Project title: **A Preliminary Evaluation of Stretch-Mesh Catch Controls**

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Project objectives:

1. Develop the concept of stretch-mesh catch controls and integrate it aboard the F/V Skimmer.
2. Conduct field trials to determine the effect of stretch-mesh catch controls on the retention of unwanted juvenile groundfish.
3. If the concept proves useful, develop plans for further evaluation under commercial fishing conditions.

The Concept:

The stretch-mesh concept is pictured in Figures 1a and 1b.

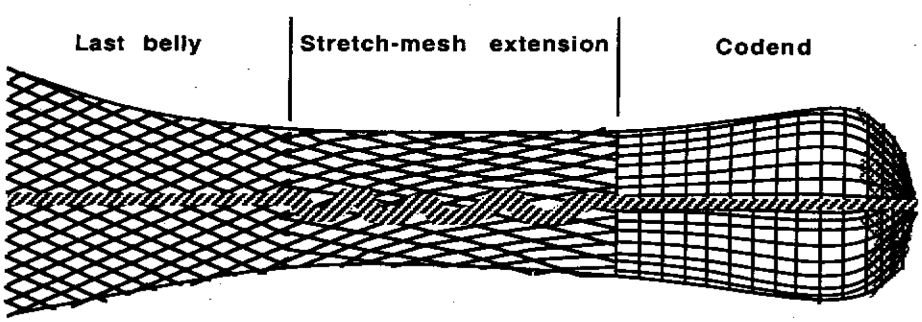

Figure 1a. Stretch-Mesh provides regulation mesh size at the beginning of the tow.

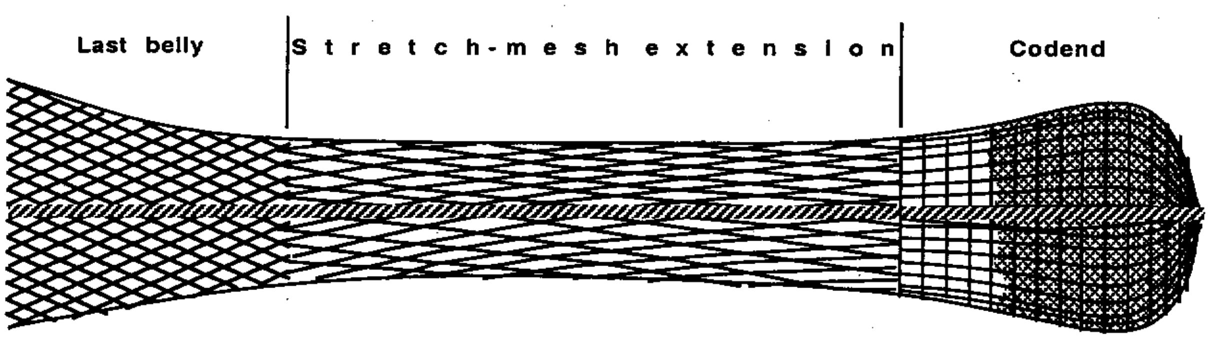

Figure 1b. Stretch-Mesh expands to increase escapement under a specified load.

Success at meeting our objectives:

This project was funded by the Northeast Consortium as a development project to explore a concept aimed at reducing the waste of resources associated with regulatory discards. The concept was conceived by Capt. Nino Randazzo in response to the frequent and often unavoidable catches of small cod that he encounters in his normal trawling. Called stretch-mesh catch controls, it involve the replacement of a portion of the extension or codend of a trawl with a section that increases its mesh size as the codend loads up with fish.

We seek a design that maintains near-normal mesh size until a specified amount of fish have been caught. After that point, the mesh size should increase to encourage the retention of only the larger and marketable fish. Our approach is to replace the normal nylon or poly twine used in the codend extension with bungee cord of the appropriate strength. However, we knew that the load on a net is a function of its hydrodynamic resistance and not directly proportional to retained catch. Our first step was to quantify that relationship.

We conducted experiments aboard the F/V Skimmer to determine the relationship between codend catch and its resistance through the water. To do this we built a test rig to allow us to tow only the extension and the codend and rigged a means of measuring its drag. This hoop and bridle is pictured in Figure 2.

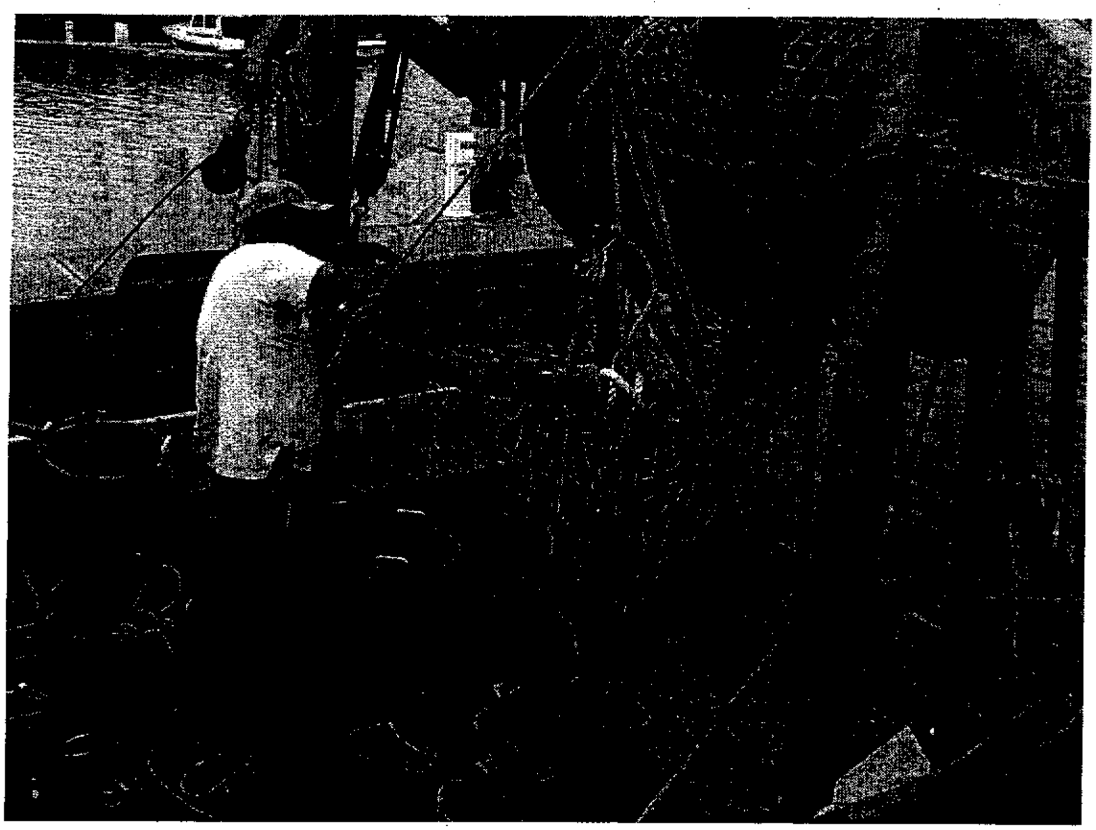

Figure 2. Captain Randazzo seizing the extension to the towing hoop.

We used skate to simulate catch and measured the towline tension over a range of speeds and catch loadings. Figure 3 pictures the large skate used in the tests and Figure 4 shows the load measuring apparatus.

Figure 3. Large skate being loaded into the test codend.

Figure 4. The dial dynamometer and strain gage load cell.

Tests were done using a 6.5″ square-mesh poly codend in combination with a 6.5″ diamond extension. These components were supported by a 50″ diameter hoop and towed with a bridle using a 20 fm length of 5/8″ polyester line. Chain was added to the hoop to provide sufficient weight to keep the apparatus submerged during the full range of towing speeds.

The rig was towed from the port gallows frame using two load measurement devices: a dial dynamometer and a strain gage load cell. The load cell was powered by a regulated 10 VDC source and connected to a multimeter. The dial dynamometer proved more useful due to the load fluctuations associated with prop wash and boat wakes. Careful visual averaging during periods when the codend was outside the wash yielded reliable results. Speed was determined from GPS. All runs were made in the same location towing in the same direction.

The rig with no fish was first tested over a range of engine RPMs from 550 to 1050, resulting in incremental towing speeds up to 5.0 knots. The load and speed at each RPM was recorded. The rig was retrieved and large skate were added in increments of totes (~160 lbs) and the resistance measured over the same range of RPMs. Table 1 is the data collected during the experiments.

The data reveals the anticipated increase in resistance and resultant decrease in speed for each RPM as fish were added to the codend. The no-fish run was repeated at the end of the experiment to verify those values and good agreement was found.

	No fish		1 tote		2 totes		4 totes		7.7 totes		No fish	
RPM	Kts	Lbs	Kts	Lbs	Kts	Lbs	Kts	Lbs	Kts	Lbs	Kts	Lbs
550	2.6	205	2.4	270	2.6	290	2.1	320	2	320	3	190
650	3	240	3	340	2.7	400	2.5	430	2.3	450	3.4	255
750	3.5	300	3.2	450	2.9	460	2.8	510	2.8	540	3.8	320
850	4.2	390	3.6	560	3.5	590	3.2	620	3	710	4	390
950	4.5	490	4.2	720	4	770	3.5	800	3.5	860	4.4	490
1050	5.3	610	4.5	890	4.2	930	4.1	980	4	1060	5	570

Table 1. Raw data from F/V Skimmer codend tests.

In order to determine the relationship between fish loading and codend resistance the data was plotted as Drag vs. Speed. A speed-squared relationship was developed for each loading run to relate the speed and the resistance. A numerical constant was added to the squared term to account for the non-zero value that would be anticipated at zero speed due to underwater weight. Numerical values were determined that produced a good fit to the data. The plotted raw data and second-order relationships are shown in Figure 5.

Using these second order plots, the relationship between codend loading and its resistance can be determined as shown in Figure 6. The results reveal a rapid increase in codend resistance with the initial loading of fish. Typically, the first 600 pounds of fish results in two to three times the rise in resistance compared to the addition of another 600 pounds of fish.

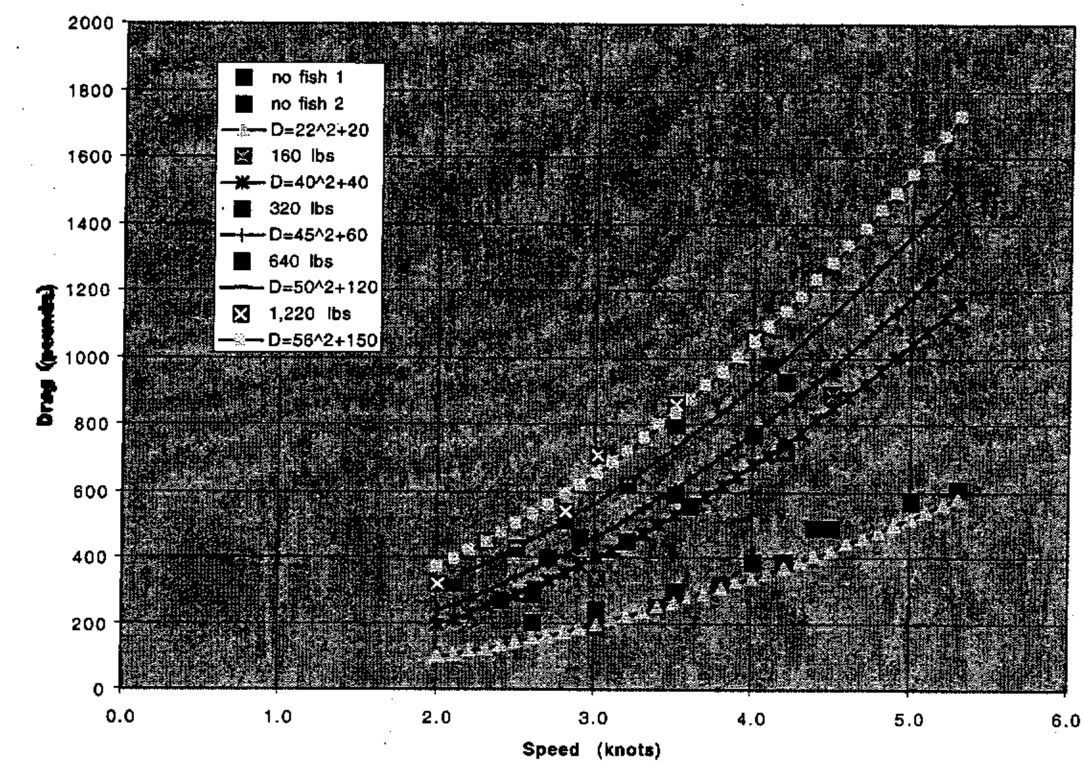

Figure 5. Drag vs. speed at various codend loadings.

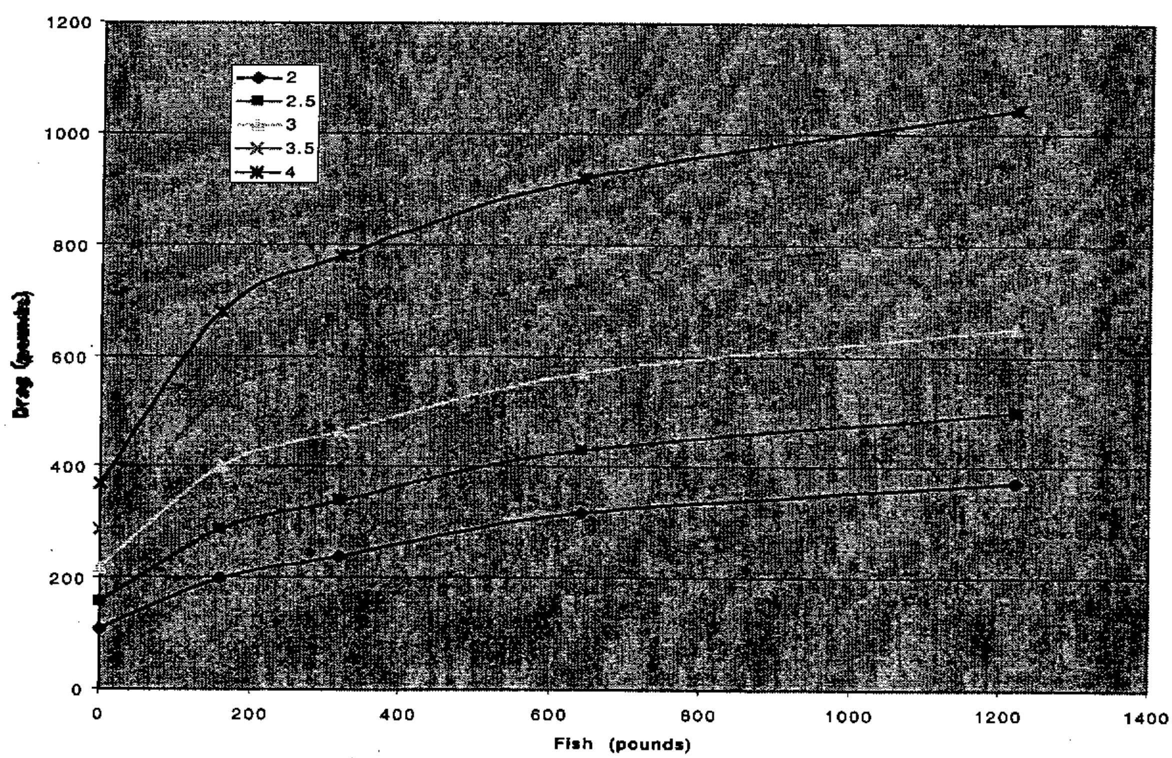

Figure 6. F/V Skimmer codend drag vs. fish loading at various speeds.

The second phase of this preliminary engineering work was to identify a suitable bungee cord that offered appropriate stretch characteristics. Bungee cord is specified based on its relaxed diameter and ultimate strength. Suppliers and even manufacturers seem to lack any knowledge of the actual performance of their products.

Six different cords from three different manufacturers were obtained and tested. Tests involved applying a load and measuring the resulting length compared to the relaxed length. One product offered acceptable stretch performance and our test results are presented in Figure 7. The results reveal the typical ogee type curve indicating more resistance early in the loading process and again as the cords elastic limit is reached. With this stretch data, the performance of a stretch-mesh catch control can now be predicted.

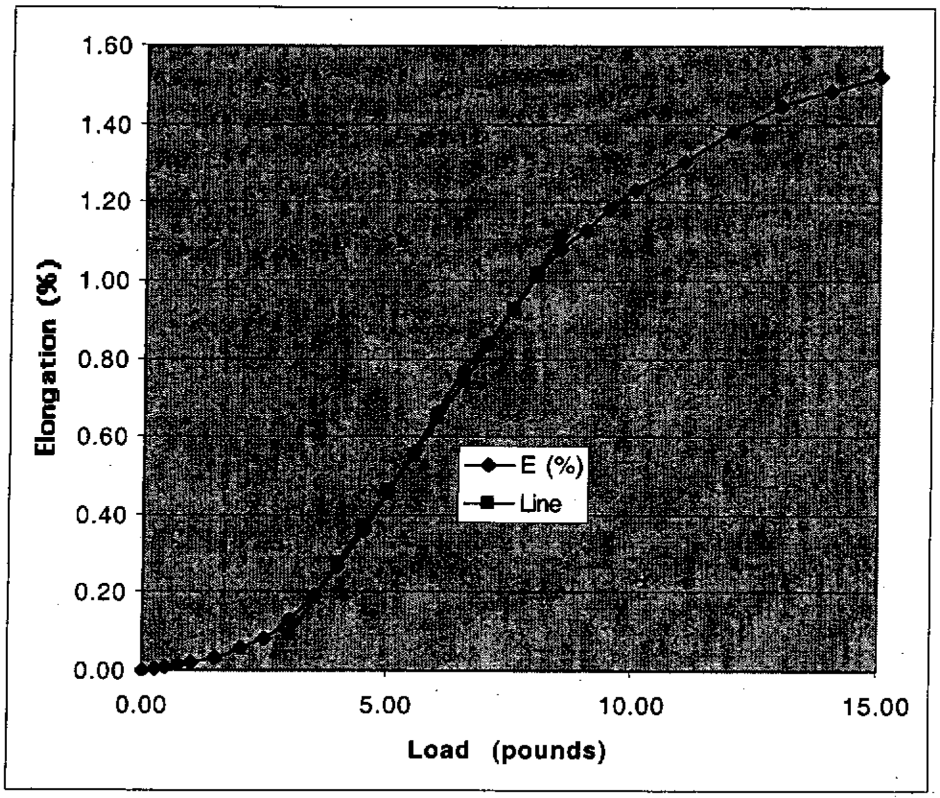

Figure 7. The elongation characteristics of 3/16″ bungee cord 3A.

Captain Randazzo uses a 6.5″ square mesh codend that is 50 meshed around. The stretch-mesh catch controls are implemented in a diamond mesh section ahead of the codend. A 1:1 mesh count is desired at this intersection, therefore there will be 100 strands of bungee supporting the codend.

Based on the test data shown in the above figure, the mesh size of the stretch-mesh catch control can be determined and is shown in Figure 8. By referring to previous Figure 6 and selecting a towing speed, the characteristics of this elastic section can be predicted under the accumulation of fish.

A ten-mesh-long section is currently being constructed by Capt. Randazzo. We are using hog rings rather than knots to ensure dimensional stability of the assembly.

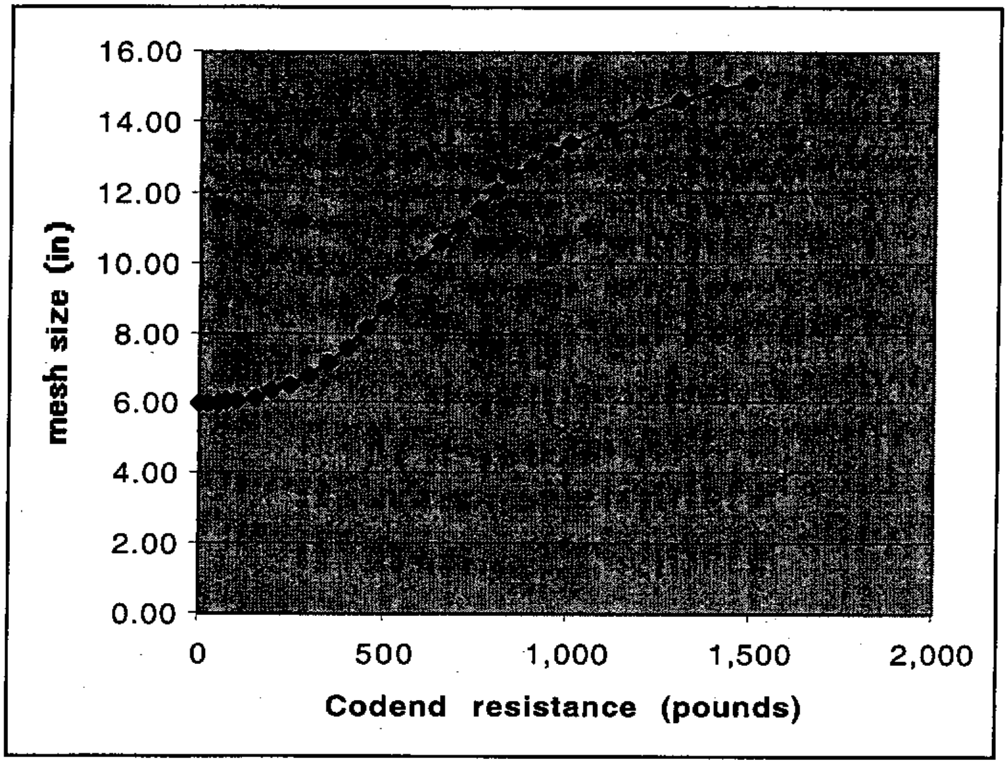

Figure 8. Mesh size vs. cod end resistance with a 100 mesh extension made of 3/16" bungee cord.

Summary of accomplishments:

1. The resistance of a codend vs. catch has been determined over a range of speeds.
2. The elongation properties of candidate bungee cord has been determined.
3. A suitable design for stretch mesh catch controls has been developed and is currently being constructed.

Next steps:

The stretch-mesh catch control being constructed by Capt. Randazzo will be tested mechanically to verify its elastic performance compared to our predictions. This will be done aboard with a load cell and a winch.

The section will then be installed into Capt. Randazzo's net preceded by a tapered conventional extension to transition the mesh count from the 60 meshes of the last bellies to the 50 meshes of the new stretch-mesh section.

As indicated in Figure 1a, gore ropes will be included in the design to provide the load carrying capacity needed during haulback and for hoisting the codend aboard. These gore ropes will also be adjustable to restrict the elongation of the stretch-mesh section to suit fishing conditions.

The assembled net will then be tested under fishing conditions. We plan to be as rigorous as our funding will allow, swapping between the experimental extension and a conventional twine extension to compare catch results.