Northeast Fisheries Science Center Reference Document 20-02

Comparative Studies of the Catch Loss of Longfin Inshore Squid when Using the TI Cable Grid in the Bottom Trawl Fishery

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ABSTRACT

NOAA Fisheries' Northeast Fisheries Science Center (NEFSC) with the assistance of the Southeast Fisheries Science Center (SEFSC) is investigating the target catch efficiency of cable Turtle Excluder Devices (TEDs) in the Northeast and Mid-Atlantic longfin inshore squid (*Doryteuthis [Amerigo] pealeii*) fishery. These cable TEDs are a substantial improvement over rigid TEDs previously tested in this fishery because the cable TEDs reduce operational and safety issues. The NEFSC chartered the F/V *Karen Elizabeth*, a twin trawl vessel (capable of towing 2 nets simultaneously), to evaluate the catch rates of trawl nets equipped with a cable grid (experimental) to identical nets without a TED installed (control). This work occurred in southern New England waters in October 2017 and 2018. The vessel completed 38-paired tows in 5 days in 2017 and 30-paired tows in 6 days in 2018. Results from the work in 2017 showed that the cable TED-equipped net caught similar quantities of longfin inshore squid as the control net but also caught an increased number of benthic species. A modification was made to the floatation to address the increase in benthic species catch. This modification was tested during the latter portion of testing in 2017 and was successful at reducing the quantity of benthic species caught. The modified gear was tested again in 2018 with 1 additional modification: the TED escape opening was switched to the bottom. The 2018 work again showed that the experimental net caught similar quantities of longfin inshore squid as the control net. In addition, it did not result in an increase of benthic species caught.

BACKGROUND

NOAA Fisheries is working to develop and implement bycatch reduction measures for trawl fisheries in the Mid-Atlantic and Gulf of Mexico when and where sea turtle bycatch has occurred or where similarities exist between a particular trawl fishery and a trawl fishery where sea turtle bycatch has occurred (74 FR 21627, May 8, 2009). In the Greater Atlantic Region (Maine through Virginia), NOAA Fisheries currently requires the use of a Turtle Excluder Device (TED) in the summer flounder trawl fishery in the Mid-Atlantic south of Cape Charles, VA, during particular times of the year.

Our objective is to find a technology that excludes sea turtles while maintaining target catch. Previous work (DeAlteris and Parkins 2010) with a rigid TED in the longfin inshore squid fishery suggested that TEDs might maintain the targeted squid catch. Several operational issues were observed during those studies, and cable TED designs were identified as a possible way to reduce those issues. The cable TED is more robust, easily wraps on the net drum, and is less prone to damage. A 2010 workshop with the fishing industry concluded that the industry members present preferred cable TED designs, over rigid TED designs (DeAlteris 2010).

METHODS

In mid-October 2017 and 2018, a paired-tow study was conducted out of Point Judith, RI, with a 24-m twin trawler, the F/V *Karen Elizabeth*, from the *Doryteuthis* (*Amerigo*) *pealeii* (longfin inshore squid) fishing fleet. A twin trawl vessel is capable of pulling 2 nets simultaneously. The twin trawl method was used to give both treatments an equal chance of catching the species available on any given tow. Both bottom trawl nets, constructed by Superior Trawl of Point Judith, RI, were identical 2-seam, 2-bridle "rope trawls" used in the longfin inshore squid fishery. Sampling stations were selected by the captain to reflect areas fished by the fleet and with the objective of capturing longfin inshore squid during each tow. The same individual conducted all tows to ensure consistent setting and hauling of the gear. Thirty-eight paired tows were completed in 2017 from the Hudson Canyon area at depths ranging from 77 to 146m (Figure 1). Thirty paired tows were completed in 2018 near the Hudson Canyon and Berkeley Canyon - Spencer Canyon areas in 64 to 121m. The gear and vessel characteristics are provided in Table 1 and Figure 2. A stainless steel Type I cable grid (TI), designed and built by Nick Hopkins at NOAA Fisheries' Southeast Fisheries Science Center (SEFSC) Harvesting Systems Unit (HSU), was laced into the body of one net (Figure 3 and 4). The TI cable grid is similar to a cable TED successfully tested in the croaker fishery.

The TI cable grid extension webbing is 3 mm diameter, 7-cm Euroline trawl mesh. It replaced the last section of the rope trawl that measures 189 meshes across at top, 120 meshes across at bottom, and 69.5 meshes deep with a 2B:1P taper. The grid weighs 256 lbs. and is spliced 316 stainless steel cables. Bar spacing is 2" in center and 3" inside 1 to outside next (see Figure 3). The opening cut has 19 bars and 30 center meshes across the grid. The escape opening is 15 bars 36" minimum, and the flap cover is 1 1/2" 1 mm Euroline, 143 meshes across sewn down to the edge of the grid and left long. The flap length below the grid is 36" hanging on net reel.

The 2017 configuration was installed as a "Top Shooter" (escape panel on top). Float location in the original configuration was twelve 11" #411 hard floats with 222 lbs. of buoyancy. This configuration was fished for pairs 1-14 and 17-20. During the study, the experimental grid was modified twice to improve the performance by reducing the catch of benthic species. This adjustment resulted in 3 configurations tested to various degrees over the course of the study. A GoPro Hero 3+ camera was used to collect video data to inform modifications. During the first 14 comparisons, the TI was fished with 12 floats (222 lb. of buoyancy) (Figures 3 and 5). In an attempt to reduce the belly contact with the seafloor and thus reduce bycatch of benthic species, 4 additional floats were added to the grid (16 floats at 296 lbs. of buoyancy). This configuration was only fished for 2 comparisons (hauls #15-16) because the bycatch from seafloor contact of benthic species actually increased and the video data showed an increased silt cloud higher in the net. On haul #20, 3 center floats were removed from the original configuration in an attempt to reduce drag from floats in the center of the grid (9 floats at 166 lbs. buoyancy). This 3-float configuration was fished for the remaining 18 comparisons and seemed to reduce the belly contact with the seafloor and benthic bycatch. (Figure 6)

In 2018, the TI cable grid was installed as a “Bottom Shooter” (escape panel on bottom) with three 11” hard floats fastened to the top of the grid frame for 55.5 lbs. buoyancy. The escape panel characteristics remained the same as described in 2017. This design was selected to help further reduce the bycatch of benthic species. This configuration was fished throughout the 2018 study (Figure 7).

The experimental and control nets were towed at 3 knots simultaneously for about 1 hour of bottom time. The speed is typical of the vessels in the fishery while the duration was standardized to 1 hour. Net touchdown and lift-off were determined from the Simrad ITI screen display of the trawl location. The Simrad ITI is a trawl positioning and monitoring system designed to improve control and efficiency in trawling. The paired nets were switched from port and starboard with an ABBA configuration where “A” is the net equipped with the TED and “B” is the net without a TED. This system helps to reduce bias associated with fishing on either side of the vessel while reducing the number of net changes required.

The data recorded for each comparative tow included catch, position, time, depth, temperature, and weather. The catch data included species caught, weight, and length frequency. For each haul and from each net individually, the total catch was sorted into bushel baskets and weighed on a Marel motion-compensated, platform scale beginning with the starboard catch. Longfin inshore squid catches were weighed after sorting. Dorsal mantle lengths (DML) were collected by net prior to sorting every tow from random subsamples of approximately 200 individuals. Dorsal mantle lengths were measured to the nearest cm. A custom conveyor system brought catch from the deck to a sorting conveyor where it was hand separated by species and weighed. Using this method, actual weights were obtained from all catch except for 1 tow that encountered a large school of spiny dogfish. In this case, an average weight of the dogfish was obtained and multiplied by the count of individuals.

RESULTS

2017

Thirty-eight paired tows were completed over 5 days between October 16 and October 20, 2017. Of the 38 tows, 29 were deemed “good” tows, i.e, tows where no traps or damage to the gear (e.g., holes or tears in the webbing, clogging by fishing gear) occurred that might have affected performance. The number of tows removed was conservative as many of these pairs were likely unaffected or minimally affected by the issue. Tows were analyzed together. Those tows that occurred before the removal of the 3 floats and those that occurred after were also analyzed separately.

When all tows were combined, total squid catch was comparable between the experimental and control gear (Figure 8). Longfin inshore squid catch was not negatively affected by the addition of the TI cable grid. During the first 17 tows with the original float configuration, it was evident that the TI cable grid-equipped trawl was catching more benthic bycatch compared to the standard (control) net (Figures 9 and 10). This bycatch was a concern to the fishermen, because it meant more sorting time and potential damage to the squid product. Initially, there was an attempt to remedy this issue by adding more floats. When this approach failed to reduce the bycatch, these floats were removed and video was reviewed to investigate what was causing the problem. It was determined that the added floats were causing drag, pulling on the headrope and causing the net to contact the sediment. These additional floats and 3 others were removed, and the remainder of the tows completed. The removal of the 3 floats reduced the catch of benthic invertebrates (Figure 9) and benthic finfish (Figure 10) so the numbers were closer to those caught by the control net (mean of 11.6 lb) and the experimental (mean of 18.9 lb [$P \leq$. 0.007]). The catch of the longfin inshore squid was not statistically different, though the mean catch for the experimental net was lower (Figure 11).

A review of the length frequencies of squid caught between the control and experimental show that the distributions of lengths overlap and, therefore, are similar (Figure 12). There was a slight difference at 10 to 11 cm but this discrepancy is likely due to differences in the sampler and not the sample (i.e., measurement error).

Finally, a plot of the catch of finfish and invertebrates shows the relative catch between the control and experimental (Figure 13). As these data are plotted on a log scale, the relative size of the bars does not reflect the relative differences.

2018

Thirty paired tows were completed over 6 days between October 13 and October 19, 2018. Of the 30 tows, 28 were deemed “good tows,” tows where no traps or damage to the gear (e.g., holes or tears in the webbing, clogging by the fishing gear) occurred that might have affected performance. An interesting note is that the 2 tows that were discarded because of the catch of lobster gear are the tows that had the largest catches of squid in both nets.

When all tows were combined except the 2 questionable tows, longfin inshore squid total catch was comparable to catch with experimental and control gear with the experimental mean of 557.91 lbs (standard error [SE] 70.96) and the control mean of 534.51 lb (SE 62.53). The Pearson correlation was similar and calculated at 0.88 and $P \leq 0.845$ (Figure 14).

Finfish results showed similar consistency with the experimental mean of 743.74 lb (SE 288.95) and the control mean of 746.89 (S.E. 221.63). The Pearson correlation coefficient was 0.85. [$P \leq 0.98$] (Figure 15). A plot of the finfish comparisons shows a reduction of catch by the experimental gear in certain species (Figure 16).

When invertebrates (crab, scallop, and lobster) and trash (echinoderms, sponges, etc.) were summed, there was no significant difference at $\alpha = 0.05$ between the control and the experimental catch [$P \leq 0.061$] with the experimental catching a mean of 1.88 lb per tow and the control catching a mean of 3.56 lb per tow. The catch of invertebrates in the experimental trawl was almost half what was caught in the control trawl (Figure 17).

A plot of the length frequencies of longfin inshore squid shows good overlap in the larger length classes (Figure 18). There is some separation at the 9 cm, but the data show that the difference is attributed to two tows.

DISCUSSION

The TI cable grid initially tested in 2017 did not substantially reduce the targeted longfin inshore squid, but there was concern that the catch from the trawl equipped with the TI cable grid was "dirty" (lots of bycatch) compared to the control trawl. This concern was addressed successfully by reducing the number of floats. The additional bycatch was likely due to the weight of the TED keeping the net close to the seafloor. These nets have large meshes in the bellies and wings. If these parts of the net are riding on the bottom, the ability of benthic species to escape is reduced. Solving this problem by reducing the number of floats may seem counter-intuitive; however, it was effective. The researchers identified that the drag on the floats was causing the gear to pull on the headrope and push the net into the substrate. When these 3 floats were removed, video showed the configuration of the gear improved.

In 2018, the design with reduced floats was tested again but in a bottom-opening configuration. The opening on the bottom was designed to help reduce the bycatch of benthic species observed in the 2017 study. Additionally, the angle of the grid creates lift and reduces the need for floatation. The data show again that the cable grid catch is comparable to the net without a TED and that the modifications to the design were successful in "cleaning up" the catch.

Testing has occurred in small and midsized squid vessels targeting longfin inshore squid (DeAlteris and Parkins 2010; DeAlteris 2010). The data suggest that for this size class of vessel, the use of a cable grid will not reduce the targeted longfin inshore squid catch and will help reduce the other species of finfish and invertebrates.

ACKNOWLEDGEMENTS

This project was possible because of the collaboration of Captain Chris Roebuck and John Knight of Superior Trawl. Both provided valuable insight into the development of this design that enabled the successful outcome. Additionally, we are grateful to the crew who helped sample the catch and to Mike Ball, Elizabeth Marchetti, and Margret Heinichen who helped with data collection.

Reference to any specific commercial product, process, or service, or the use of any trade, firm or corporation name is for descriptive purposes only, and does not constitute endorsement, recommendation, or favoring by NOAA Fisheries.

REFERENCES CITED

DeAlteris J. 2010. Summary of 2010 Workshop on Mitigating Sea Turtle Bycatch in the Mid-Atlantic and Southern New England Trawl Fisheries. [Final report; 16 p.] NOAA Contract No. EA133F10SE2585

DeAlteris J, Parkins C. 2010. Evaluation of the effect on catch performance of the NMFS flounder Turtle Excluder Device (TED) with a large opening in the Southern New England long fin squid trawl fishery. [Final report; 19 p.] NOAA Contract No. EA133F08CN0182.

Table 1. Characteristics of the 2-seam, (*Doryteuthis [Amerigo] pealeii*) twin trawl and the F/V *Karen Elizabeth.*

Doors	Thyboron Type IV 213.4 cm, 720 kg per door
Bridles	73.2 m
Backstraps	9.1 m
Ground cables	36.6 m of 22 mm wire with 6 cm rubber cookies
Headrope	42.64 m Tenex with 92 20.3-cm floats
Footrope	48.25 m of 16 mm SS wire with 6 cm rubber cookies
Net mouth circumference	288 meshes × 40 cm; 240 cm spectra face
Wings	240 cm of 11 mm Polytron
Belly	First bottom belly is 240 cm of 11 mm Polytron graduating to 60 mm of 1.1 mm Dyneema
Extension	None
Control codend	60 mm diamond polyethylene (3.0 mm) hanging ratio = 0.4
Experimental codend	70 mm diamond polyethylene (2.5 mm) hanging ratio = 0.4
Codend strengthener	10.6 m × 4.8 m of 16 cm square mesh 14 mm Polytron wrapped with 19 mm polyethylene
Chafing gear	40 × 50 meshes of 165 mm diamond double 5 mm polyethylene
Gross registered tonnage, vessel length overall (m)	156 GRT 24 m
Engine horsepower	705
Trawl monitoring system	Simrad ITI

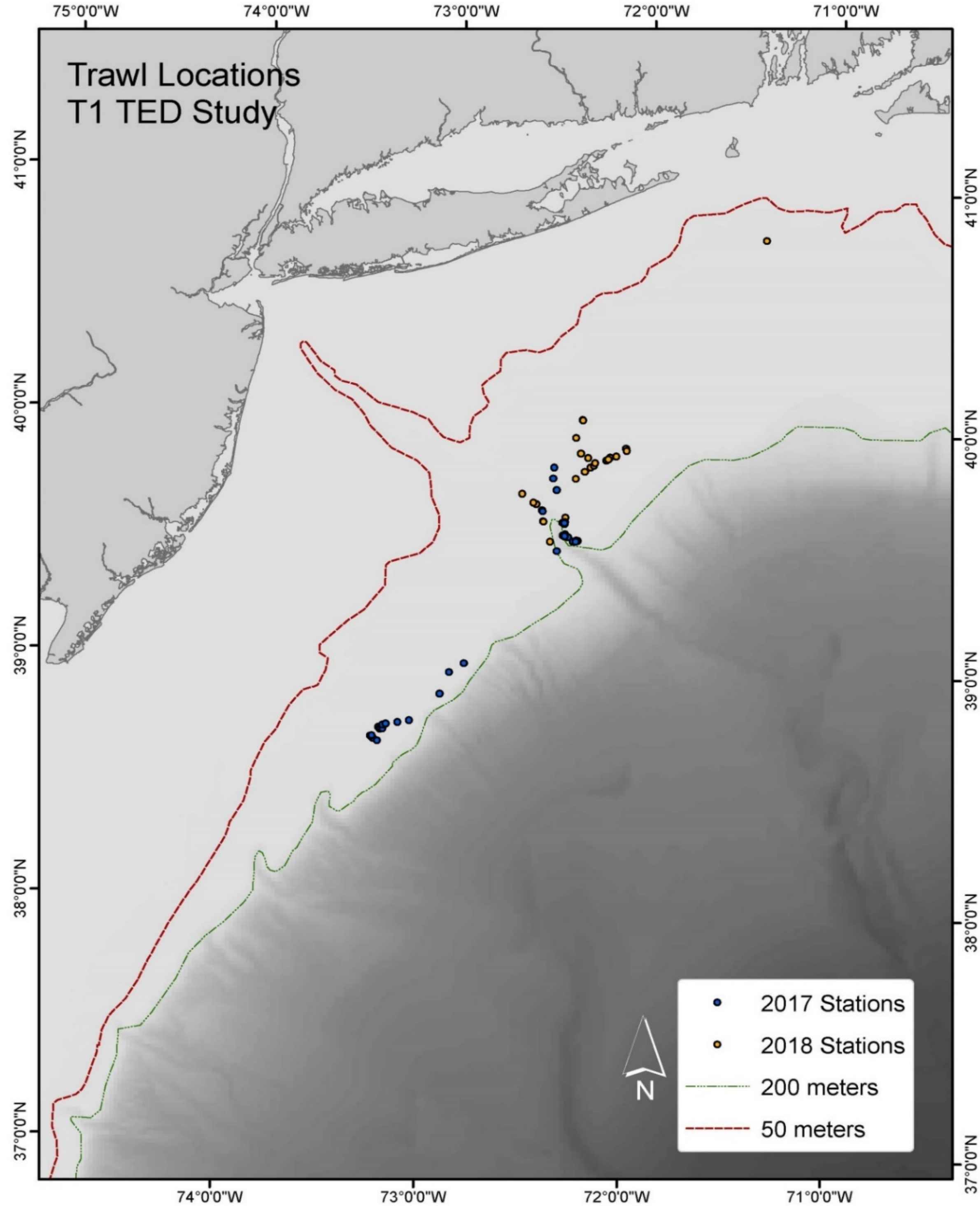

Figure 1. Location of hauls completed during the comparative study of a Type I cable grid (TI) Turtle Excluder Device (TED).

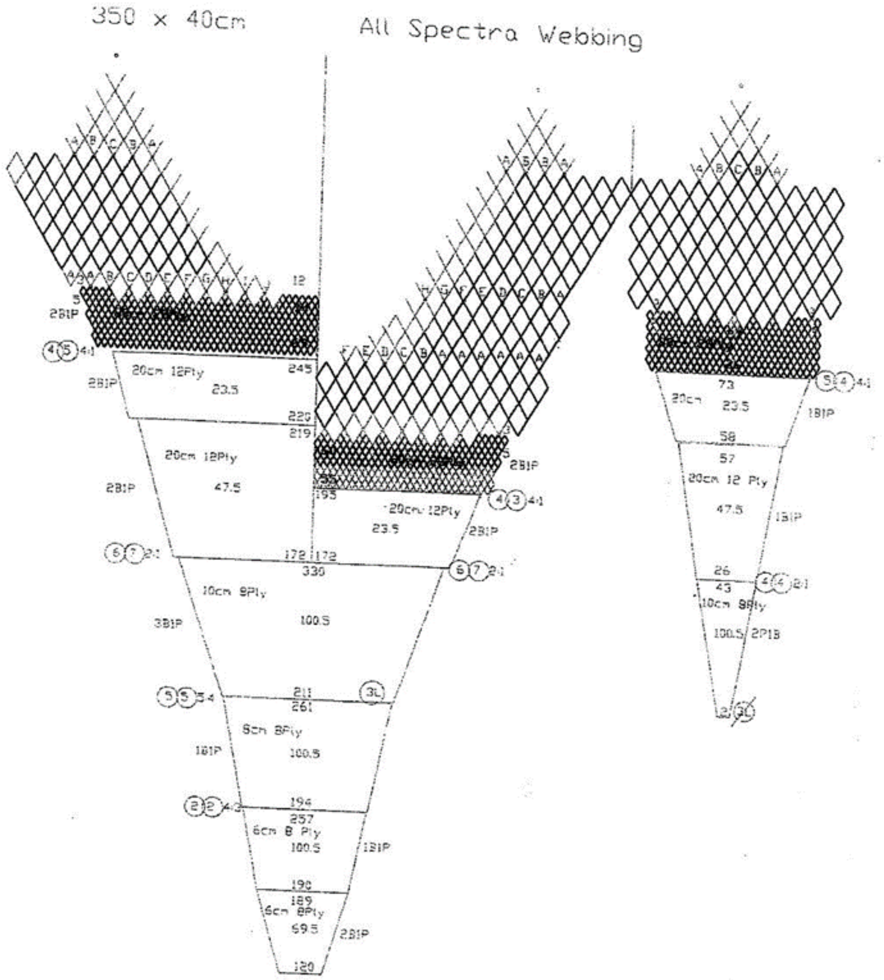

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Figure 2. Net diagram for test of Type I Cable TED.

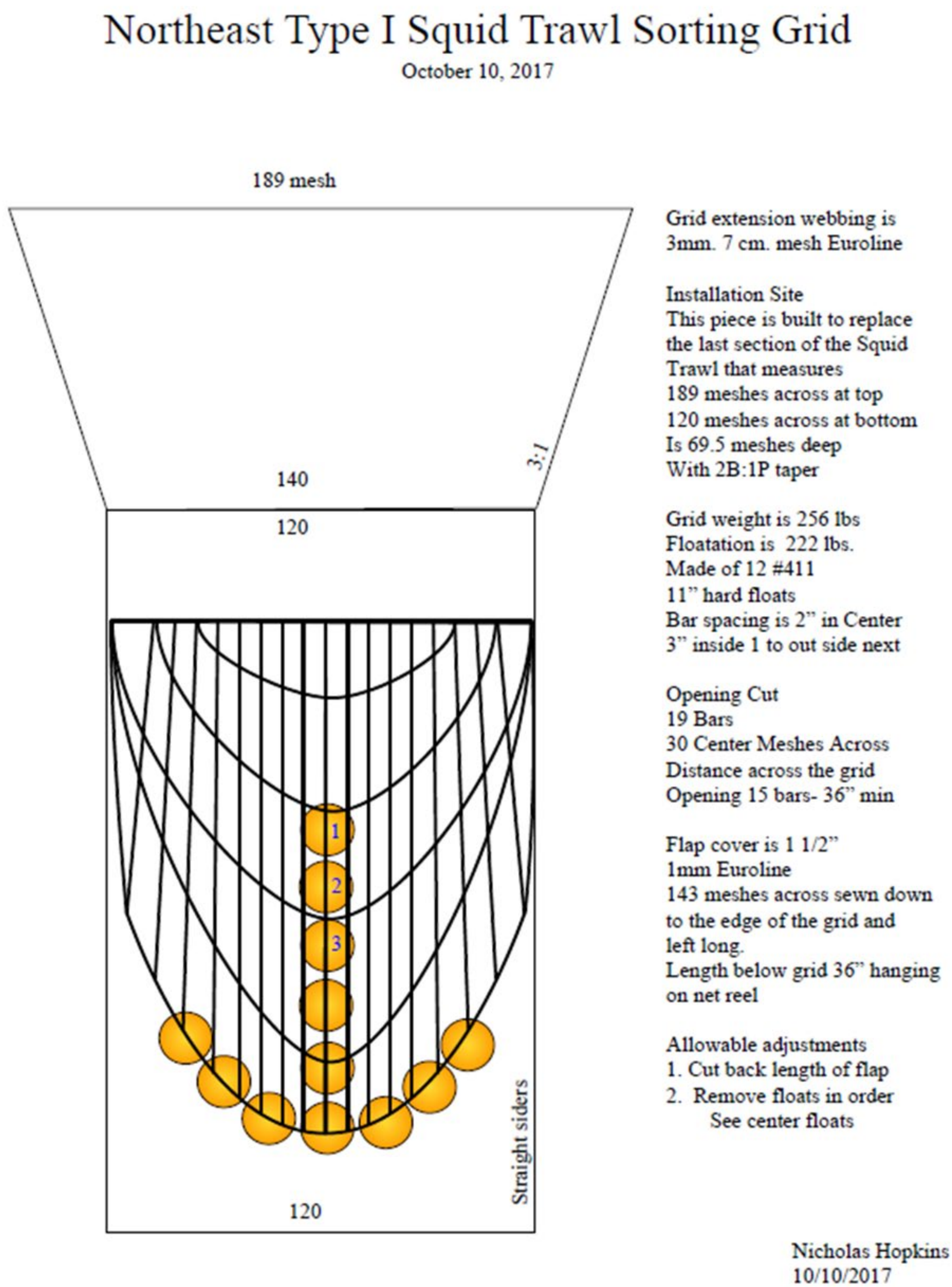
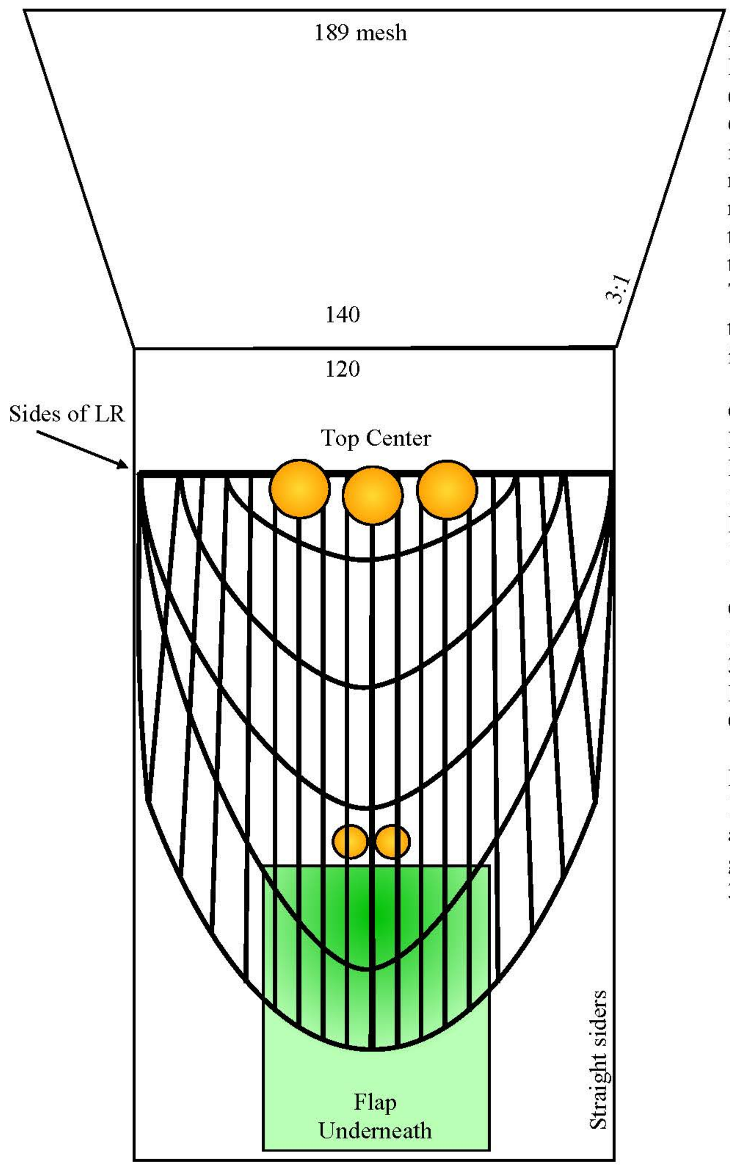


Figure 3. Type I cable grid configuration tested in 2017.

Northeast Type I Squid Trawl
Sorting Grid
Bottom Shooter



Grid extension webbing is 3mm. 7 cm. mesh Euroline. Installed as bottom shooter

Installation Site
Installed at the end of the 8cm section (194 mesh) and sewn to the following 6 cm section (257 mesh). This piece is 189 meshes across at top 120 meshes across at bottom is 69.5 meshes deep with 2B:1P taper in the transition piece and a straight shot in the grid extension webbing.
The Exp Trawl is 120 meshes longer than control- unless 1st 6 cm. section is removed

Grid weight is 256 lbs
Floatation is 55.5 lbs.
Made of 3 #411
11” hard floats
Bar spacing is 2” in Center 3” inside 1 to out side next.

Opening Cut
19 Bars
30 Center Meshes Across
Distance across the grid
Opening 15 bars- 36” min

Flap cover
1 1/2” 1mm. Euroline 143 meshes across sewn down to the edge of the grid and left long. Length below grid 36” hanging on net reel

Nicholas Hopkins
10/06/2018

Figure 1. Type I cable grid configuration tested in 2018. LR is Lead Ring, the foundation of the grid frame.

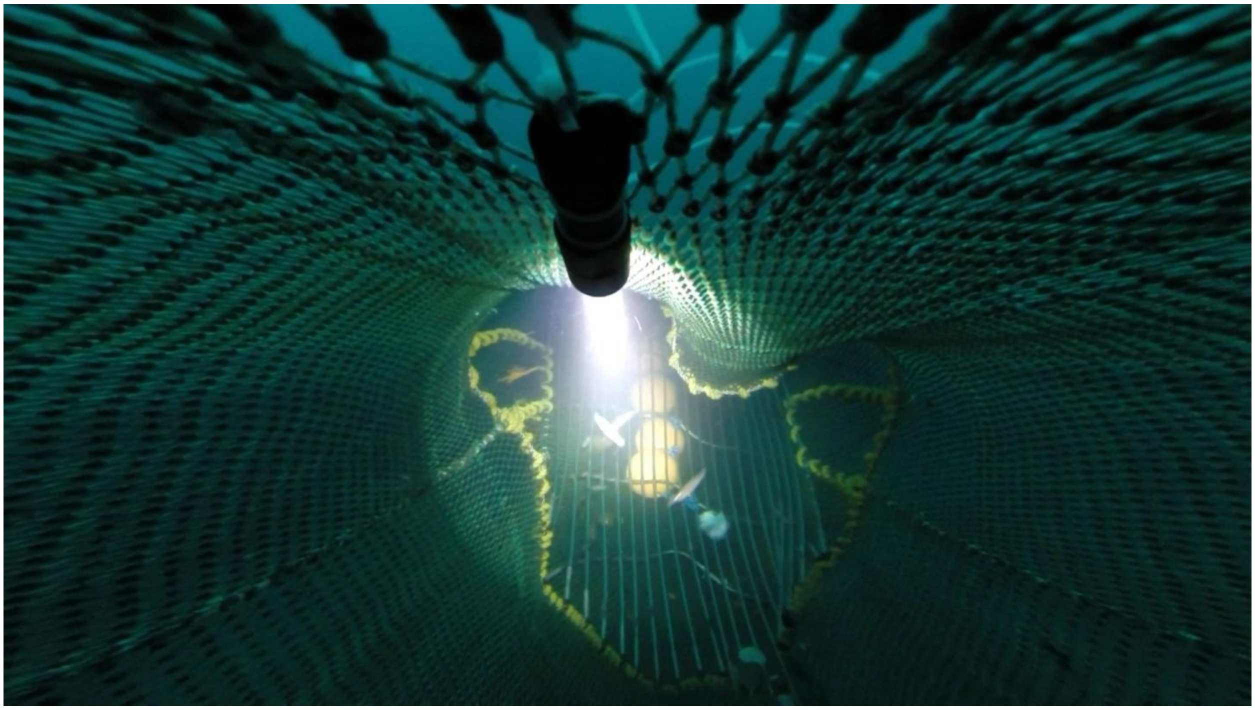


Figure 5. Type I grid "original configuration" with twelve 11" floats. Fished on hauls 1-14 and 17-20 in 2017.

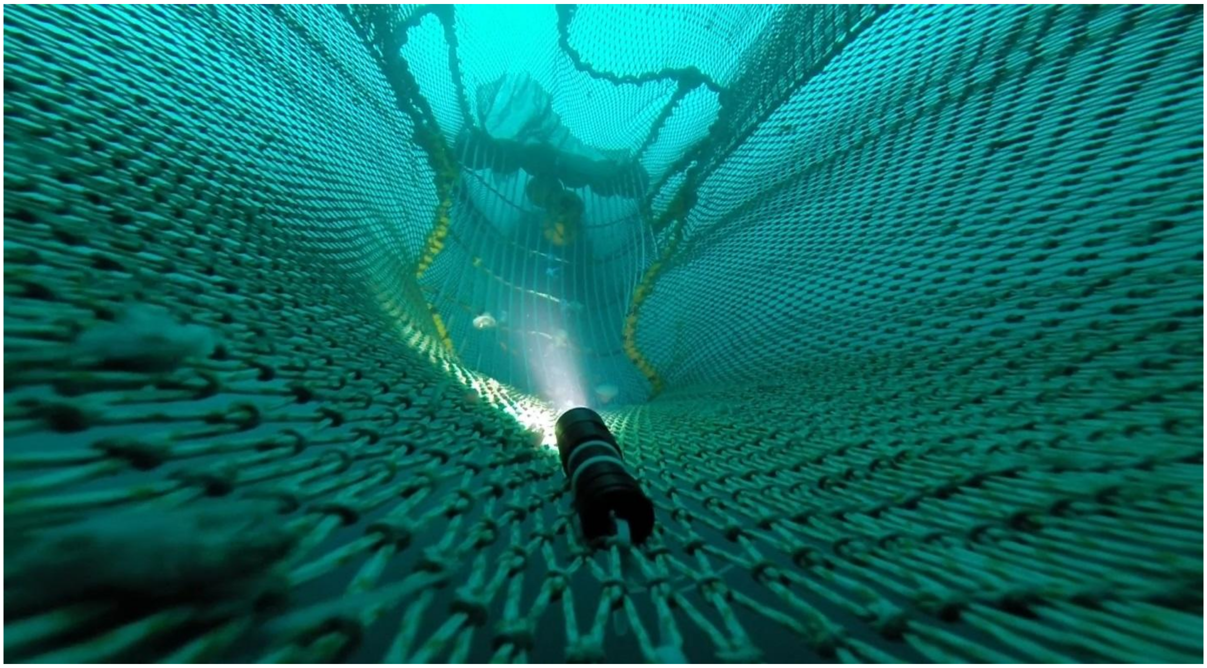


Figure 6. Type I grid with 3 floats removed from center of grid. Fished on hauls 20-38 in 2017.

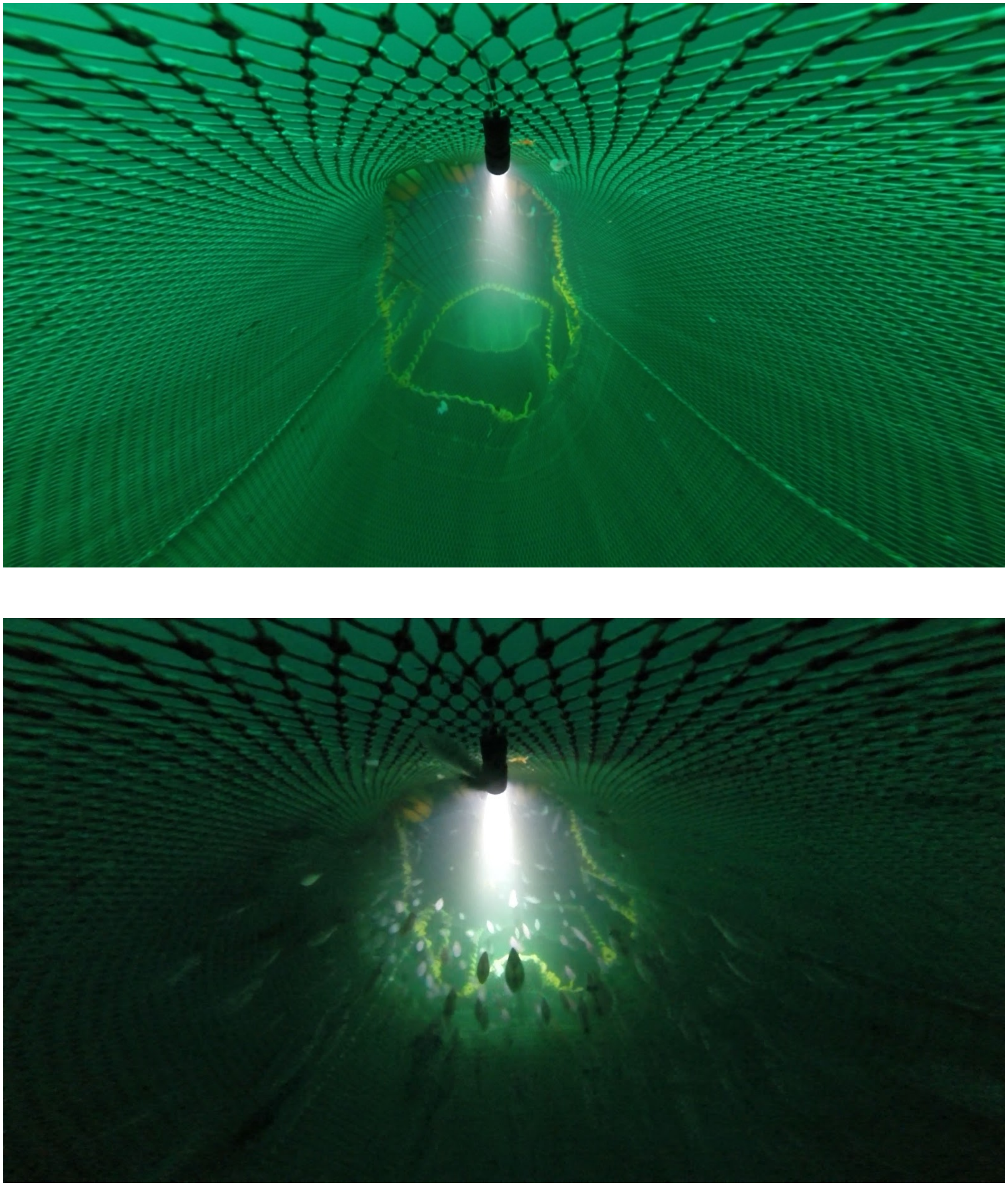


Figure 7. Type I grid configuration for all tows in 2018 fishing.

t-Test: Paired Two Sample for Means
2017 Data

	Control	*Experimental*
Mean	188.9069	192.9413793
Variance	4100.501	5491.692512
Observations	29	29
Pearson Correlation	0.608956	
Hypothesized Mean Difference	0	
df	28	
t Stat	-0.35186	
P(T<=t) one-tail	0.363789	
t Critical one-tail	1.701131	
P(T<=t) two-tail	0.727578	
t Critical two-tail	2.048407	

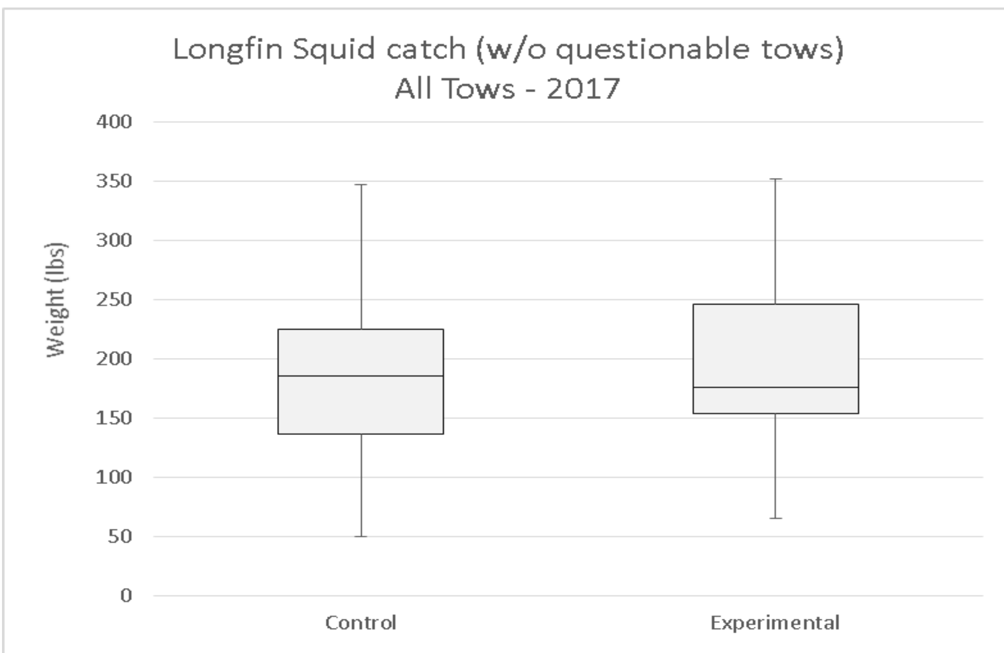
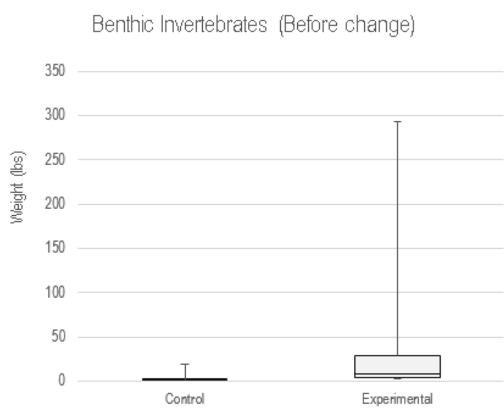
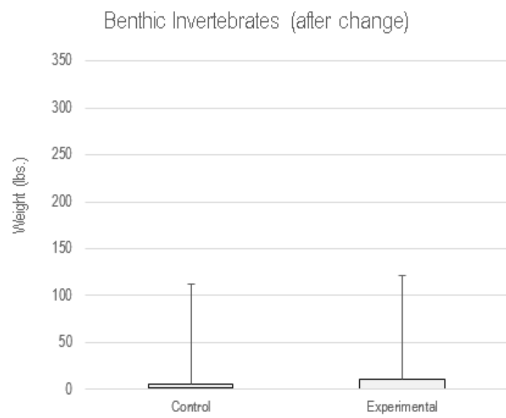


Figure 8. Longfin inshore squid catch results for all tows in 2017. Box and whisker plot (1st and 3rd quartiles, median, and range) and results of a paired 2-sample t-test of squid Type I cable grid. All tows shown except tows where gear problems occurred.

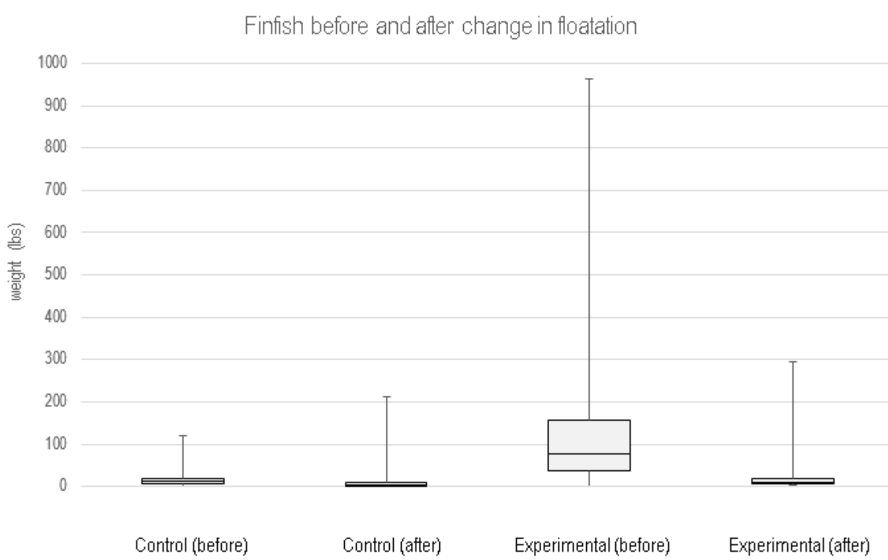




	Control	*Experimental*
Mean	3.1333333	39.89166667
Variance	30.27515152	6546.20447
P(T<=t) one-tail	0.060036255	

	Control	*Experimental*
Mean	10.98235	18.77058824
Variance	749.014	1041.137206
P(T<=t) one-tail	0.001519	

Figure 9. Benthic invertebrate catch results in 2017. Box and whisker plot (1st and 3rd quartiles, median, and range) of the benthic invertebrate comparison between the control and experimental nets before and after the change of the float numbers.



	Control (before)	*Control (after)*	*Experimental (before)*	*Experimental (after)*
Mean	24.28461538	29.29375	162.7692308	44.30625
Variance	1274.508077	3852.307292	65417.75731	8551.779292
Observations	13	16	13	16

Figure 10. Finfish catch results in 2017. Box and whisker plot (1st and 3rd quartiles, median, and range) of the finfish bycatch comparison between the control and experimental nets before and after the change of the float numbers. All tows shown except tows where gear problems occurred.

t-Test: Paired Two Sample for Means

	Control	*Experimental*
Mean	183.93125	164.3125
Variance	3117.224958	5187.981167
Observations	16	16
Pearson Correlation	0.751856531	
Hypothesized Mean Difference	0	
df	15	
t Stat	1.651431668	
P(T<=t) one-tail	0.059712638	
t Critical one-tail	1.753050356	
P(T<=t) two-tail	0.119425277	
t Critical two-tail	2.131449546	

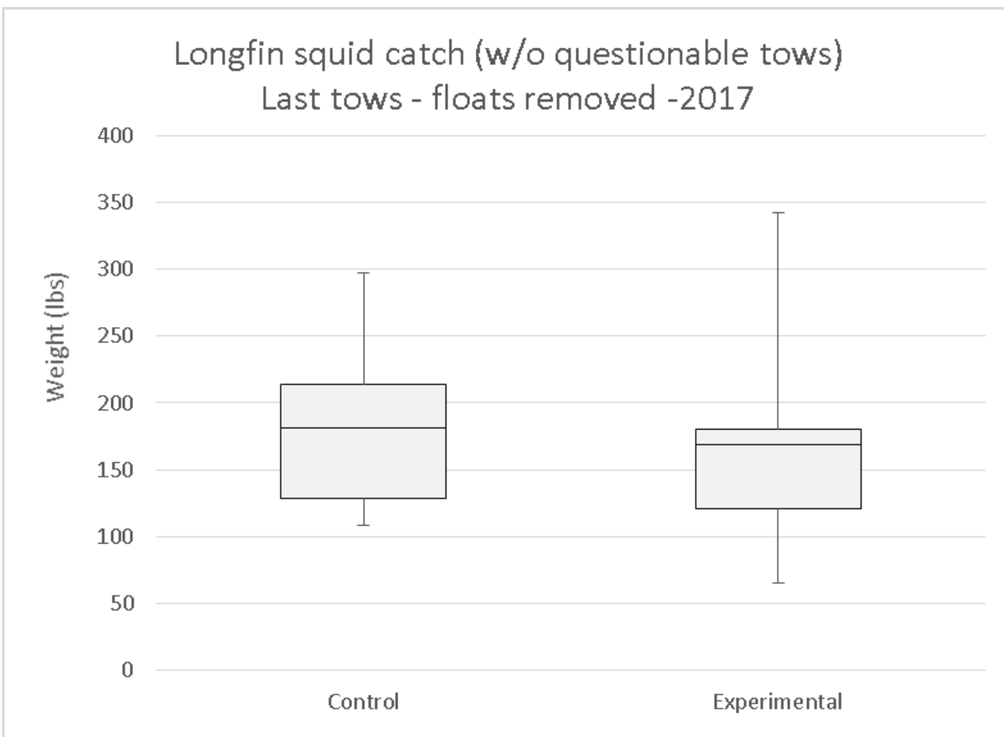


Figure 11. Longfin inshore squid catch in 2017 after removal of floats. Box and whisker plot (1st and 3rd quartiles, median, and range) and results in 2017 of a paired 2-sample t-test of the weight of squid after the additional floats were removed from the squid TI cable grid. All tows shown except tows where gear problems occurred.

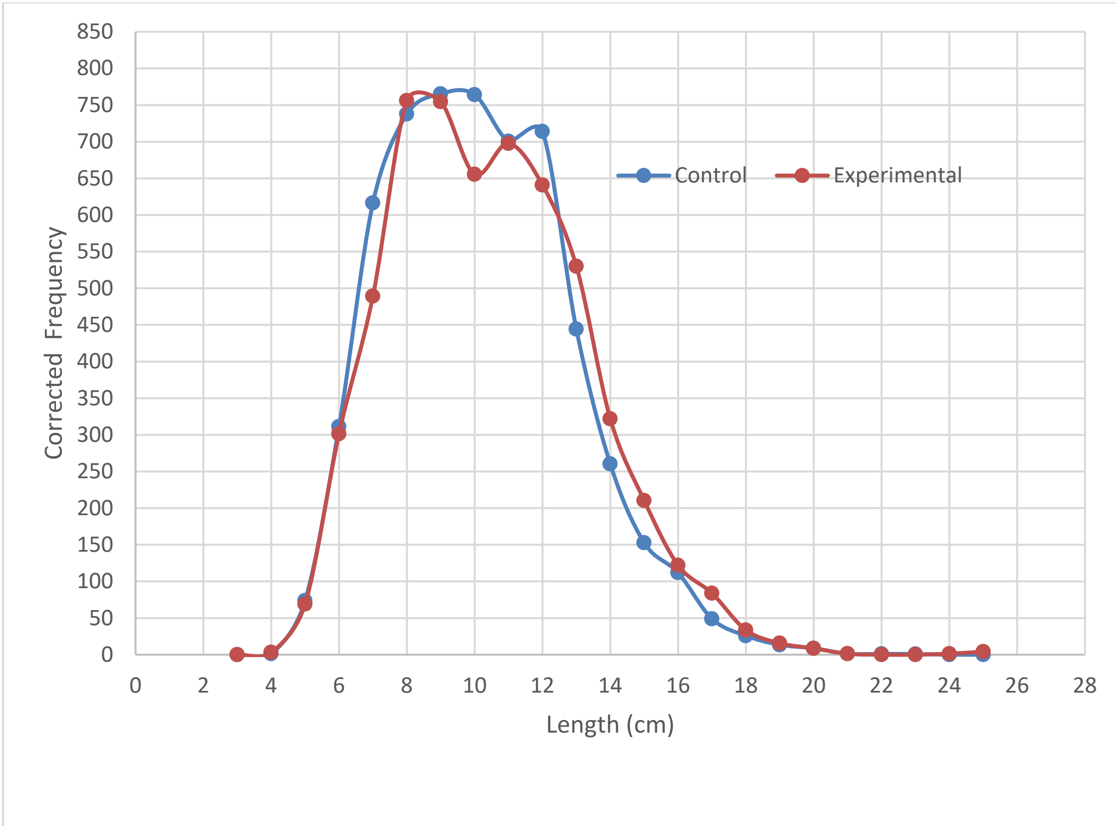


Figure 12. Longfin inshore squid length frequency in 2017. Normalized length frequency plot of squid lengths between the control and experimental gear.

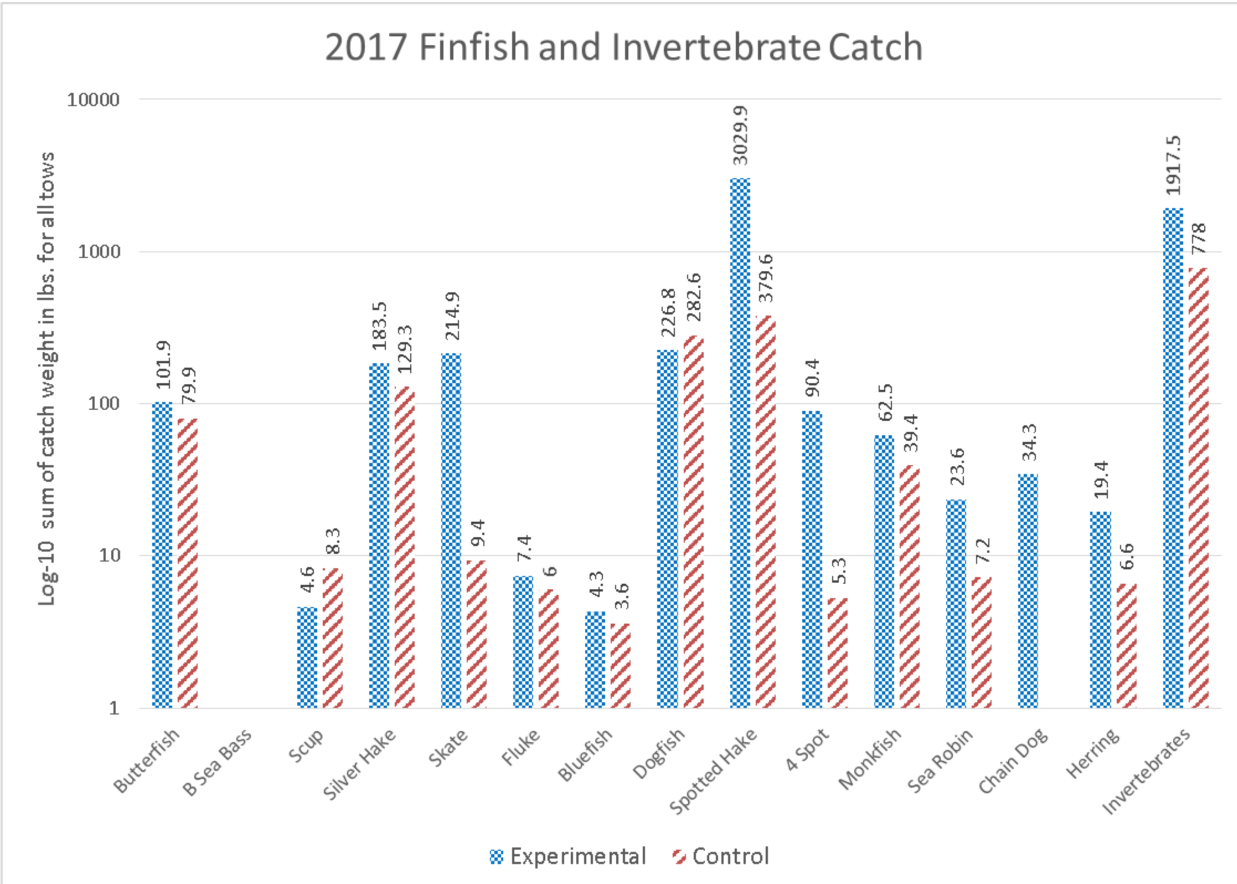


Figure 13. Sum of the weights of butterfish (*Peprilus triacanthus),* black sea bass (*Centropristis striata*), scup (*Stenotomus chrysops*), silver hake (*Merluccius bilinearis*), skates (Rajidae sp.), fluke (*Paralichthys dentatus*), dogfish (Squalidae sp.), spotted hake (*Urophycis regia)*, fourspot flounder (*Paralichthys oblongus*), monkfish (Lophius sp.), searobin (Triglidae sp.), chain dogfish (*Scyliorhinus retifer*), herring (Clupeidae sp.), and invertebrates (mix of echinoderms, arthropods, and other) plotted on a log^{10} Scale. Sum of the weights of individual finfish species and invertebrate/trash complex plotted on a log^{10} Scale. All tows in 2017 used.

t-Test: Paired Two Sample for Means

2018	*Control*	*Experimental*
Mean	534.5060714	557.9142857
Variance	109490.5229	141000.9698
Observations	28	28
Pearson Correlation	0.884558544	
Hypothesized Mean Difference	0	
df	27	
t Stat	- 0.707195216	
P(T<=t) one-tail	0.242752374	
t Critical one-tail	1.703288446	
P(T<=t) two-tail	0.485504747	
t Critical two-tail	2.051830516	

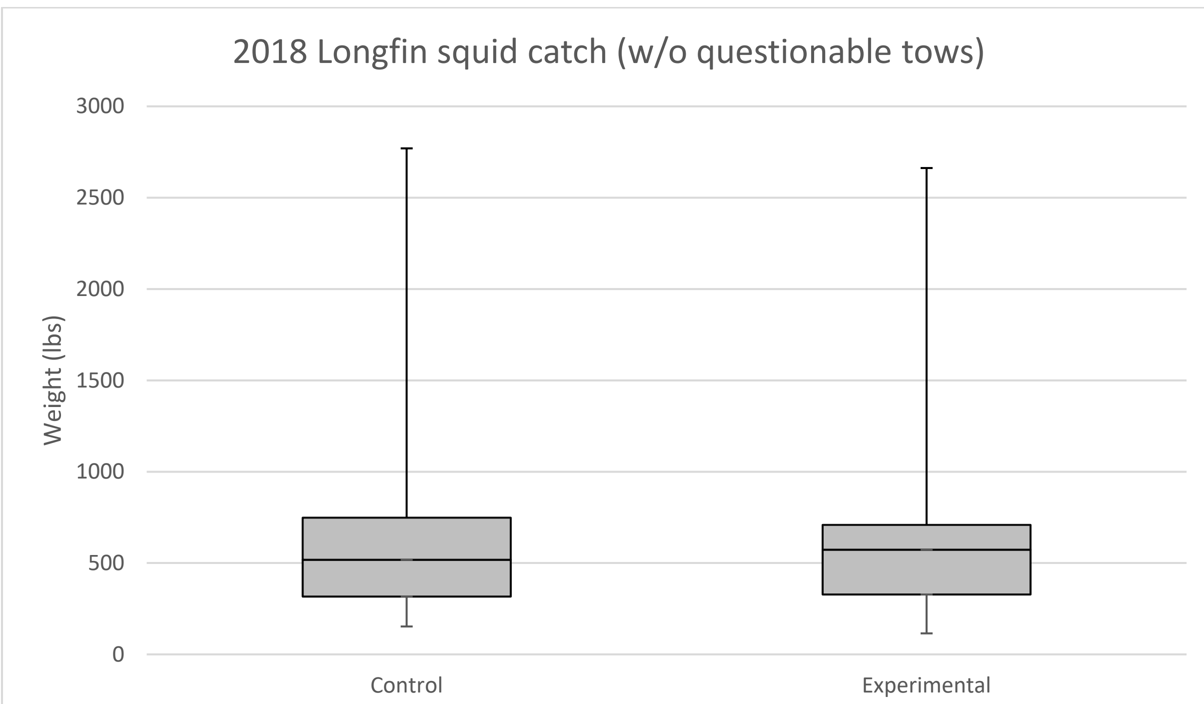


Figure 14. Longfin inshore squid catch results for all tows in 2018. Box and whisker plot (1st and 3rd quartiles, median, and range) and results pf a paired two-sample t-test of squid Type I cable grid. All tows shown except tows where gear problems occurred.

t-Test: Paired Two Sample for Means

2018	*Control*	*Experimental*
Mean	746.8892857	743.7396429
Variance	1375395.534	2337828.937
Observations	28	28
Pearson Correlation	0.845563951	
Hypothesized Mean Difference	0	
df	27	
t Stat	0.020199719	
P(T<=t) one-tail	0.492016296	
t Critical one-tail	1.703288446	
P(T<=t) two-tail	0.984032592	
t Critical two-tail	2.051830516	

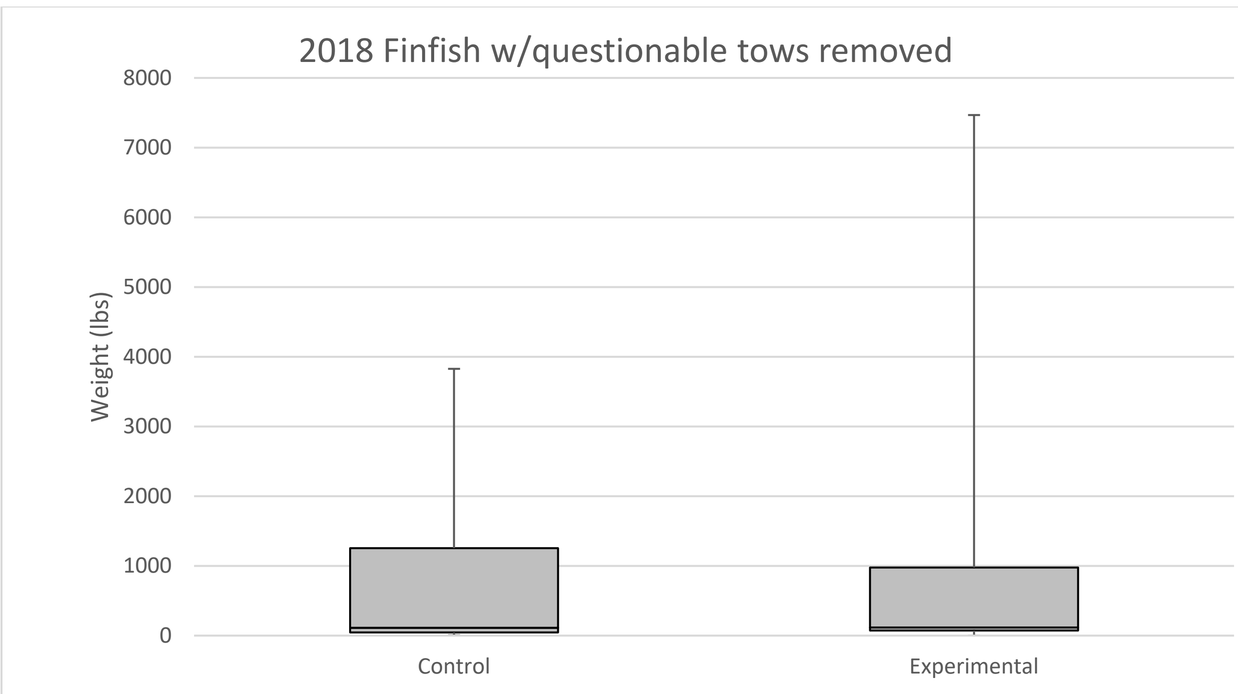


Figure 15. Finfish catch results for all tows in 2018. Box and whisker plot (1st and 3rd quartiles, median, and range) of the finfish bycatch comparison between the control and experimental nets. All tows shown except tows where gear problems occurred.

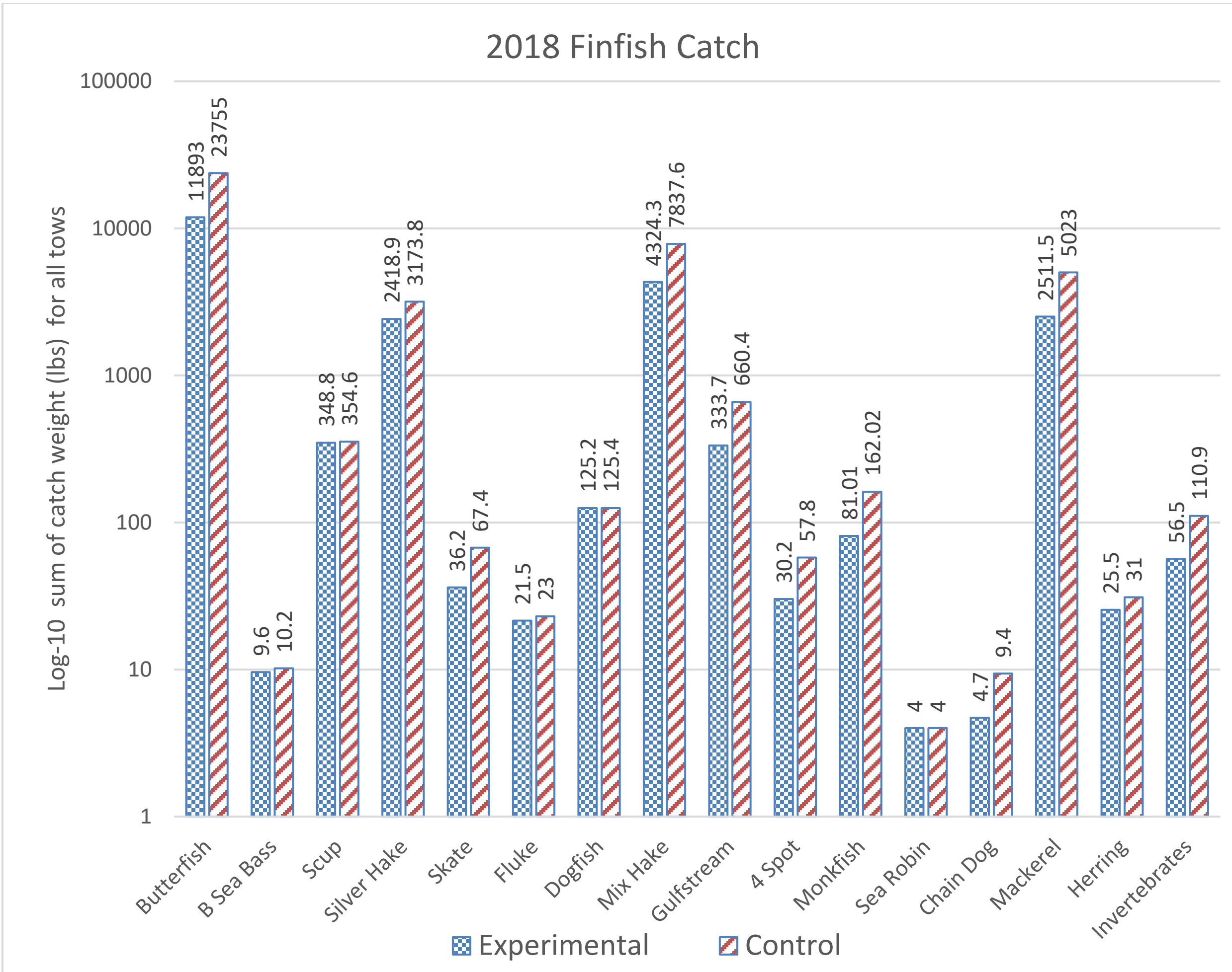


Figure 16. Sum of the weights of butterfish (*Peprilus triacanthus),* black sea bass (*Centropristis striata*), scup (*Stenotomus chrysops*), silver hake (*Merluccius bilinearis*), skates (Rajidae sp.), fluke (*Paralichthys dentatus*), dogfish (Squalidae sp.), hake mix (Merluccius sp*.),* Gulf stream flounder (*Citharichthys arctifrons*), fourspot flounder (*Paralichthys oblongus*), monkfish (Lophius sp.), searobin *(*Triglidae sp.), chain dogfish (*Scyliorhinus retifer*), mackerel (*Scomber scombrus*), herring (Clupeidae sp.), and invertebrates (mix of echinoderms, arthropods, and other) plotted on a $\log^{10}$ Scale. All tows in 2018 used.

t-Test: Paired Two Sample for Means		
2018	*Control*	*Experimental*
Mean	3.557142857	1.878571429
Variance	23.38328042	1.732857143
Observations	28	28
Pearson Correlation	0.355062528	
Hypothesized Mean Difference	0	
df	27	
t Stat	1.957173367	
P(T<=t) one-tail	0.030369816	
t Critical one-tail	1.703288446	
P(T<=t) two-tail	0.060739633	
t Critical two-tail	2.051830516	

Figure 17. Invertebrate and trash catch results for all tows in 2018. Box and whisker plot (1st and 3rd quartiles, median, and range) of the benthic invertebrates comparison between the control and experimental. All tows shown except tows where gear problems occurred.

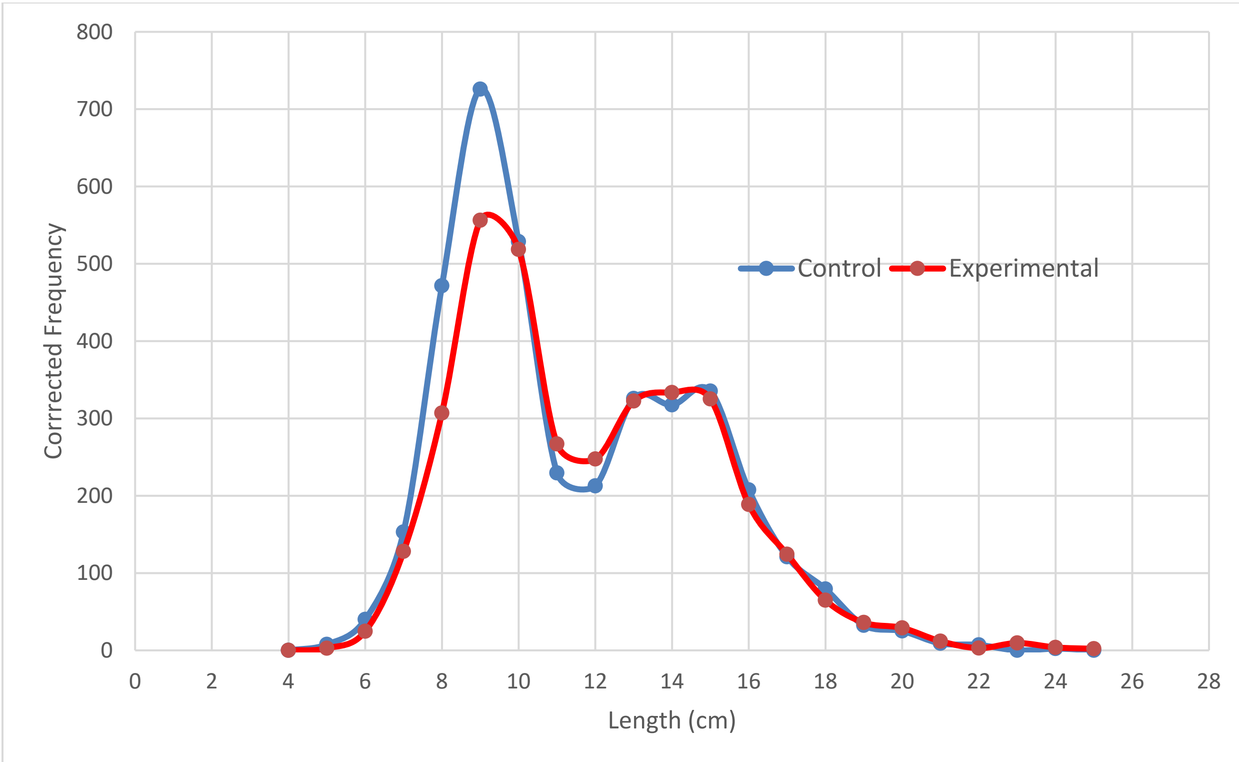


Figure 2. Longfin inshore squid length frequency in 2018. Normalized length frequency plot of squid lengths between the control and experimental gear.

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