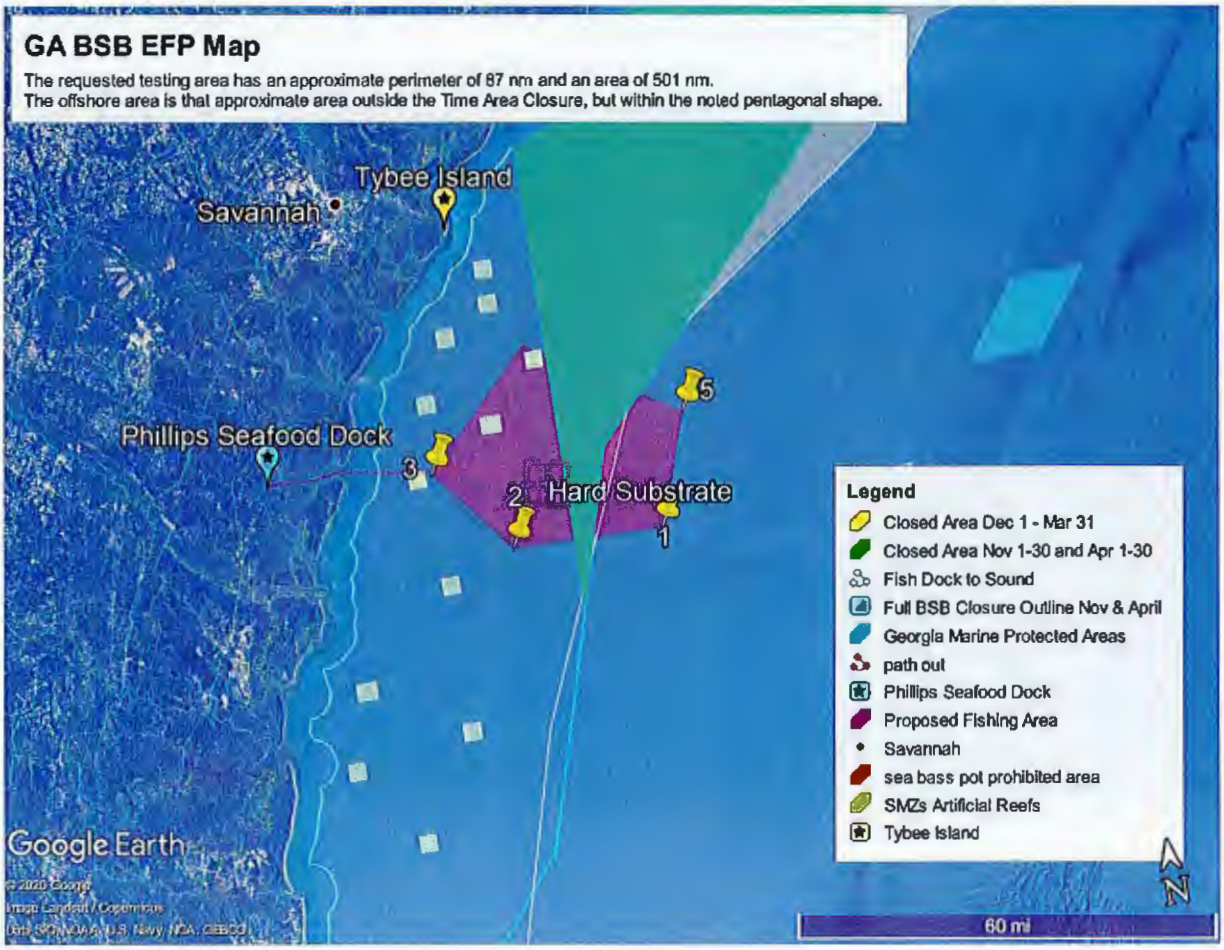

Figure 10 Testing Area with SMZs and MPAs noted

Figure 11 Testing Areas Inshore and Offshore within Pentagon

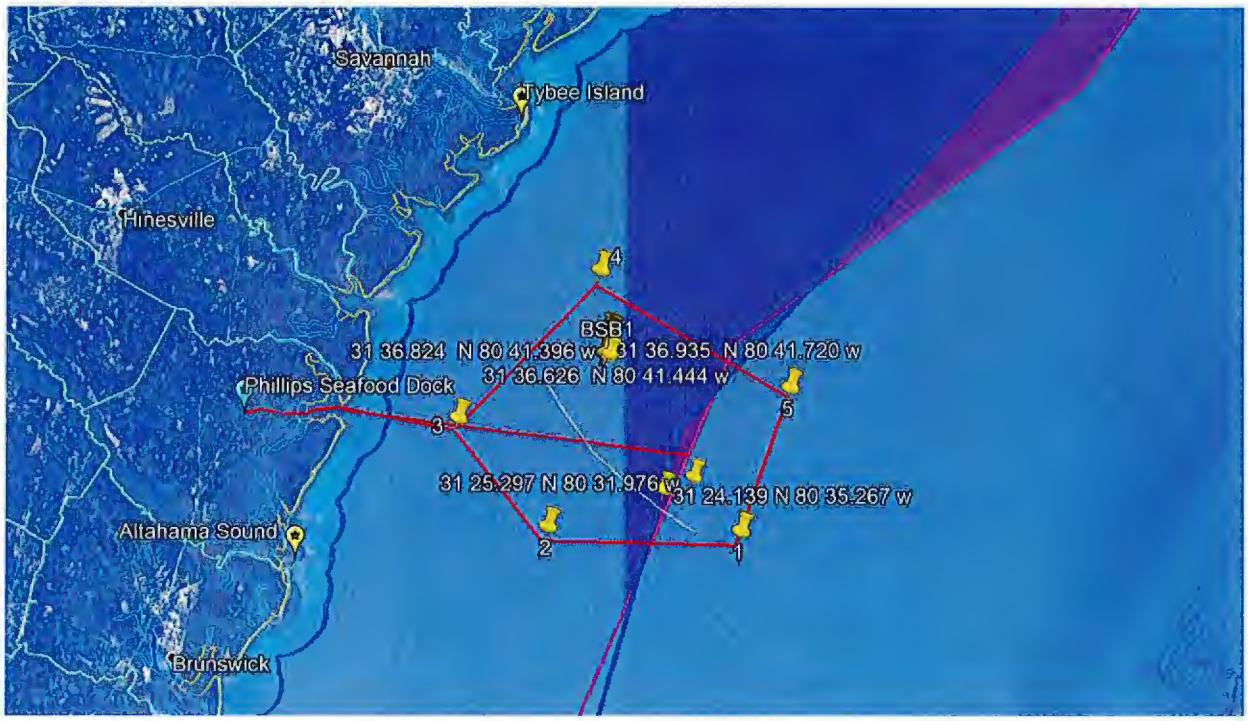

Figure 12 Testing area with coordinates of boundaries

The total deployments required for statistical significance of research for both ASBRS and traditional gears are detailed in the Table 2 & 3 below. (See Appendix 1 for Power Analysis)

Deployments	2020		
		In	Off
	Traditional (Control)	45	45
	LL	45	0
	LR	45	0
	FIO AUC	45	0
	DS AUC	45	0
	ASH	45	0
	EDGE	45	0
Configurations	Sept 2020		
		In	Off
	Singles	180	X
	4BY	180	X

Table 2 Gear Configurations and Locations

Total Fishing Days = 8-10
Total Pots Fished = 360
Traditional Gear Deployments = 90
Total Deployments of ASBRS Gears = 270

Table 3 Summary of ASBRS Testing

Information for vessels to be used for the EFP as soon as the information is available and before operations begin under the EFP:

F/V Fish Hound (SBPE-18) USCG documentation number, state license or registration: Townsend, Georgia

F/V Captain Lynn (SBPE-20) USCG documentation number, state license or registration: Townsend, Georgia

Vessel owner information – name, mailing address, phone number, email.

Charles Phillips
1418 Sapelo Avenue NE
Townsend, GA 31331
(912) 832-4423
GA_Capt@yahoo.com

Vessel captain information and primary project participants –

Captain Charlie Phillips
Kim Sawicki, Bryan Fluech

8. Principal Investigator's CV. *Included after Appendices*
9. Signature of applicant.

5/15/2020

Bryan Fluech,
Associate Marine Extension Director

Appendix 1. Power Analysis for ASBRS Fishing Sample Size

[1] -- *Friday, July 19, 2019 -- 21:52:40*

Exact – Proportion: Sign test (binomial test)			
Analysis:	A priori: Compute required sample size		
Input:	Tail(s)	=	One
	Effect size g	=	0.24
	α err prob	=	0.05
	Power (1−β err prob)	=	0.95
Output:	Lower critical N	=	28.0000000
	Upper critical N	=	28.0000000
	Total sample size	=	44
	Actual power	=	0.9550476
	Actual α	=	0.0480709

Exact – Proportion: Sign test (binomial test)			
Analysis:	A priori: Compute required sample size		
Input:	Tail(s)	=	One
	Effect size g	=	0.24
	α err prob	=	0.01
	Power (1−β err prob)	=	0.99
Output:	Lower critical N	=	55.0000000
	Upper critical N	=	55.0000000
	Total sample size	=	87
	Actual power	=	0.9903537
	Actual α	=	0.008913776

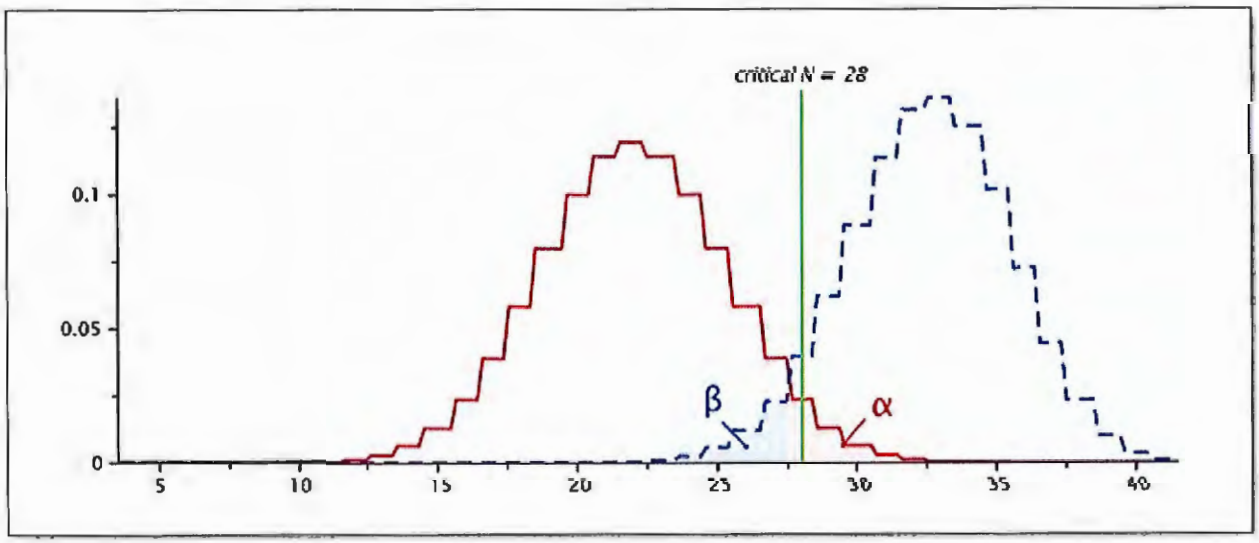

Figure 1 Power Analysis

Appendix 2

Testing of Ropeless Fishing Gear= In the past 20 years, more than 30 research projects have tested ropeless concepts and ropeless retrieval systems, with more planned and ongoing.

In 1998, the U.S. National Marine Fisheries Service (NMFS) issued a federally funded contract to "design, develop, and evaluate...a cost-effective prototype acoustic release system for the buoy endline of offshore lobster trap gear." Since this first initiative, a considerable amount of testing of ropeless retrieval systems has taken place. A comprehensive overview of all the research to date indicates a total of 32 ropeless technology projects. Overall, this testing has served to drive the evolution from a technical concept to a working prototype to an operational system and finally to an established product with commercial viability.

Testing of Ropeless Concepts

Since 1998, at least 11 research projects that funded conceptualization of ropeless gear were developed in the U.S. Six of these were based on acoustic release technology, the innovation at the heart of many ropeless retrieval systems. Table 1 outlines the full scope of conceptual research over the last twenty years in the U.S., which led to the creation of fully operational ropeless systems. The table describes the gear style, sample size (when available), location, funding source, and type of project. The types of projects are very diverse, including the creation of a ropeless prototype, lab testing of ropeless gear, demonstrations of gear, and using gear for fishing (Table 2).

Testing and Use of Ropeless Systems

Results and ideas generated from the conceptual projects detailed above led to the development of full-blown operational systems available for further testing and daily use. These tests have produced iterative improvements to gear and brought several systems to commercial viability. Equally important, testing has generated helpful data on how well ropeless systems work. 2 gives an overview of 21 testing projects (or demonstrated use) of ropeless retrieval systems, several in "at-sea" conditions. For these tests, testers deployed the gear, virtually marked its location, virtually relocated it, and then retrieved it. It describes gear style, sample size, type of testing, and location of testing for each project. Tests of ropeless gear have been conducted all around the world, including in Australia, Canada, New South Wales, Scotland, and Massachusetts.

Year	Project author and citation	Type of project	Location	Sample size (n)	Gear style and name	Funding source
1999	(DeAlteris, 1999)	Prototype and Testing	RI	10	Acoustic releases (Benthos 875, EdgeTech AMD)	NOAA
1999	(Turner *et al.*, 1999)	Concept, Built, and Lab Tested	NH	N/A	Acoustic release Buoyless Lobster Trap	NH Sea Grant
2013	(Partan and Ball, 2016)	Research and concept	MA	N/A	ORE (EdgeTech) line canister, Desert Star, FioBuoy, WHOI concept	NOAA
2007	(Allen and DeAlteris, 2007)	Prototype and Test	RI	129	Acoustic	NFWF
Before2010	NOTUS (ALWTRT, 2010)	Built	NJ	NA	Notus Acoustic Release	NMFS
2012	(PFC, 2012)	Test and used for Fishing	ME	386	GPS and Grapple (not recommended)	NMFS
2012	Gwinn Grapple	Test and used for Fishing	MD	30	GPS and Grapple (not recommended)	NMFS
2014	(Hopkins *et al.*, 2014)	Concept, Built, and Lab Tested	NH	UNK	Acoustic release	NH Sea Grant
2015	(Basque *et al.*, 2015)	Concept, Built, and Lab Tested	NH	N/A	Acoustic release buoyless trap	NH Sea Grant
2018	(Biedron, 2018)	Trial	MA	N/A	Desert Star	IFAW
2018	(Shester, 2018)	Demonstration	CA	8	FioBuoy, Desert Star	Oceana

Table 1. Research on ropeless concepts in the United States since 1998

Year	Project author and citation	Type of testing	Location	Sample size (n)	Gear style and name
1996-2019	FioBuoy, FioMarine (pers. comm.)	Internal Test	AUS	206	FioBuoy
2000-2019	Multiple Customers (pers. comm. Ridd *et al.* multiple dates & McCrindell)	Active Use	AUS	N/A	FioBuoy Line spool, timer or acoustic release
1999	(DeAlteris, 1999)	Prototype Test	RI	50	Acoustic release
2005	(Hopkins and Hoggard, 2005)	Prototype Test	MS	N/A	Subsea Sonics AR 50
2007	(Allen and DeAlteris, 2007)	Prototype Test	RI	129	Acoustic
2011	FRDC, (Liggins, 2012)	Test used for fishing	NSW AUS	>100	Acoustic release line storage bag
2018	CWLA, (Terhune *et al.*, 2018)	Used for fishing	CAN	94	Desert Star ARC-1
2018	Acadian Crabbers Assn (DFO, 2018; Gies, 2018)	Used for fishing	CAN	UNK	Desert Star ARC-1
2019	(CWLA, 2019)	Tested	CAN	ongoing	Ashored MOBI
2011	(Porter, 2018) for MLA	Used for fishing	NSW	active use	Desert Star
2018	SMELTS & NOAA (Milliken, 2018; Riels, 2018)	Test	MA	50	SMELTS
2018	WHOI/NOAA(Milliken, 2018; Ball, *et al.*, 2018)	Test	MA	50	WHOI Spool
2019	Acadian Crabbers Assn (DFO, 2018)	Used for fishing	CAN	ongoing	Ashored MOBI Edgetech5112 SMELTS
2019	Lobster Lift (C. McCarthy pers. comm.)	Internal Test	MA	>50	Lobster Lift Prototype
2019	EdgeTech/NOAA (E. Matzen pers. comm.)	Used for fishing	MA	>12	EdgeTech 5112
2019	SMELTS/ NOAA (pers. comm.)	Used for fishing	MA	>12	SMELTS Lobster Raft
2016-2019	(Partan and Ball, 2016, 2018; Ball *et al.*, 2018)	Test	NE AL	42 proposed	Line spool, acoustic release
2017-2019	SMELTS (Riels, 2018)	Internal Test	PNW, NE AL	608	SMELTS
2018-2019	Ashored (M. Poole, pers. comm.0029	Internal Test	CAN	>100	Ashored MOBI
2018-2019	EdgeTech (R. Morris, pers. comm.)	Internal Test	MA	>100	EdgeTech 5112
2019-2020	(Sawicki, results not yet published)	Test, Used for fishing	Scotland, UK	>100	Desert Star ARC-1 Fiobuoy

Table 2. Testing of ropeless gear systems from 1996 – January 2020

Appendix 3

Traditional and allowable Black Sea Bass pot gear regulations for control pots

(Will adhere to the most current and restrictive at the time of testing)

- Black sea bass pots must be less than 25 inches in height, width, and depth.
- All black sea bass pots must have attached a valid identification tag issued by NMFS.
- Only 35 pots are allowed per vessel and pots must be removed from the water at the conclusion of each trip.
- Mesh size for the main body of the traps - square mesh greater than 1 1/2 inches
- Back Panels (the side of the pot opposite the side with pot entrance) - Mesh that is at least 2 inches between bar sides.
- Escape panel and vent will have the following: Escape panel or door (excluding top and bottom), equal to or larger than trap's throat interior with hinges or fasteners made of degradable material (specified material; see below), and
- All black sea bass traps or pots must have two escape vents placed in lower corners of the parlor portion of the pot or trap that each comply with one of the following minimum size requirements: 1.375 inches by 5.75 inches (3.49 cm by 14.61 cm); a circular vent of 2.5 inches (6.4 cm) in diameter; or a square vent with sides of 2 inches (5.1 cm), inside measure; however, black sea bass traps constructed of wooden laths instead may have escape vents constructed by leaving spaces of at least 1.375 inches (3.49 cm) between two sets of laths in the parlor portion of the trap. These dimensions for escape vents and lath spacing may be adjusted pursuant to the procedures in § 648.140.

- Black sea bass traps or pots must contain a ghost panel affixed to the trap or pot with degradable fasteners and hinges. The opening to be covered by the ghost panel must measure at least 3.0 inches (7.62 cm) by 6.0 inches (15.24 cm). The ghost panel must be affixed to the pot or trap with hinges and fasteners made of one of the following degradable materials: Untreated hemp, jute, or cotton string of 3/16 inches (4.8 mm) diameter or smaller; or Magnesium alloy, timed float releases (pop-up devices) or similar magnesium alloy fasteners; or ungalvanized or uncoated iron wire of 0.094 inches (2.4 mm) diameter or smaller.

  The use of a single non-degradable retention device designed to prevent loss of the ghost panel after the degradable materials have failed is permitted, provided the device does not impair the egress design function of the ghost panel by obstructing the opening or by preventing the panel from opening at such time that the degradable fasteners have completely deteriorated.

  [76 FR 60637, Sept. 29, 2011, as amended at 79 FR 52583, Sept. 4, 2014; 84 FR 65705, Nov. 29, 2019]

Or

An unobstructed escape vent opening on at least two opposite sides excluding top and bottom (1 1/8 by 5 3/4 inches for a rectangular vent, 1 3/4 by 1 3/4 inches for a square vent, or 2.0-inch diameter for a round vent. Degradable material includes: Wire mesh will consist of ungalvanized

or uncoated iron wire not to exceed 0.041 inches (19 gauge wire), or galvanic time-release mechanism with a letter grade designation (degradability index) no higher than J.

And,

- All buoys will be attached to buoy line with a weak link (weak link breaking strength requirement varies by area fished and season; Table 1).
- Weak links must be chosen from the list of NMFS approved gear, which includes off the shelf weak links, rope of appropriate breaking strength, hog rings, and other materials or devices approved in writing.
- Weak links must be designed in such a way that the bitter end of the buoy line is clean and free of any knots when the weak link breaks.
- Southeast Restricted Area North - South Carolina and Georgia state waters Blue & Orange Weak Link <600lbs Breaking Strength<2200 Nov 15-April 15 Purple Line Not Required.
- The letters and numbers to mark gear must be at least 1 inch (2.5 cm) in height, block letters or Arabic numbers, in a color that contrasts with the color of the buoy.
- Buoy lines will be marked with three 12-inch colored marks - one at the top, one midway, and one at the bottom of the buoy line with appropriate marking color based on area and season (Table 1).
- If the mark consists of two colors, each color mark may be 6-inches for a total mark of 12-inches.
- Each color code must be permanently affixed on or along the line and each color code must be clearly visible when the gear is hauled or removed from the water.
- New Line Marking Regulation: A rule for requiring an additional purple mark on the line will become effective January 30, 2017. Requirements include three additional 12-inch purple marks - one at the top, one midway, and one at the bottom of the buoy line. The additional markings are effective for the following seasons and areas: • November 15 – April 15 in the Southeast Restricted Area North; • September 1 – May 31 in the Offshore Trap/Pot Area; and • September 1 – May 31 in the Southern Nearshore Trap/Pot Waters Area. Line marking is not required outside of the seasons listed in Table 1. However, if a fishermen switches between areas, they must follow the markings for that area and season.

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