Positively Buoyant Ground Cables and Sweep to Reduce Seabed Contact and Enhance Species Selectivity

Final Report to the Northeast Consortium

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Abstract:
Bycatch reduction, and the minimization of benthic impacts continue to be important issues relative to Gulf of Maine fisheries. The project described below was an attempt to redesign the ground gear of a bottom trawl in a configuration that would minimize both bycatch and benthic impact. We hoped to be effective in keeping legal sized cod and haddock, while allowing flatfishes, and undersized roundfish to escape. Difficulties were encountered in weighting the gear sufficiently to achieve the bottom contact necessary to retain a credible catch, but the PI's were successful in securing funding for a follow-up study, to be conducted in 2006.

Introduction:
The improvement of trawl selectivity is a long-standing goal, for fishermen, scientists, conservationists and resource managers alike. Improved selectivity in bottom trawls regularly appears as a high priority for agencies such as the Northeast Consortium and the New England Fisheries Management Council, and is highlighted in such regulations and policies as the Sustainable Fisheries Act and Amendment 13 to the New England Groundfish Plan. Related to improved selectivity is the goal of reduced benthic impact, stemming principally from the passage of the trawl doors, ground gear, and trawl sweep.

Fortunately, we have better tools with which to modify fishing gear and to catch the species we desire, beginning with fish behavior. The investigations into fish behavior that began with Dr. Clem Wardle in Aberdeen, Scotland in the 1970's and 1980's are recognized as key to designing trawls that catch the target species with a minimum of bycatch and discards. Thus, the 'back flip' of tiring flatfish, the moderately high turn of codfish and the 'shooting' behavior of haddock have become fairly well known and documented, and have had great impact on how trawls are designed in modern times

The project described in this report was the result of a desire to increase the selectivity of trawls being used in the mixed groundfish fishery of coastal Maine, and the hope of limiting bottom contact by the trawl and ground gear. It is a delicate balance, since the gear has effect on the behaviors. However, off-bottom and high-rise nets have been used in certain applications, such as for whiting (*Merluccius bilinearis*) in Massachusetts (Sheppard et al, 2004; Carr and Caruso 1993), for haddock and pollack in the Gulf of Maine (He, 2005) for 'sensitive' or 'non-pressure' stocks in the UK (Arkley, 2003) or to capture squid and butterfish (Goudey, 1987). Such works as these have focused on the equipment from the wing ends and back. Investigations into the lines that run between the doors and the wing ends specifically – usually termed 'ground gear' - are less abundant, but not necessarily scarce (Main and Sangster, 1983; Morse and Daley 1999, Walsh, 1989). We therefore had a frame of reference from which to begin.

With that in mind, the goals of the project were:

Project Objectives:
1. To reduce seabed contact while trawling, including the net and the ground gear.
2. To separate out fish species, by using their instinctive responses to fishing gear, both before encountering the net and while entering it.
3. To reduce stresses imposed on non-target species by allowing them to pass under the ground gear and net.
4. To document fish behavior in the presence of standard and experimental ground gear and net; fish behavior in the mouth of the nets; and the effects of standard and experimental gear on the sea floor.
5. To distribute the results of the project of fisheries managers, fishermen and those people concerned with the effects of trawling on the seafloor, and with essential fish habitat.

Specific targets included being able to capture haddock without capturing cod, and being able to capture cod and haddock without the capture of flounders. These examples are recognized current and pressing needs by scientists and managers.

The original approach was to construct a net frame for a groundfish trawl that would be positively buoyant everywhere except the wing ends of the net. This would be combined with buoyant ground gear, so that there would be very little bottom contact, from the doors and aft. Some potential for success, and description of fish behavior had been found in the whiting fishery in southern New England (Morse and Daley, 1999), and it seemed a good place to build on.

Methods, Materials and Project Participants:
Description of the nets:
Two trawls were built by Kelo Pinkham. The net bodies were identical, and used 6.0" mesh, 3mm polyethylene twine throughout, and a traditional 6.5" codend, 50 meshes around by 50 meshes deep, of doubled 4mm polyethylene. Both nets carried 13 eight-inch floats on the headrope, to equal an approximate buoyancy of 86 lbs. Headrope and footrope lengths on both nets were 53' and 70' respectively.

Behind each trawl door was 20 fathoms of 1/2" wire, covered by 2.5" rubber cookies. Aft of the ground line, we tested two sets of ground gear. The <u>standard</u> ground gear consisted of 20 fathoms of 7/16' bare steel wire in the upper leg, with the lower leg the same length and material, but covered by 2.5" rubber cookies. The <u>buoyant</u> set of ground gear consisted of the same upper leg as the standard set. The lower leg had identical wire and rubber cookies, but also included 14 8-inch trawl floats, strung directly on the wire. Each float was immediately preceded and followed by an 8" rubber disk, as protection.

As a development project this effort emphasized exploration, rather than a rigorous testing of a specific gear. When the initial trials were not up to expectations, we re-rigged the experimental trawl and tried again. Consequently, five different configurations of the experimental net were tried, and are described below. These different rigs were used in conjunction with both the standard and buoyant ground gear.

As the field trials of the experimental gear were carried out, it was evident that the net was too high off bottom; catches of most species were at or near zero. Consequently, increasing amounts of weight were added to the net, and in varying spots along the wing ends and footrope. Details of these different arrangements ('Rigs' 1 through 5) are as follows:

Rig #1:
Forty-two pounds of weight were attached to each wing end, in the form of large single links of anchor chain. Buoyant ground gear was used.

Rig #2:
Rig #2 was a catchall comprised by three tows, each of which had different amounts of weight. Tow #1 included 35 lbs of chain hung 1 foot below the sweep in the bosum section, in combination with the anchor chain on the wing ends. Tow #2 included the wing end weights, and two sections of chain along the net quarters, 23 pounds each. Tow #3 included the wing end weights, 35 pounds of chain at each quarter, and 30 pounds of chain at the center of the footrope. Buoyant ground gear was used for each tow.

Rigs #3 and #4:
Both trials used the same amount of weight – 117 pounds chain to offset the headrope floats, and 35 pounds of chain on each wing end. Rig #3 was fished with the standard ground gear, while Rig #4 was fished with the buoyant ground gear.

Rig #5.
This rig was fished with the standard ground gear exclusively, and employed weight in the following arrangement: 35 pounds of chain at each wing end, a 42 pound link of chain at each quarter, a 25 pound can of cement (15 lbs. in water) 3 ft. on each side of the footrope center. Total weight in water of the weight added was 184 lbs.

Fishing dates, location, approach:
Due to space limitations aboard the F/V Jeannie C, only one net (experimental or control) was fished per day. The region south of Boothbay Maine, known as The Kettles, was chosen for the fishing site because of the mix of fish that occurs there, and because of its proximity to our home port of Boothbay Harbor.

A variety of standard data were collected during each tow, including: tow start and stop time, date, depth (fathoms), amount of trawl warp deployed (fathoms), towing speed, start and stop location.

Fishing dates in 2004 for the various rigs were as follows:
Control: May 26, May 31, June 29, July 17, July 20
Rig #1: May 30
Rig #2: June 18
Rig #3: June 28

Rig #4: June 28
Rig #5: July 18, July 21

Catch sampling and data recording:
Upon landing to the deck, the catch was sorted by species. Species of principal interest included cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), plaice (*Hippoglossoides platessoides*) and grey sole (*Glyptocephalus cynoglossus*). For these species, individuals were sorted to legal-size and sub-legal groups. During this sorting, length frequencies (Total Length) were recorded, to the nearest centimeter, on a standard plastic strip. Once this sorting was complete, catch weights were taken, via a digital scale (Northern Industrial Tools 300 lb. Remote Display Scale, www.northerntools.com).

Data:
This project was investigative, as opposed to a strict test of a control vs. an experimental net. We therefore followed a fishing approach that allowed us to follow our observations and instincts, and supported that approach with catch data. Thus, data are presented more or less in summary.

Results:
Trawl construction and fishing
Our biggest challenge in this project was to add enough weight to the trawl. We matched our observations about the catches (bordering on zero in Rigs 1 and 2) with the observations of the gear as it came aboard (presence of mud, shine on metal components, etc), to evaluate the degree to which the trawl was on the bottom. There is some minimum of bottom contact necessary to retain any catch, and early trials were exceeding that minimum. No extraordinary difficulty was encountered in the actual setting, fishing and retrieval of the nets and ground gear, though the weights attached to the sweeps required caution by those on deck.

Catches:
Catch weight information was converted to Catch Per Unit Effort (CPUE) and given in pounds/hr; a summary of the catch weights is shown in Table 1, together with mean tow times, and standard deviations. Tows within rigs were very stable, though rigs 3 and 4 were half the duration of the other rigs and the control.

Table 1.Summary of catch rates for all species caught, in pounds per hour.

	Control	Rig #1	Rig #2	Rig #3	Rig #4	Rig #5
# Tows	20 Tows	3 tows	3 tows	3 tows	3 tows	9 tows
Total towing time (hr)	38.2	6.0	6.0	3.0	3.0	18.0
Mean tow time (min)	114.6	120.3	120.0	60.0	60.0	120.0
Tow time std. dev.	14.0	0.6	0.0	0.0	0.0	0.0
	CPUE	CPUE	CPUE	CPUE	CPUE	CPUE
	(lbs/hr)	(lbs/hr)	(lbs/hr)	(lbs/hr)	(lbs/hr)	(lbs/hr)
Cod-Small	2.1	0.0	0.0	0.5	0.8	0.2
Cod-Legal	46.8	0.0	2.3	18.7	101.5	7.4
Haddock-Small	0.1	0.0	0.0	1.7	0.7	0.2
Haddock-Legal	17.1	0.0	4.0	62.8	53.0	6.2
Dabs-Small	1.2	0.0	0.0	1.8	0.3	0.1
Dabs-Legal	9.1	0.0	0.5	8.2	1.2	0.3
Grey Sole-Small	0.2	0.0	0.0	0.0	0.0	0.0
Grey Sole-Legal	2.8	0.0	0.0	1.7	1.3	0.1
Pollock-Small	0.0	0.0	0.0	0.0	0.0	0.0
Pollock-Legal	0.6	0.0	0.0	0.0	3.2	0.8
Monkfish	50.1	0.0	0.0	14.7	1.7	1.0
Lobster	2.8	0.0	0.0	0.5	2.0	0.1
Crab	0.3	0.0	0.0	0.7	0.2	0.0
Skate	31.3	0.0	0.0	26.0	6.7	0.1
Halibut	0.0	0.0	0.0	0.0	0.0	0.0
Whiting	0.0	0.0	0.0	0.0	0.0	0.9
Hake sp.	2.7	0.0	0.0	0.0	0.0	3.2
Sea Robin	0.0	0.0	0.0	0.0	0.0	0.0
Sculpin	0.0	0.0	0.0	0.0	0.0	0.0
Redfish	0.4	0.0	0.0	1.3	9.0	1.6
Herring	8.1	0.0	0.8	0.0	0.0	0.0
Dogfish	39.5	0.8	6.3	48.0	0.0	29.2
Eelpout	2.0	0.0	0.0	0.0	0.0	0.0
Lumpfish	0.0	0.0	1.2	0.0	0.0	0.0

Length Frequencies:
Length frequency data are summarized for the species of principal interest, including cod, haddock, plaice, and grey sole. While it is often the practice to convert numbers of fish per given size interval to a percentage of the total catch (by size interval), we present our

findings in the former arrangement rather than the latter, principally because of the low catch numbers.

Figure 1
Length frequencies for Cod, over all nets tried.

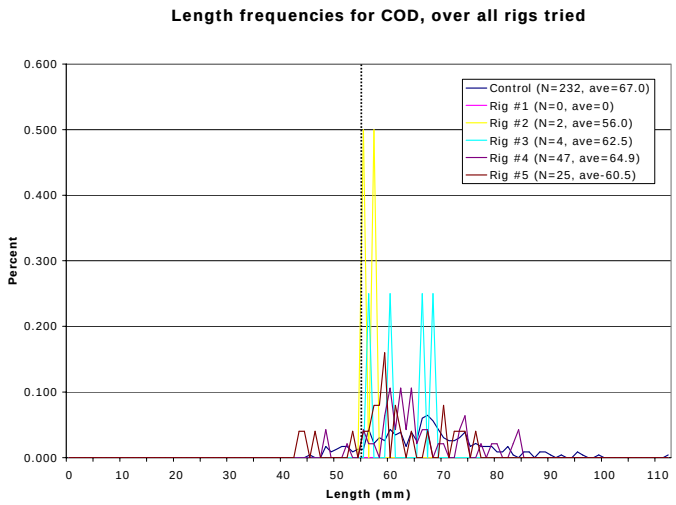


Figure 2
Length Frequencies for Haddock, over all nets tried.

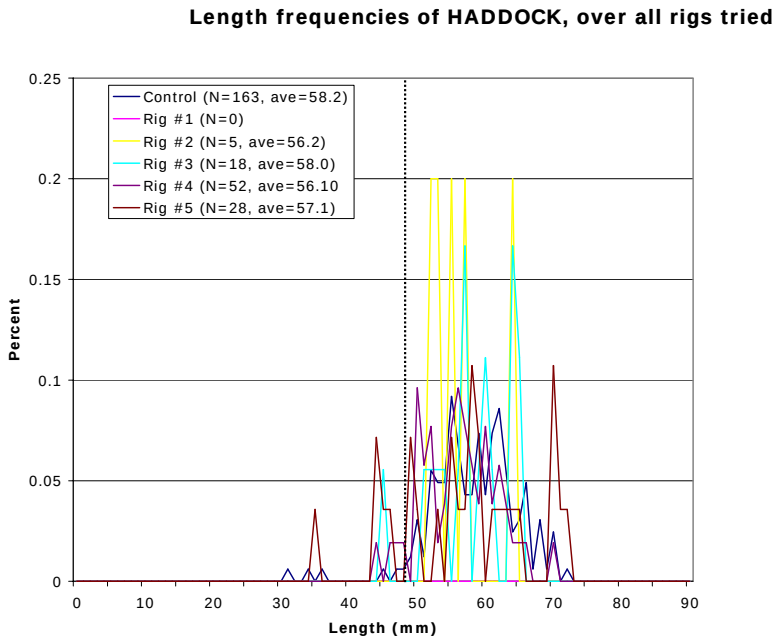


Figure 3
Length Frequencies for American Plaice, over all nets tried

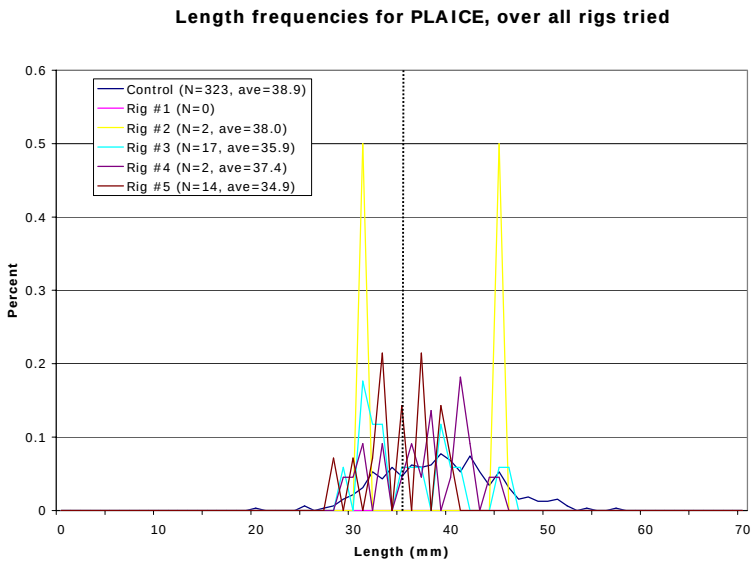
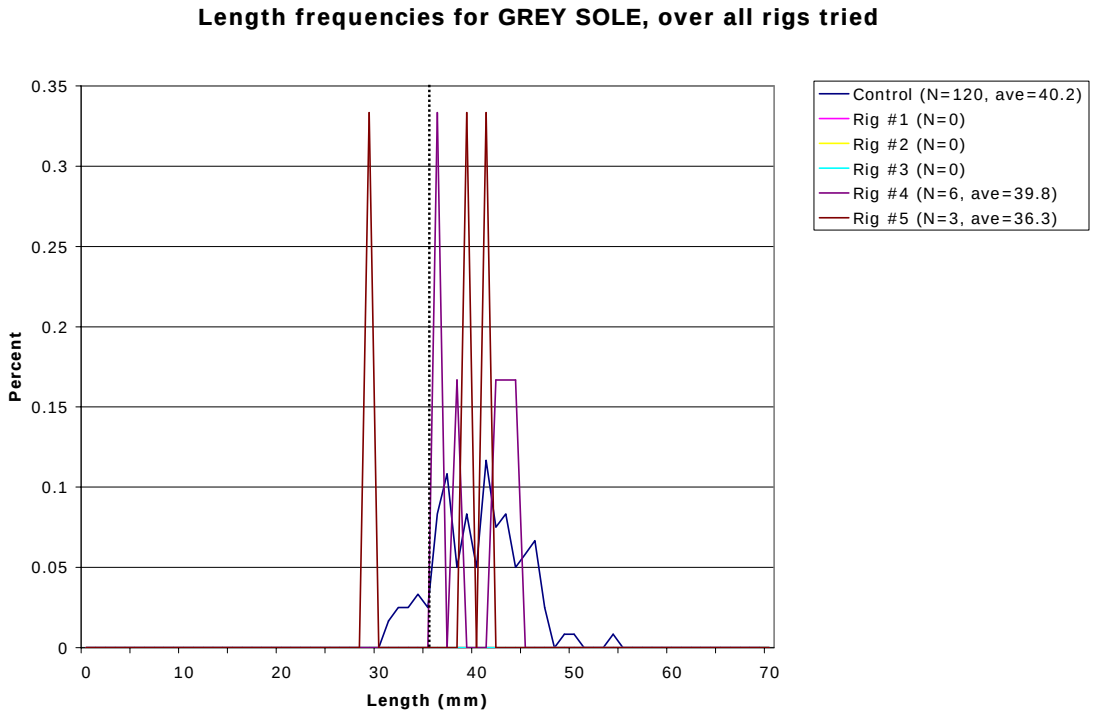


Figure 4.
Length Frequencies for Grey Sole, over all nets tried.



Discussion:
Though disappointing, the PI's feel that it is yet possible and feasible to achieve the complementary goals of reducing bycatch and bottom contact simultaneously. It is clear that all experimental rigs tried were ineffective at retaining sufficient quantities of marketable fish to be considered feasible by industry members.

The task of modifying gear to limit bottom contact while maintaining sufficient catch rates has been addressed in other fisheries, a fact that has kept the PI's hopeful of an eventual solution. For example, the fishery for whiting in Massachusetts waters mandates a series of trawl configurations such as: sweep type and length, drop chain length and number, number and type of headrope floats, aimed at reducing bycatch (http://www.mass.gov/dfwele/dmf/commercialfishing/322cmr8.htm#8.14). However, these modifications have allowed fishermen to continue their activities, and with a level of harvest that makes it worthwhile financially.

With the results of the project being what they were, the PI's decided to 'go back to the drawing board.' Specifically, Capt. Pinkham has submitted a proposal to the NEC, that included funds to build a model of the proposed trawl gear, by the personnel at the Marine Institute of Memorial University in Newfoundland. This proposal was subsequently funded. Thus, we will again examine, from a more tractable modeling perspective, the effects of lightening the ground gear and trawl on the bottom contact by the net. Results from the tow tank will be incorporated into fieldwork, to begin in late spring/early summer of 2006.

It will be important during the upcoming fieldwork to obtain as much useful video data as possible. Improving fishing gear is an iterative process, and direct observation of fish behavior in relation to the trawl will increase speed and precision during the project.

Partnerships:
The principal partnerships utilized in this project were between the PI's. We have worked together in previous work, and have continued this beneficial relationship. In addition, contact has been renewed with members of the Flume Tank at the Marine Institute of Memorial University in Newfoundland (MI MUN). Recently, the NEC has agreed to fund a follow-on study of off bottom ground gear, and we plan to work with MI MUN on modeling, prior to building the next full scale prototype.

Impacts and applications:
Because of the low catches in the present project, we cannot say with certainty that this effort will have appreciable impact in the short term. However, it is likely that pending advances in the next approach, we could have a strong impact by reducing landing of species of concern, such as yellowtail flounder and cod. The concept of off-bottom trawling for the purpose of limiting bottom damage is also an important one, and

advances in this arena will be important, especially if they can be accomplished without compromising commercial catches.

Related Projects, and Future Research:
Please see above, for work funded by the NEC, and to begin in 2006.

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