A Study of the Underwater Profiles of Lobster Trawl Ground Lines

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Commonwealth of Massachusetts
Executive Office of Environmental Affairs
Robert Durand, Secretary

Department of Fisheries, Wildlife and
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David M. Peters, Commissioner

Division of Marine Fisheries
Paul J. Diodati, Director

Abstract: Massachusetts Division of Marine Fisheries (DMF) contracted a commercial lobsterman to deploy 5-pot lobster trawls in coastal waters to allow DMF SCUBA divers to measure the profile in the water column of the lines attached to - and connecting - the traps. Three different neutrally buoyant lines were observed as well as a floating line and a sinking line. Laboratory testing and underwater monitoring showed that neutrally buoyant lines have a much lower vertical profile than floating line and are similar in performance to sinking line. All three neutrally buoyant lines were negatively buoyant and were observed in contact with the sea floor. Independent laboratory testing of these lines bore this out with the specific gravities measuring greater than that of seawater. The deployment of trawls with all floating line also yielded useful measurements of the maximum heights achieved by floating groundline. Average heights within each trawl rigged with floating line were, 8-, 16-, and 18-feet. Replacement of floating line with negatively buoyant line will reduce the probability of whale entanglements.

I. Background. The Massachusetts Division of Marine Fisheries since 1997 has aggressively regulated fixed gear fisheries in Cape Cod Bay Critical Habitat during winter and early spring months when right whales are expected to be present. Since that time, lobstermen setting gear in the Critical Habitat area during winter and early spring have been subjected to state and federal gear restrictions to minimize risk of whale entanglement in their gear.

Two primary components of lobster gear pose a risk of entanglement: buoy lines that connect the set of pots to a buoy at the surface, and the "groundline" (or "mainline") to which each pot is attached with a short piece of line known as a "gangion". Only sinking groundline has been permitted by Massachusetts and federal regulation since 1997 for lobstermen fishing in Critical Habitat from the beginning of January through mid-May. As a result of DMF's adoption of the settlement agreement to end the *Strahan v. Durand* litigation filed in federal court in January 2001, new Massachusetts regulations will prohibit the use of floating groundline <u>year-round</u> beginning in January 2003 in Cape Cod Bay Critical Habitat. In 2004, this restriction will be extended to all waters west of the Critical Habitat in Cape Cod Bay south of 42 degrees 5 minutes (Figure 1). This area includes fishing grounds along the Plymouth, Kingston, and Duxbury shorelines.

The lobster industry prefers to use groundlines that float for several reasons. Floating line, typically comprised of polypropylene, is less expensive than sinking line, typically comprised of nylon. When fished over uneven and hard substrate, floating line is less subject to abrasion and to parting, thus reducing gear losses. When buoy lines that mark the ends of the trawls are cut off, floating groundlines allow fishermen to more easily retrieve trawls by towing a grapnel hook perpendicular to the trawl hoping to hook onto the trawl mainline. Finally, floating line can be used as a visual target for depth sounders when searching for lost pot-trawls with lost buoy lines. Most electronic sounders are capable of displaying a floating arc of line above the substrate.

DMF observations in 1997 using a remote operated vehicle (ROV) demonstrated that use of floating lines for groundlines produced arcs of line between traps that were 10- to 18-feet above the substrate. This elevation was higher than previously believed (Appendix 1- Report by DMF's H.A. Carr to NMFS). DMF’s position is that the most effective strategy to reduce entanglement is to lower the profiles of groundlines by prohibiting the use of floating line in that portion of the gear.

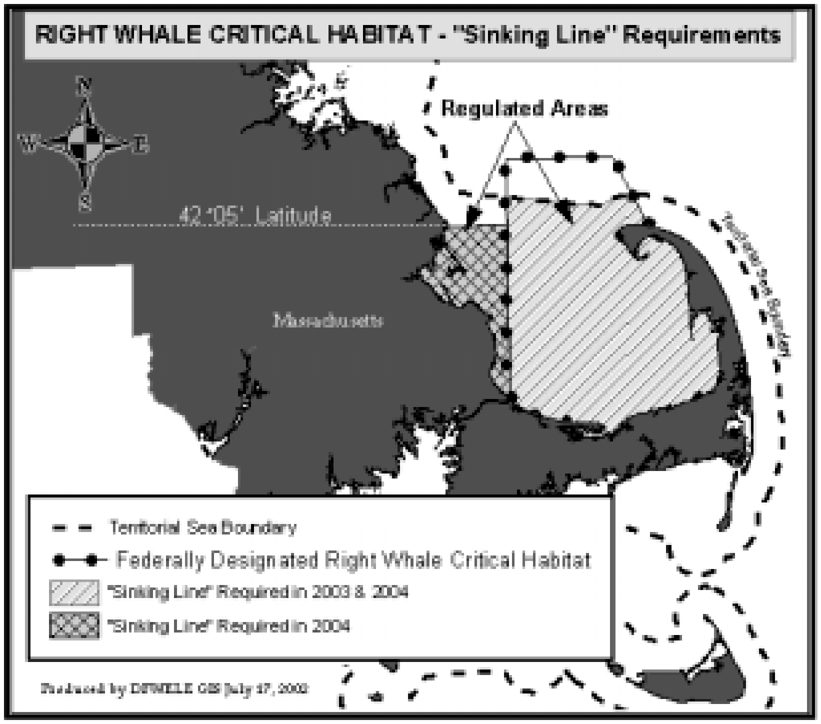

Figure 1. Map depicting groundline requirements in Cape Cod Bay effective January 2003 and beyond.

Several cordage companies now manufacture a new line type, marketed as “neutrally buoyant” line. Neutral buoyancy (in theory) allows the line to remain closer to the ocean floor than floating line (reducing vertical profile) while minimizing bottom contact and consequent abrasion (avoiding risk of gear loss). NMFS and DMF personnel distributed spools of this line to fishermen for testing under field conditions during 2000 and 2001. Reports from Massachusetts fishermen collected by DMF and forwarded to NMFS Fisheries Engineering were mostly favorable.

To further promote the use of neutrally buoyant line, NMFS Fisheries Engineering Program staff, working with Maine lobstermen, produced video footage of lobster gear rigged with various groundline types including neutrally buoyant line. This video has been instrumental in convincing some fishermen about the risk posed by floating line and the potential for neutrally buoyant line to become a viable alternative groundline.

II. Statement of the Problem. The field use of neutrally buoyant line and the NMFS video were seen as progress toward adoption of this line by the lobster industry. However, DMF noted that elevations of "typical" lobster trawl groundlines underwater were inadequately documented. More precise data were needed to demonstrate the reduction in entanglement risk and the practicality of replacing floating groundlines (including mainlines and gangions) with non-floating lines. Also, comparisons among various "neutrally buoyant" line products were needed to measure the variability of performance in the laboratory and in the field. Finally, DMF and other state agencies sought high quality underwater photos and film as part of the ongoing outreach program to overcome resistance to the further restriction on use of floating groundlines.

III. Study objective. To measure the profile and document the utility of various configurations of floating, sinking and neutrally buoyant lobster trawl groundlines.

IV. Methods.

A. Field Study of *in situ* lobster trawls. DMF contracted a local lobsterman to rig, set, and fish various 5-pot lobster trawl configurations. A lobster trawl is defined as a multiple set of traps attached in series by a single line. Fishing locations were chosen by the lobsterman within a single site in southwestern Cape Cod Bay. The site was within 1/2 mile of the east end of the Cape Cod Canal in depths of 30 to 50 ft.

The only variation among the gear configurations was the line type used in the ground lines and gangions. Lobster pot dimensions and characteristics, as well as setting protocols were identical. Buoy lines were comprised entirely of sinking line, and where possible the condition of the lower half of the buoy lines was documented. If the line was wrapped around the trap or other obstruction on the ocean floor (e.g. boulders), that condition was noted.

DMF provided three different neutrally buoyant lines to the contracted fisherman: Everson (7/16 in diam); Anacko (3/8 in diam); Poly-steel Atlantic (3/8 in diam). The contracted fisherman rigged all gear per DMF specifications and set the gear at times and locations as specified by DMF. The contractor was required to maintain gear at locations specified and not move the gear without permission from DMF. The contractor was required to occasionally maintain the gear by hauling and re-setting to ensure the gear was properly functioning. The contractor was encouraged to actively fish the traps at the prescribed locations and was allowed to retain all lobsters that met Massachusetts' regulations. The contractor was responsible for removing the gear from the water after the completion of the study and was allowed to keep all lines used in the study. DMF used its own vessels as diving platforms to perform the underwater work.

The first trial used five trawls and focused primarily on a comparison among the three neutrally buoyant line types to measure the variation among manufacturers (Trawls A, B, and C). Two additional trawls were fished for contrast: a trawl rigged with all sinking groundlines (both the mainline and the gangions - Trawl D) and a trawl rigged with all floating groundlines (mainline, Crowe 3/8”; gangion, Crowe 5/16” - Trawl E). This trial was conducted over smooth substrate.

The second trial was designed to determine if various gangion line types (floating vs. neutral line) would result in changes in mainline elevation. For visual presentation, this trial was replicated in two habitats: cobble, and boulder bottom habitats . Each of these replicates included trawls rigged with all floating groundline (Trawls H & K). Unlike the previous trial involving three neutral line products, this second trial used just one neutral line product type: Everson 7/16" line. Trawls F & I consisted of floating groundlines and floating gangions. Trawls G & J were made of neutral groundlines and floating gangions.

Trawl descriptions for each trial were:

Trial #1 - Set on smooth bottom:

Trawls A, B and C: Three different *neutrally* buoyant groundlines with *neutrally* buoyant gangions.
Trawl D: *Sinking* line groundlines with *sinking* gangions.
Trawl E: *Floating* line groundlines with *floating* gangions.

Trial #2A - Set on cobble bottom:

Trawl F: *Neutral* groundlines with *neutral* gangion.
Trawl G: *Neutral* groundlines with *floating* gangion.
Trawl H: *Floating* groundlines with *floating* gangion.

Trial #2B - Set on boulder bottom:

Trawl I: *Neutral* groundlines with *neutral* gangion.
Trawl J: *Neutral* groundlines with *floating* gangion.
Trawl K: *Floating* groundlines with *floating* gangion.

Two DMF SCUBA divers worked together to document line profiles. During the trials the methodology of underwater measurements varied. During the first trial, the first diver measured and recorded the line heights at the mid-point between traps along the mainline with a 10-ft. PVC pipe marked at one foot intervals with permanent marker. Values were recorded on an underwater writing slate. The second diver was independent of the first and swam along the trawls and filmed the line along the ocean floor. In the second trial, the two divers worked in tandem with diver #1 holding the metered PVC pipe behind the groundlines to allow diver #2 to film both the line and the meter stick held by the diver (Figure 2). In those instances when groundline height exceeded the limits of the 10-ft. marked pipe, the diver estimated the distance from the top of the pipe to the line (Figures 2, 3, and 4). DMF staff viewing the video images visually corroborated these estimates.

Equipment: The following equipment was purchased to conduct the study:

- (2) Aeris Diver Propulsion Vehicles - the scooters were used to move between trawls, greatly increasing the efficiency of the divers.
- Sony DCR VX2000 Digital Video Camera - broadcast quality digital video camera with still photo capability.
- Light & Motion Bluefin Housing with Lights and Wide-angle lens - Professional video housing designed specifically for the DCR VX2000 camera. Special wide-angle lens provides 100 degree field-of-view, allowing close focus in poor visibility.
- Dry suits to minimize diver exposure to cold water during winter months.
- Communication equipment: Diver to diver and diver to surface communication equipment included an OTS Surface Communication Station and Divator Full Face Mask with Buddy Phones.

- PVC Pipes custom marked in 1 ft. increments

B. Laboratory Specific Gravity Tests. Northwest Laboratories of Seattle verified the buoyancy characteristics of all lines used in the study (Appendix 2).

V. Results

Specific Gravity Tests. Northwest Laboratories of Seattle performed measurements on three different lines sold as neutrally buoyant line, two sold as floating line, and one sold as sinking line (Appendix 2). The specific gravity results are presented below:

Table 1. Results of specific gravity tests on the study groundlines by Northwest Laboratories of Seattle.

Product	Type	Apparent Specific Gravity
Everson Co. 7/16”	Neutral	1.056
Anacko 3/8”	Neutral	1.064
Poly-steel Atlantic 3/8”	Neutral	1.055
Hy-Line 7/16”	Sink	1.167
Crowe 3/8” (mainline only)	Floating	0.880
Crowe 5/16” (gangion only)	Floating	0.890

The apparent specific gravity is an estimate of the specific gravity of the line itself, not including anything filling spaces between threads of the line (such as air). The experimental results should be compared to a sea water specific gravity of 1.023. Lines with values less than 1.023 float; those above 1.023 sink. The values for the three neutral lines are close to those of seawater at 15ºC. In colder, deeper water, the specific gravity of seawater is slightly higher than 1.023.

B. Groundline Profile Measurements. Gear was set by the contractor during October 2001 and fished regularly. The gear was filmed on December 28, 2001, January 4 and 24, 2002.

<u>Trial #1: Comparison among three neutral line products used in the groundlines with contrasting sinking line and floating line trawls</u>. All three neutral buoyant line products performed similarly with groundlines observed in contact with the substrate or within inches of the bottom (Table 2, Figures 5 and 6). Video footage showed the sinking line (Hy-line 7/16") groundline appeared to be in more continuous contact with the substrate than the three "neutral" line types.

The trawl rigged with all floating groundlines was found wrapped around a large metal object (gallows frame), and the contracted fisherman was unable to haul the gear to the surface. This trawl was under heavy strain and not in a “natural configuration.” The lines between the first four pots were pulled extremely taut and measured just 2 - 2.5 feet off bottom, much lower than expected. However, the line between the fourth and fifth traps was slack because these traps had shifted closer together allowing the line to arch up into the water column approximately 25 feet. The contracted fisherman suspected a scalloper inadvertently dragged the gear into this position.

<u>Trial #2: Comparison of the effect of neutral line gangions vs. floating line gangions on trawls rigged with all neutral groundline, and a trawl rigged with all floating line set as contrast.</u> This trial was conducted in two habitats: cobble and boulder bottom (Tables 3A and 3B). During the two trials there

was only a one-inch difference between the trawls rigged with the neutral vs. floating gangions. On the cobble substrate the average maximum mainline height was 2-inches for the trawl with floating line gangions (Trawl F) and 3-inches for the trawl with neutral gangions (Trawl G). On the boulder substrate the result was similar: the average maximum mainline height was 5-inches for the trawl with floating line gangions (Trawl I) and 4-inches for the trawl with neutral gangions (Trawl J).

The two trawls rigged with all floating groundlines (Trawls H and K in Tables 3A and 3B) demonstrated similar profiles. These two trawls featured elevated mainlines that were no lower than 4 – 5 feet above the ocean floor. The arcs created by the floating line between gangions rose to an average of 18.5 and 16.3 feet for the two trawls, respectively.

VI. Discussion and Conclusions. Floating, neutral, and sinking groundlines used in the inshore lobster fishery were demonstrated to behave differently underwater. Neutral line produced by three different manufacturers showed no difference among the profiles observed in the field. These observations are verified by their specific gravities (1.055, 1.056, and 1.064) as calculated in the laboratory. The specific gravity of the sinking line (1.167), as measured by the contracted laboratory was substantially above that of the neutral lines while both floating lines measured lighter than sea water (0.880 and 0.890) as expected.

Neutrally buoyant lines were observed in contact with the substrate or within inches of the bottom, while sinking line appeared to be in more continuous contact with the substrate and was never measured above the bottom. The neutral line products appear to afford the same protection to whales as sinking lines based on their similar low profiles.

For trawls rigged with neutral line mainlines, no increase in the mainline elevation was seen to be caused by deploying floating line gangions (Figure 6). Some fishermen had suggested that floating line gangions might serve to buoy the neutrally buoyant mainlines. We did not observe any effect caused by the use of floating line gangions.

The floating line trawls set for contrast purposes serve as a vivid example of the threat of entanglement posed by arcs of floating groundlines in the water column. The line-drawing image produced for this report by state graphic artist David Gabriel (Figure 7) provides a much different but more accurate profile than those portrayed in a schematic drawing from a previous study by Wiley et al. (1997) (Figure 8). That previous study featured the groundline appearing as a near "bell-shaped curve" between traps, with the line in contact with the substrate near each trap. In contrast, we observed the mainline continuously elevated above the substrate. The minimum height of the mainline was at the vertical gangion connection between the bridle and the mainline. The maximum height was usually at the midpoint between gangions and averaged approximately 16 feet above the substrate.

In summary, both laboratory-testing and field-testing demonstrated that neutrally buoyant line is actually negatively buoyant. Neutrally buoyant lines rigged with lobster gear featured low vertical profiles, remaining at or within inches of the bottom regardless of substrate. Use of floating line gangions did not noticeably alter the profile of the neutrally buoyant mainline. However, the one line product marketed as "sinking line" (Hy-Line 3/8") did have a higher specific gravity than the neutrally line products, and this line was observed to be in more continuous contact with the substrate.

Floating line was observed to be very high off the bottom, between 4.5 to 25 feet. The line quickly rose in height from the gangion to form a uniform height between gangions, as opposed to the gradual bell shape often depicted. Sinking line was always observed to be on the bottom.

Neutrally buoyant line offers an effective alternative to sinking line, and may be less subject to wear and parting due to its slight elevation and less contiguous contact with the bottom. This information, combined with images of the line underwater, fishermen’s experience with the product, and the dramatically high profile of the floating line, will provide substantial encouragement for industry members to accept the future restrictions on this gear.

VII. Acknowledgements. We acknowledge the following for their contributions to this project: Commercial lobsterman Gary Ostrom for his work rigging, setting, and maintaining the gear; DMF field biologists and SCUBA divers Bob Glenn, Terry O'Neil, Paul Caruso, Neil Churchill and Matt Camisa for their efforts on and in the water; DMF Fishery Supervisor Vin Manfredi for his video editing work; Program Coordinator Melanie Griffin provided editorial assistance; State graphic artist David Gabriel provided artwork for the report. Scott Landry of the Center for Coastal Studies provided components of the line drawing depicting the floating line arcs.

National Marine Fisheries Service supported this research through its funding of DMF's Right Whale Conservation Program. Support came from the Protected Species Branch at the Regional Office in Gloucester, in close consultation with John Kenney and Glenn Salvador of the NMFS Fisheries Engineering Program.

TABLE 2: Results from Groundline & Gangion Arrangements for Five Trawls set on Sand and Cobble Substrate					
TRAWL	**A**	**B**	**C**	**D**	**E**
Mainline Diameter	7/16 "	3/8 "	3/8 "	3/8 "	3/8 "
Manufacturer	Everson	Anacko	Poly-steel Atlantic	Hy-Line	Crowe Rope
Mainline Buoyancy Properties	Neutral	Neutral	Neutral	Sinking	Floating
Gangion Diameter	7/16 "	3/8 "	3/8 "	3/8 "	3/8 "
Gangion Buoyancy Properties	Neutral	Neutral	Neutral	Sinking	Floating
Maximum Gangion Elevations					
Average Maximum Gangion Elevation	*Not Measured*	*Not Measured*	*Not Measured*	*Not Measured*	*Not Measured*
Maximum Mainline Elevations Between Gangions	0",0",2",4"	0",2",4",1"	0",0"	0",0",0",0"	2',2',2',25'
			(2 traps missing)		
Average Maximum Mainline Elevation	*2 inches*	*2 inches*	*0 inches*	*0 inches*	*7.8 feet (93 inches)*

TABLE 3A: Results from Groundline & Gangion Arrangements for Three Trawls set on Cobble Substrate			
TRAWL	**F**	**G**	**H**
Mainline Diameter	7/16 "	7/16 "	3/8 "
Manufacturer	Everson	Everson	Crowe Rope
Mainline Buoyancy Properties	Neutral	Neutral	Floating
Gangion Diameter	7/16 "	7/16 "	7/16 "
Gangion Buoyancy Properties	Neutral	Floating	Floating
Maximum Gangion Elevations	2",1",2",4"	1',2',1.5',1'	5',4',4',4.5'
Average Maximum Gangion Elevation	*2 inches*	*1.4 feet*	*4.4 feet*
Maximum Mainline Elevations Between Gangions	8",3",0",0"	3",2",2",2"	14',20',14',26'
Average Maximum Mainline Elevation	*3 inches*	*2 inches*	*18.5 feet (222 inches)*

TABLE 3B: Results from Groundline & Gangion Arrangements for Three Trawls set on Boulder Substrate			
TRAWL DESIGNATION	**I**	**J**	**K**
Mainline Diameter	7/16 "	7/16 "	3/8 "
Manufacturer	Everson	Everson	Crowe Rope
Mainline Buoyancy Properties	Neutral	Neutral	Floating
Gangion Diameter	7/16 "	7/16 "	5/16 "
Gangion Buoyancy Properties	Neutral	Floating	Floating
Maximum Gangion Elevations	2",3",2",2"	1.5',2',2',1'	5.5',5.5',5.5',3'
Average Maximum Gangion Elevation	*2 inches*	*1.4 feet*	*4.9 feet*
Maximum Mainline Elevation Between Gangions	4",4",2",3"	5",5",3",6"	14',16',20',15'
Average Maximum Mainline Elevation	*4 inches*	*5 inches*	*16.3 feet (197 inches)*

Figure 2. DMF Diver Bob Glenn measuring the maximum height of the gangion (~5.5 ft) on a trawl rigged with all floating groundline.

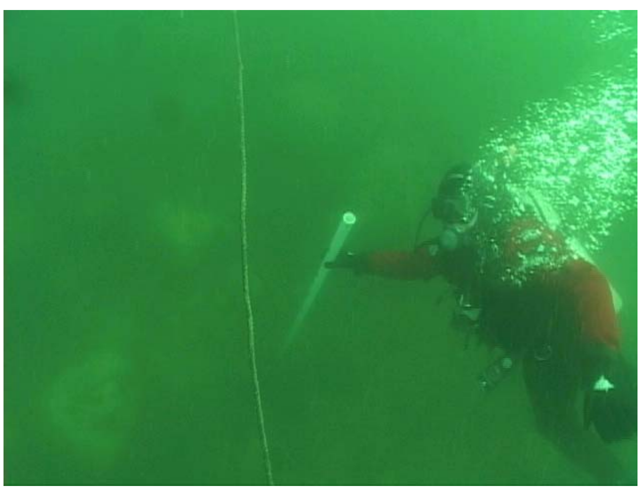

Figure 3. Topside view of DMF SCUBA diver measuring floating mainline arc.

Figure 4. Diver preparing to lower the 10-foot PVC the pipe to measure groundline arc (arcs ranged from 14 – 26 feet on trawls set in their natural position).

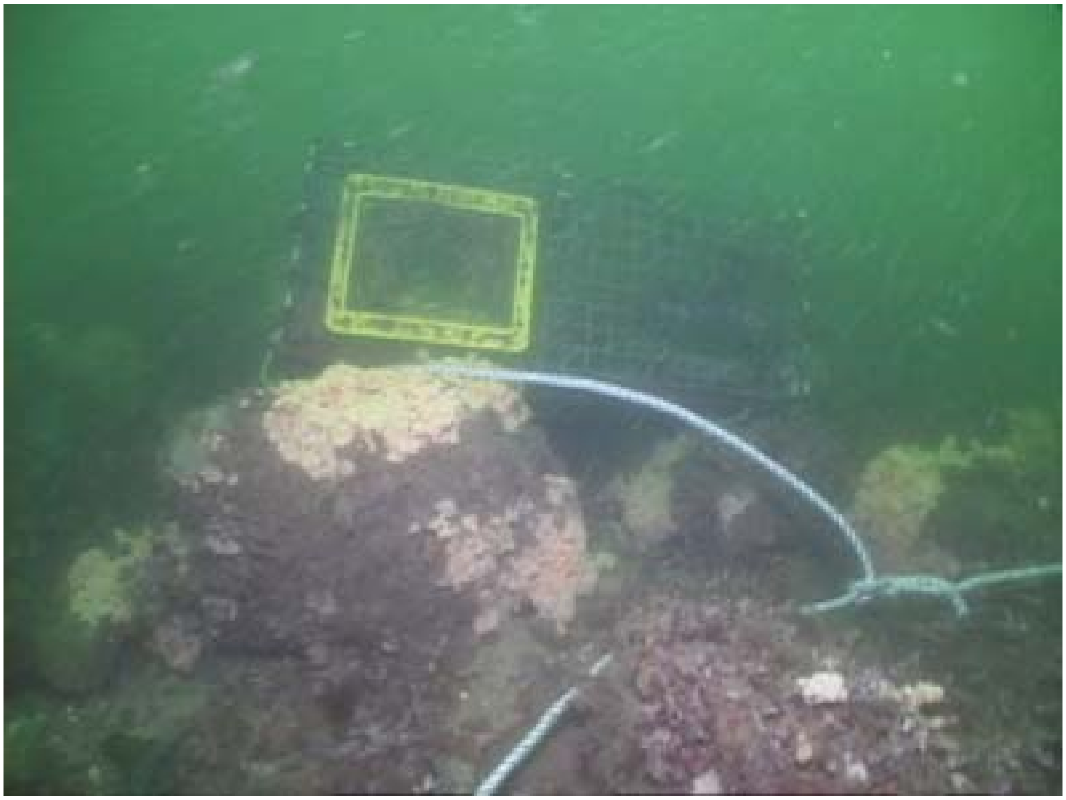

Figure 5. Groundlines composed of all neutral buoyant line were observed in contact with the substrate on all substrates fished including the boulder bottom as shown.

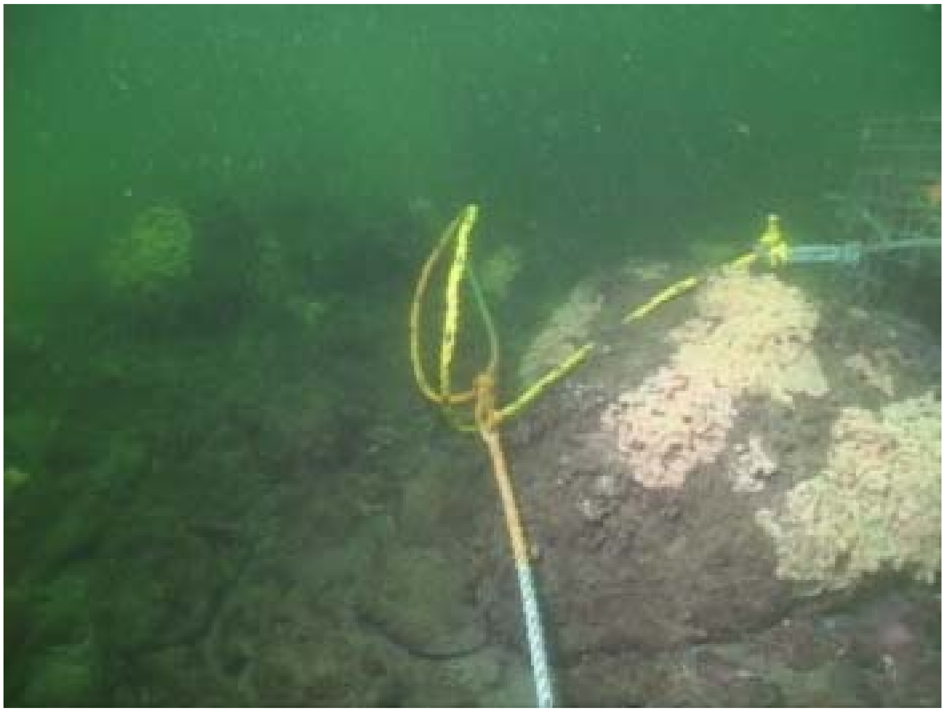

Figure 6. Use of floating line gangions had no effect on the measured height of the neutral buoyant mainline.

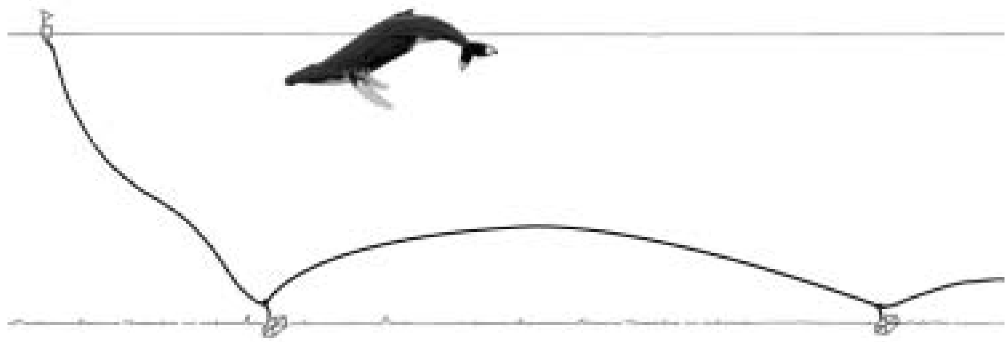

Figure 7. Schematic drawing of lobster trawl rigged with floating groundlines. This depiction demonstrates the elevated mainline reaching 16 ft., vertically suspended gangions, and the 90 ft. distance between traps (Humpback whale illustration courtesy of Scott Landry of Center for Coastal Studies & gear illustration by David Gabriel).

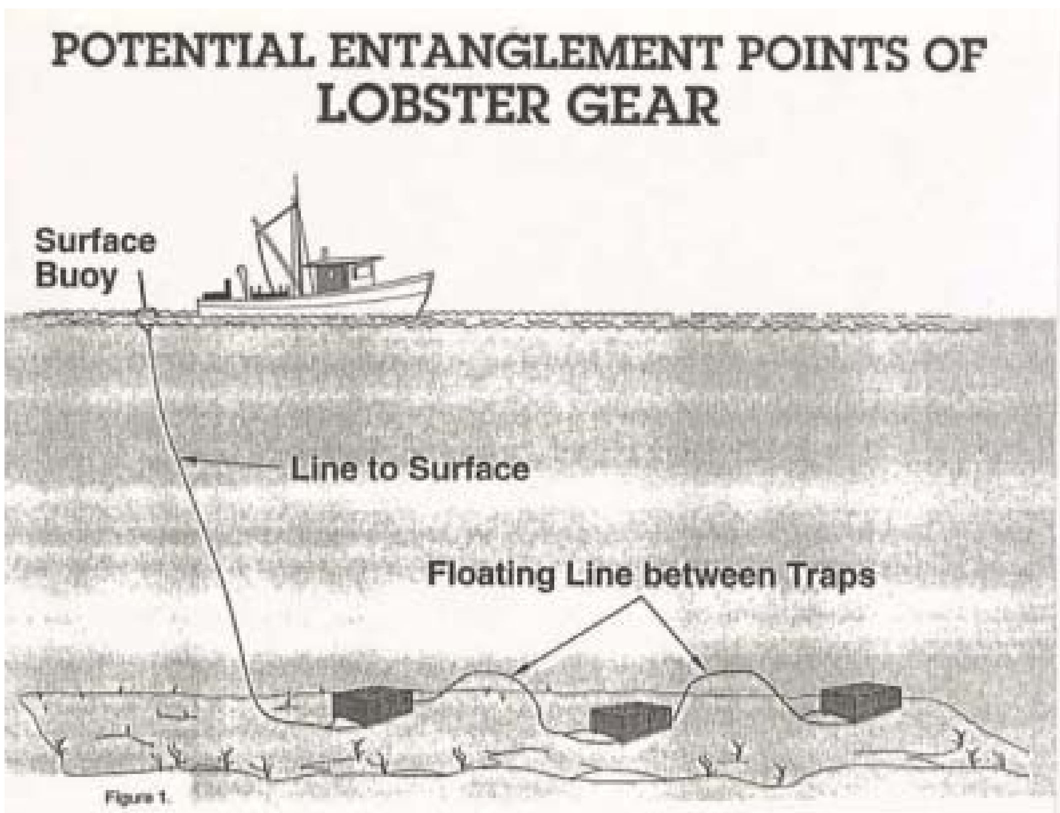

Figure 8. (below) Reprinted illustration depicting trawl with floating groundline from report by Wiley et al. (1997)*. This depiction did not properly characterize the extent of the groundline elevation because the distance between traps was short; lines were depicted tied between traps without gangions, and the lines were depicted in contact with the ocean floor.
**Development and operational testing of snag-free fishing gear for use in reducing right whale entanglement and mortality,* by David N. Wiley, Ron Smolowitz, William Adler, and Robert MacKinnon. A report to The Massachusetts Environmental Trust, 33 Union St., 4th floor, Boston, MA 02108.

Appendix 1

1998 Report by DMF's H. Arnold Carr documenting groundline height observations of *in situ* lobster trawls (2 pp.)

In Situ Observations of Lobster Gear

H. Arnold Carr
Massachusetts Division of Marine Fisheries

Introduction: In situ observations of lobster gear was undertaken in waters located off the New England coast. Some of the gear is found in or adjacent to waters deemed critical habitat for endangered marine mammals such as the Right Whale. Attached to this summary is a cruise report and a video script of a 16 minute summary tape of these activities.

Purpose: To ascertain the in situ functional attributes of commercial lobster trawl gear so as to determine the potential to entangle marine mammals and to provide an understanding toward possible approaches to mitigate this potential. A lobster trawl is defined as a multiple set of traps attached in series by a single line.

This investigation is considered part of a primary response resulting from a series of meetings with NMFS and the commercial fishing community. The meetings discussed the potential for entanglement of Right Whales in commercial lobster and gillnet gear and avenues of possible mitigation. The gear is sometimes abundant in areas deemed critical habitat for this species. This investigation addresses the issue of how this fishing gear lies in situ; determining this will greatly assist ascertaining the means to reduce entanglement of endangered marine mammals.

Methods: A team of biologists, gear technologists and commercial fishermen combined with remote operated vehicle (ROV) equipment gathered on commercial lobster vessels off the coast of Massachusetts and Maine. The team observed static commercial fishing gear set under commercial conditions. Commercial lobstermen voluntarily provided vessel support.

Results: The ROV was deployed at sea for four days. One day was spent in Massachusetts Bay and the other days off the Maine coast. All of the observations were made on lobster gear. In Massachusetts Bay multi-pot trawl (lines) were surveyed; the trawls consisted of more than 10 pots per trawl, but only 2-3 pots or traps were observed on each trawl because of the normal restriction of the ROV tether length. Off the Maine coast, single traps and the more common paired traps were observed as well as trawls of up to three traps. Paired trawls, a trawl with two traps, were the most common.

The trap lines, a line or combination of lines in series that attach the buoy to the bridle of the first trap, consisted of: a) sinking line held up off the bottom by a buoy (or toggle) attached on the line in the midwater column; or b) sinking line on the buoyed end of a buoy line and floating line on the trap or deep part of the buoy line. These result in the line having a vertical configuration near the water surface and just off the bridle of the trap nearest the buoy line. The buoy line did loop where the two lines met and the magnitude of the loop related to the scope and lengths of the respective lines. The vertical configuration of the line near the sea bottom is declared important nearer the sea bottom in order to prevent the line from entangling on very rocky bottom.

One of the objectives of the survey was to view sinking and floating groundlines that connected the traps in a trawl. Observations in each dive proved that the sinking line did what it was intended to do: it was usually right on the bottom, but in a few instances it was up to six inches above the substrate. Several makes of floating line were observed. In Massachusetts Bay, one trawl observed was set with a taut floating groundline. The groundline, that was observed by the ROV, was consistently 10 feet off the seabottom.

The attitude of the floating groundline may also relate to the way it was rigged to the buoy lines.

Two experiments were conducted with pair traps. The experiments involved different types of groundlines - some floating varieties and a sinking type - set between two traps in each experiment. The first experiment set the paired traps “loose” where the second trap in the trawl is pushed overboard just before being pulled by the groundline attached to the first trap. The maximum altitude (off the sea bottom) of each 10 fathom groundline (as measured by the ROV) was as follows:

Superhaul (sinking)	0 feet
Polysteel (floating)	6 feet

Orange poly (floating) 10 feet

The second experiment involved first setting the trawls “loose” and then setting them “tight”. Tight is described where the second trap is pulled off the vessel by the first set trap in the trawl.

Loosely Set		Tightly Set	
Superhaul (sinking)	0 feet	Superhaul (sinking)	0 feet
Polysteel (floating)	12 feet	Polysteel (floating)	16 feet
Yellow poly (floating)	10 feet	Yellow poly (floating)	18 feet

The second set, which was more tautly made than the first set resulted in floating groundline altitudes higher than the “loose” set trawls. The observers speculate that this may be result of a “rubber band” effect of the first trap pulling the second closer to it. Other variables may contribute, too. These would include depth, current speed and direction, and trap design and size. The “rubber band” phenomenon warrants further investigation and it should be done with paired trawls as well as 10-20 pot trawls.

Concerns:

- The loop of the line in a composite (consisting of floating and sinking lines) buoy lines. This loop gives a larger exposed profile to the buoy line.
- Knots in the buoy line especially where the sinking and floating line connect
- Toggles or buoys placed on the buoy line within the water column
- Knots in the buoy line where the buoy is attached
- Knots in the groundline
- The method of attachment of the gangion or bridle
- Floating line and its off bottom configuration even when apparently set taut.

Note: These results are a product of cooperative research undertaken by a team of investigators from the Maine Department of Marine Resources, Massachusetts Division of Marine Fisheries and NMFS and Maine and Massachusetts commercial lobstermen.

30 January 1998.

Appendix 2

Results from contracted laboratory of Specific Gravity Tests on lines deployed during this study (2 pp.)

NORTHWEST LABORATORIES *of Seattle, Incorporated*
ESTABLISHED 1896
Technical Services for: Industry, Commerce, Legal Profession & Insurance Industry
241 South Holden Street • Seattle, WA 98108-4359 • Phone: (206) 763-6252 • Fax: (206) 763-3949 • www.nwlabs1896.com

Report To: Commonwealth of Massachusettes
Division of Marine Fisheries

Date: April 24, 2002

Attention: Melanie Griffin

Report On: Specific Gravity

Lab No. E76036

SUBMITTED: Six (6) Rope Samples

IDENTIFICATION:
A: Everson 7/16"
B: Anacko 3/8"
C: Polysteel Atl.
D: Hy-line
E: Crowe 3/8"
F: Crowe 5/16"

ANALYSIS:

Procedure:

Samples were dried for 24 hours @ 80° C and subsequently weighed. The samples were then immersed in salt water from Puget Sound, with a specific gravity of 1.023 at 61° F, for 96 hours. Samples were agitated to remove any air bubbles.

Samples were then weighed, to the 0.01 of a gram, while immersed in the salt water. The samples were removed from the water and placed on a non-absorbent counter top, allowing the surface water to drip off. Any visible surface water was removed with a damp cloth. The specimens were again weighed at this saturated-surface-dry condition. The specific gravity was calculated in the following ways:

A = Weight of oven-dry test sample in air.
B = Weight of saturated-surface-dry test sample in air.
C = Weight of saturated test sample in water.

Bulk specific gravity (saturated-surface-dry) = B/(B-C)

Apparent specific gravity = A/(A-C)

Sample	Weight (g) Oven-Dry A	Weight (g) Sat. Surface-Dry B	Weight (g) Saturated in Water C
#A	55.76	67.56	2.94
#B	41.67	58.22	2.52
#C	41.91	56.95	2.18
#D	53.13	72.41	7.59
#E	27.11	38.76	-3.71
#F	24.98	32.31	-3.08

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Sample	Bulk Specific Gravity (Saturated-Surface-Dry)	Apparent Specific Gravity
#1	1.046	1.056
#2	1.045	1.064
#3	1.040	1.055
#4	1.117	1.167
#5	0.913	0.880
#6	0.913	0.890

Note: Samples #E and #F floated. All others sank.

This report applies only to the actual samples tested. Northwest Laboratories does not certify, warrant or guarantee any products manufactured by others. Samples discarded within two months unless otherwise requested in writing by you.

NORTHWEST LABORATORIES, INC.

Omar Simon, Chemist

bjc