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# Selectivity Tests with Knotless Mesh in Trawl Codends in the Northeast Groundfish Fishery

Dana Morse, Maine Sea Grant and University of Maine Cooperative Extension
*in collaboration with*
Captain Stanley Coffin, F/V Bad Penny, Edgecomb, Maine
Captain Kelo Pinkham, F/V Jeannie C, Boothbay, Maine

## Background

The selective properties of knotless twine have been of interest to fishermen, scientists and resource managers alike. Knotless twine holds appeal for some in northeast U.S. trawl fisheries, though its use is sometimes limited by high material costs. Ideally, knotless mesh enhances selection against undersized flatfish, while maintaining the catch of legal-sized individuals.

This project, funded by the Northeast Consortium, examined knotless codend performance when fished in the diamond configuration. The specific objective was to evaluate the selective properties of knotless 6.5" (165.1 ml) mesh, in the codend of a bottom trawl, used in the groundfish fishery of the Gulf of Maine. A companion project, similarly funded by the Northeast Consortium, was conducted concurrently.

This publication describes the project in brief, and provides some general pros and cons on the use of knotless twine. The full project report (Maine Sea Grant Technical Report MSG-TR-04-01) can be downloaded in PDF format from the Maine Sea Grant Web site (www.seagrant.umaine.edu).

## Research Methods

Two codends were constructed, both with 6.5" (165.1 ml) diamond mesh, 60 meshes around by 50 meshes long. The control codend was constructed with green 5.5 mm doubled RedLine polyethylene netting, and the experimental (knotless) with black 600-ply Ultra Cross polyethylene twine, with a twine diameter of 8.8 mm (Figures 1 and 2).

**Figure 1**. Knotted twine used in Control codend.

**Figure 2**. Knotless twine used in Experiemental codend.

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F/V Bad Penny
Length: 54 ft
Beam: 16.5 ft
Horsepower: 300
Engine: Volvo Penta, TMD 121
Doors: Steel, 650 lbs
Groundgear: 30 fa. 2.5” cookies over wire
Net Headrope/Footrope: 120ft/140ft
Flotation: 11 - 8” dia. trawl floats
Sweep: Disk-and-spacer, 12” disks

**Figure 3**. F/V *Bad Penny,* owned and operated by Captain Stanley Coffin.

Codends were attached to a groundfish net aboard the F/V Bad Penny, owned and operated by Capt. Stanley Coffin of Edgecomb, ME (Figure 3).

We used an alternate-tow approach, and separated the catch by species at the end of each tow. Data were collected on weights (all species) and length frequencies (cod, haddock, pollock, monkfish, all flatfish species). Underwater video clips of the nets in action, courtesy of Capt. Bill Lee of Rockport, MA, are available for viewing on the Maine Sea Grant Web site.

| Species | Control N* | Exper. N* | Ave Control CPUE (kg/hr) | Ave Exp CPUE (kg/hr) | Significant difference? |
|---|---|---|---|---|---|
| Monkfish | 13 | 13 | 51.6 | 48.2 | No |
| Am Plaice (dab) | 13 | 13 | 9.1 | 7.8 | No |
| Grey sole | 13 | 13 | 2.5 | 2.7 | No |
| Skate speices | 13 | 13 | 11.1 | 12.7 | No |
| Lobster | 9 | 10 | 3.2 | 3.5 | No |
| Crab species | 13 | 13 | 5.0 | 5.2 | No |

**Table 1.** Weight summaries and t-Test results for 6.5” diamond knotted/knotless codend comparison, F/V Bad Penny, 2003.

** N refers to the number of tows in which the species was recorded.*

## Results

Thirteen useable tow pairs were conducted aboard the F/V Bad Penny, between April and July of 2004. Tows averaged 2.6 hours in length, and were conducted in the Gulf of Maine, in the areas of Three Dory Ridge and Harvey Black’s Ridge.

**Comparison of catch weights by species:**
A summary of the catch rates and t-Test results for monkfish, American plaice and grey sole are given in Table 1. Meaningful analysis was not possible for several other species due to low fish abundance.

**Length Frequency Analysis:**
Due to the low catch numbers of individuals for many species, analysis of length-frequency (LF) data was possible only for plaice, grey sole, and monkfish. Kolmogorov-Smirnov (K-S) test results indicated no significant difference between the nets in all comparisons made, except for a slight difference detected for legal plaice. Of the 1,871.4 kg of monkfish caught in total by the knotted codend, 645.5 kg was used for LF analysis, or 35.0% of the total by weight. The knotless codend retained 1,641.8 kg of monkfish, of which 1,330.4 kg or 81.0% by weight was used for LF. Table 2

| Species/size | # Individuals Knotted tows | # Individuals Knotless tows | Predicted K-S Statistic | Observed K-S Statistic | Significant difference? |
|---|---|---|---|---|---|
| Plaice sub-legal | 275 | 190 | 12.82 | 6.76 | No |
| Plaice legal | 375 | 334 | 10.23 | 10.28 | Yes |
| Grey sole sub-legal | 117 | 129 | 17.37 | 5.78 | No |
| Grey sole legal | 135 | 136 | 16.52 | 12.28 | No |
| Monk fish sub-legal | 471 | 433 | 9.05 | 4.94 | No |
| Monk fish legal | 129 | 126 | 17.03 | 15.13 | No |

**Table 2.** Kolmogorov-Smirnov results for 6.5” diamond knotted/knotless codend comparison, F/V Bad Penny, 2003.

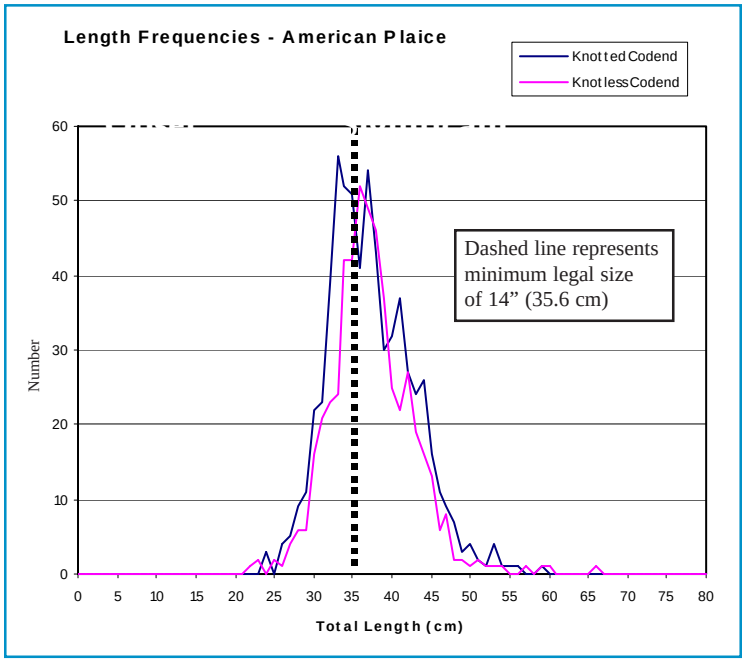


**Figure 4.** Length frequencies for American plaice.

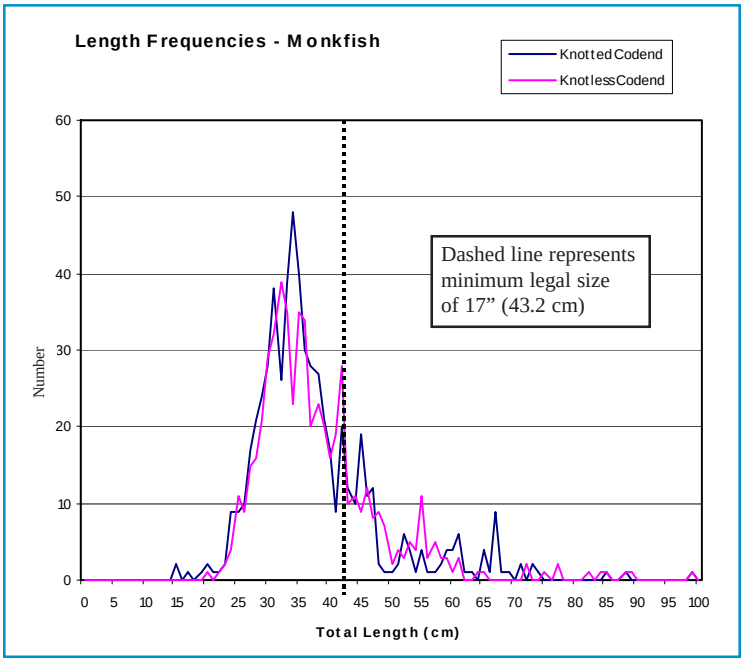


**Figure 5.** Length frequencies for monkfish.

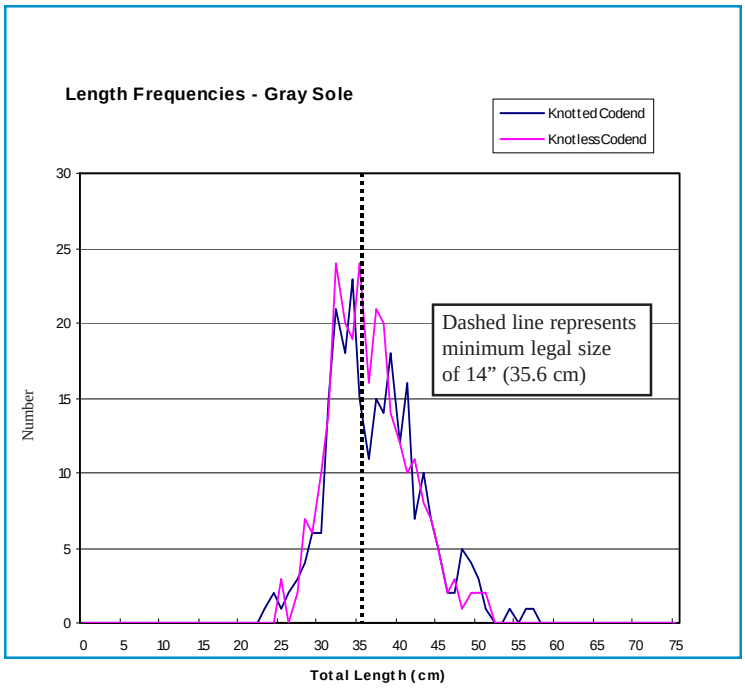


**Figure 6.** Length frequencies for grey sole.

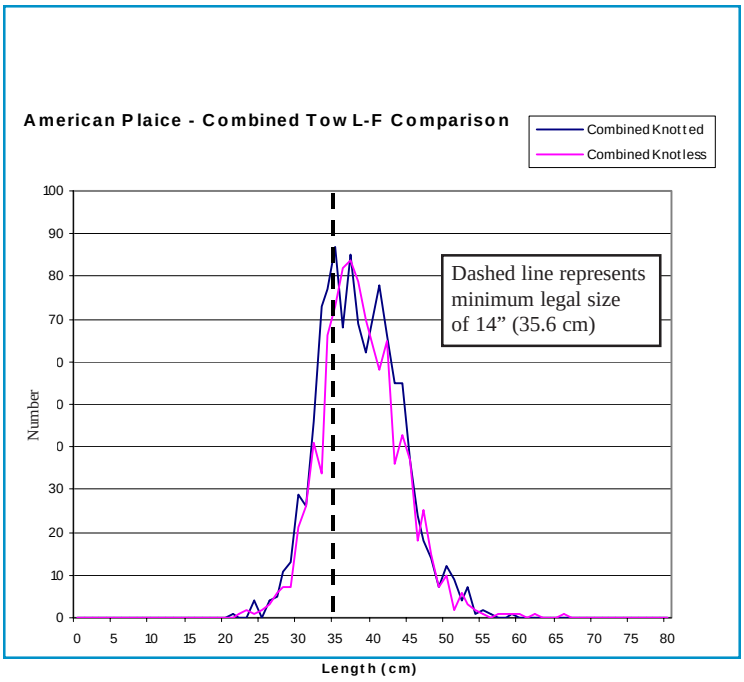


**Figure 7.** Length frequencies for American plaice, using data combined from field trials aboard the F/V Bad Penny and F/V Jeannie C.

summarizes the results of K-S test analyses. Figures 4, 5 and 6 show cumulative length frequencies for American plaice, monkfish and grey sole, respectively.

The same two codends used aboard the F/V Bad Penny were also used in a companion project, aboard the F/V Jeannie C. Twelve pairs of tows resulted from that study, and length data for plaice were combined with that from the Bad Penny, shown below in Figure 7. The K-S test, when applied to the combined length data for plaice, detected no difference between the knotted and knotless codends.

## About Knotless Netting

There are pros and cons to using knotless twine in trawling operations. On the pro side, knotless twine has superior strength per given twine diameter to knotted, especially when hung in the square configuration, where it excels in holding shape. By virtue of such strength, smaller twine diameters of knotless can be incorporated into various parts of a trawl, and may have significant impact. For example, when smaller diameter twines are used, twine surface area goes down and drag is reduced. Thus, if nets use a high proportion of small diameter knotless twine, then larger nets for a given vessel can be constructed and used without changing other factors such as door or engine size. Reduced drag from the net can also improve fuel efficiency.

In certain applications, longevity is cited as a benefit; knots act as high points and are especially subject to abrasion. Fish quality is reportedly higher in some applications, and depending on the situation, may have a positive result at the marketplace.

Conversely, knotless twine is more expensive than knotted, and depending on the material and twine diameter, can be three times the price for knotted. Fishermen have to balance the up-front cost against the potential for the knotless twine to accommodate heavier catches. In addition, patching a rip in knotless twine is a technique new to many fishermen, and generally requires more time to perform the job correctly. Lastly, knotless twine requires a little more in maintenance to prevent shrinkage, though the maintenance is not difficult. After trawling in areas of soft bottom or mud, it is recommended to tow the gear in the prop wash. This can be accomplished while steaming, and reduces the amount of sediment accumulating in the weave of the twine.

As with any piece of equipment, those seeking more information are encouraged to visit their local gear shop, and talk with fellow fishermen. Other sources include:

www.net-sys.com - Manufacturer/Distributor of knotless twine; repair tips on this web site as well

Farmer, M.J., D.T. Brewer, and S.J.M. Blaber. 1998. Damage to selected fish species escaping from prawn trawl codends: a comparison between square-mesh and diamond mesh. *Fisheries Research* 38(1): 73-81.

Wray, T. 1990. Knotless trawls reduce fuel costs and improve fish quality. *National Fisherman* 71(3): 40-42.

## Discussion

We did not detect dramatic differences for catch weights or length frequencies for any species in this study. However, Figure 7 shows an interesting trend toward release of plaice just under the legal size. Additional research would assist in further quantifying this trend. Mesh sizes for the knotless netting were slightly larger than for the knotted (average sizes of 165.0 mm for the knotted and 169.6 mm for the knotless), so higher escapes from the knotless in that size range might be expected.

Health of the escapees and the discards are of interest. Observations from the deck seemed to indicate that fish coming out of the knotless codend were less abraded and generally in better shape, but no testing was done to confirm this. The knotless twine also appeared more supple and easier to handle. Underwater video displayed a general tendency for the knotless twine to remain more open than the knotted, potentially increasing the selectivity of the codend. Further observation would help in understanding this tendency, such as where along the codend the meshes do stay open (e.g., along the whole length or just ahead of the catch), and what influence the amount of catch has on mesh openness.

In summary, the experiment described in this paper did not detect significant differences between knotless and knotted twines, either in catch weights or in lengths of retained fish. Further study should focus on the potential selection difference that is suspected with undersized plaice, on the health of escapees through knotless twine, and on the effects of knotless twine on quality of landed fish.

*For more information please contact:*
Dana Morse
University of Maine
School of Marine Sciences/Darling Marine Center
193 Clark's Cove Road
Walpole, ME 04573
Phone (207) 563-3146 ext. 205
Email dana.morse@maine.edu.

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