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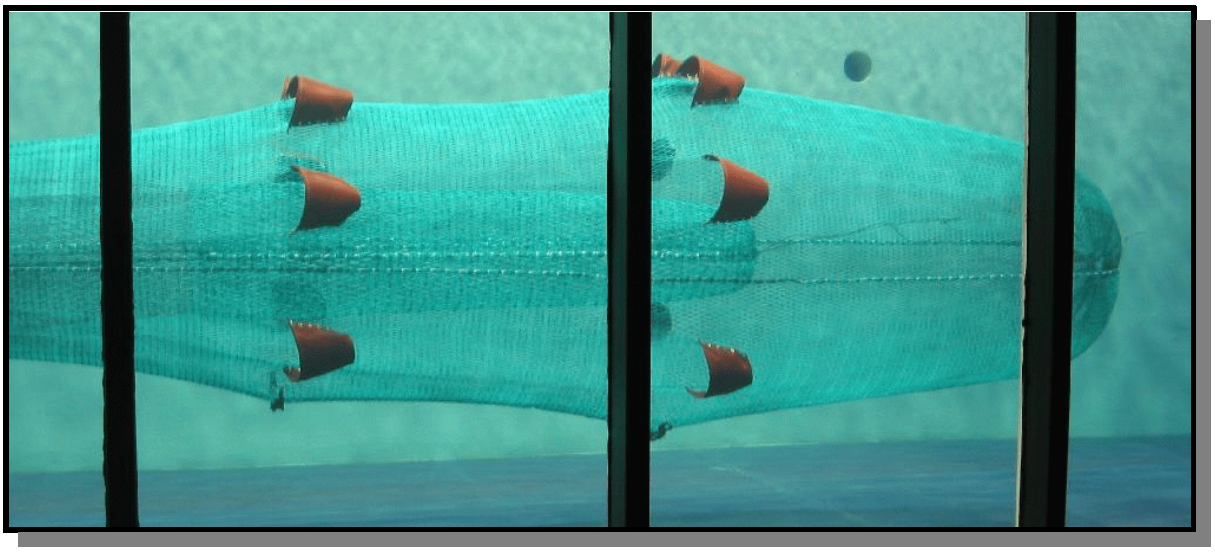
Final Report

A Kite-assisted Cover for Conducting Experiments on Selectivity of Trawl Codend Onboard Fishing Vessels



Submitted to:

The Northeast Consortium
142 Morse Hall
University of New Hampshire
Durham, NH 03824

June 2005 **UNH-FISH-REP-2005-011**

A Kite-assisted Cover for Conducting Experiments on Selectivity of Trawl Codend Onboard Fishing Vessels

by

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A Kite-assisted Cover for Conducting Experiments on Selectivity of Trawl Codend Onboard Fishing Vessels

Summary. The project involves the design and development of a codend cover for conducting codend selectivity studies onboard small (45') commercial trawlers in New England. The focus of this developmental project was to devise a suitable codend cover and to evaluate its application for codend selectivity studies using the covered codend method. Design was completed and flume tank tests were carried out in December 2002. The prototype codend cover was fabricated and field tests were conducted in May/June 2003. The codend cover has been proven suitable in terms of its function and handling by small inshore commercial trawlers. The cover has since been used in a project to study selectivity of the trawl codend of different mesh sizes and mesh shapes funded by the National Marine Fisheries Service Cooperative Research Partnership Initiative during spring/summer 2003 and 2004.

1. INTRODUCTION

Trawl is one of the most important fishing gears in the Gulf of Maine multispecies fishery counting for more than 90% of groundfish landings. Fishery management measures on trawls include the specification of the minimum codend mesh size allowed in the gear to reduce capture of undersized fish, as well as the minimum landing size. At present, the minimum mesh size is 6 ½" or 165 mm measured from inside the opposing knots of a mesh. At times, a large amount of undersized fish is caught and subsequently discarded despite the use the legal mesh size. Determining suitable codend mesh size and mesh shape to reduce undersize fish while maintaining legal size fish catch can provide the National Marine Fisheries Service and the New England Fisheries Management Council means for regulating trawl mesh size to provide benefits to the fish and the fishing industry.

There are a few means to study trawl codend selectivity. They include alternating tows using one vessel, parallel tows using two vessels, twin trawls where one vessel tows two trawls, trouser trawls where two codends are attached to one trawl body, and the covered codend where a larger diameter codend cover of small mesh sizes collects the fish escaping through the codend meshes (Wileman, *et al.* 1996). The covered codend method, if used properly, provides the most direct results for the number and sizes of fish escaped from the codend.

Codend covers intend to collect all the fish escaped from codend meshes, without "masking" the codend. Therefore the covers have to be kept away from the codend mesh, so that fish inside the codend are not inhibited from escaping through the meshes. In the past, hoops have been used to physically expand the cover to make sure the netting of the cover is away from the netting of the codend. It was recommended that stretched dimensions (length and width) of the cover should be at least one and half times the stretched dimensions of the codend to reduce possible "masking" effects of the cover (Wileman *et al.*, 1996). "Hooped" codend covers are difficult to handle with net drums currently in use in New England inshore trawlers. To overcome the handling problem, a codend cover expanded with a combination of kites, floats and weights was tested in Denmark (Madsen *et al.*, 2001), though the design of kites and their installation were quite complex. This report describes the design, flume tank tests and sea trials of the new and simple kite-assisted codend cover without floats and weights.

The objective of the project was to:

- Design a codend cover using hydrodynamic water-borne kites.
- Conduct flume tank tests of the full scale codend cover to determine size, shape, number and position of kites, and the resulting shape of the codend cover in relation to towing speed;
- Conduct full scale trials with the new codend cover onboard a commercial trawler in Gulf of Maine;
- Conducting underwater video camera observation of the behavior of fish exiting the codend and the shape and formation of codend cover under fishing conditions;
- Developing methodology for the use of the codend cover for testing codend mesh selection using cover method.

2. METHODOLOGY

2.1 Design of the Kite and the Codend Cover

The kite was a rubber-coated canvas trapezoid (Exhibit 1). The original kite was larger than the finally-adopted size shown in the exhibit. The leading edge of the kite was strengthened by a ¼" diameter steel wire to ensure that the kite is expanded in the right direction. Altogether 12 kites were used in a cover with eight on the top side and four on the belly side.

The dimension of the cover was intended for codend used in the Gulf of Maine inshore trawlers. The typical codend dimensions are 50 meshes round and 50 meshes long. The cover was 101 meshes long and 254 meshes on the round excluding the selvage. The codend cover was made of 80 mm mesh size (center knot) 3 mm diameter polyethylene netting. A strengthening rope (or lastridge rope) which was 7% shorter than the stretched length of the netting was attached to each side of the selvage to take over strains on the mesh and to allow the meshes to expand from the lift forces generated by the kites. The cover was joined to the trawl's last tapered section using nylon purse rings to allow easy attachment and detachment.

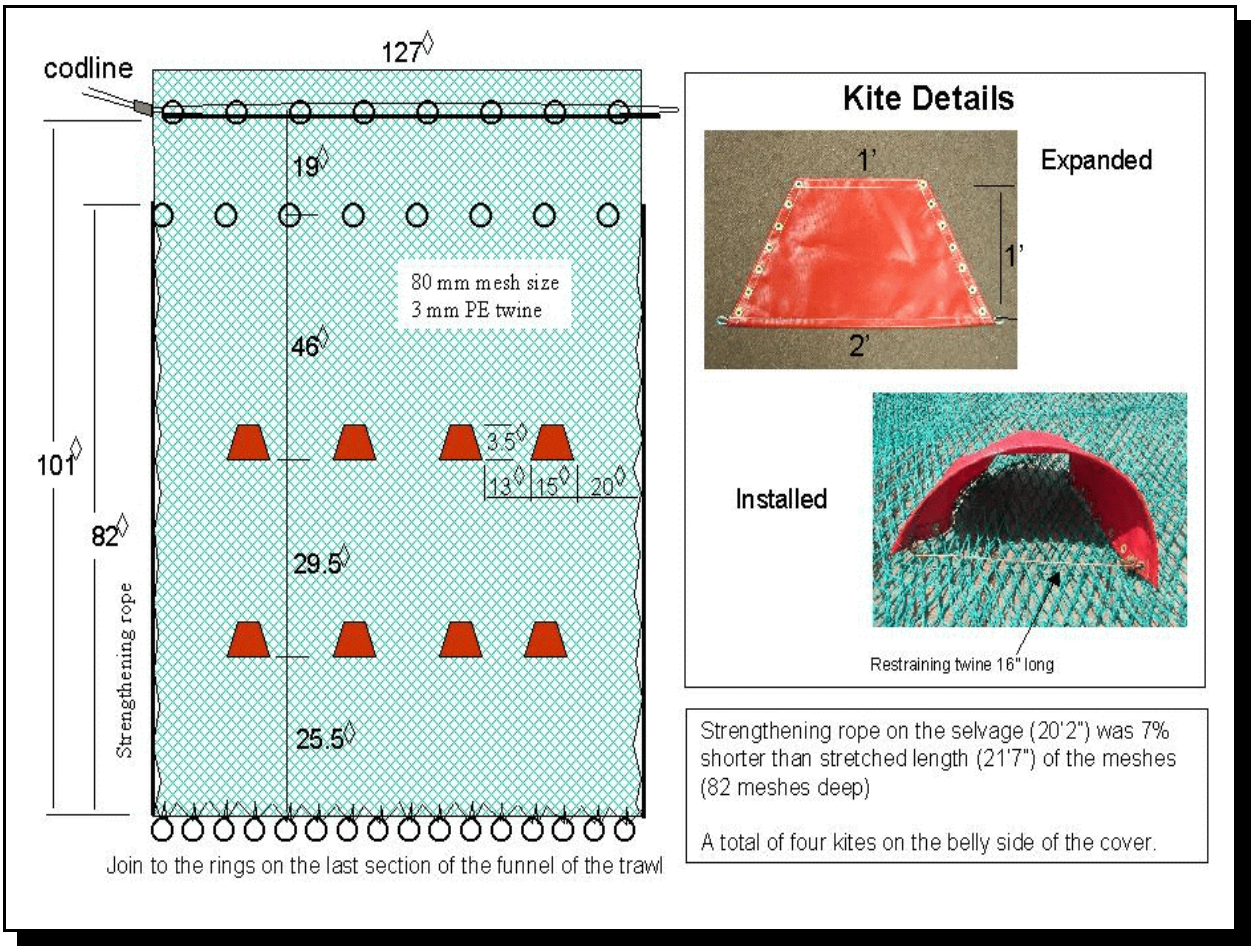

Exhibit 1. Kite design and its installation on the codend cover.

2.2 Flume Tank Tests

The full scale prototype codend cover was tested in the flume tank at the Memorial University of Newfound in St. John's, Canada in December 2002. The tank tests allowed for observation of the

shape of the cover in relation to the codend inside the cover. Twelve smaller kites provided the codend cover with more desirable shape (Exhibit 2, bottom) than the eight large kites used in earlier tests (Exhibit 2, top). The diameter of the cover at the location of second sets of kites was about 2 m (6') at 2 knots.

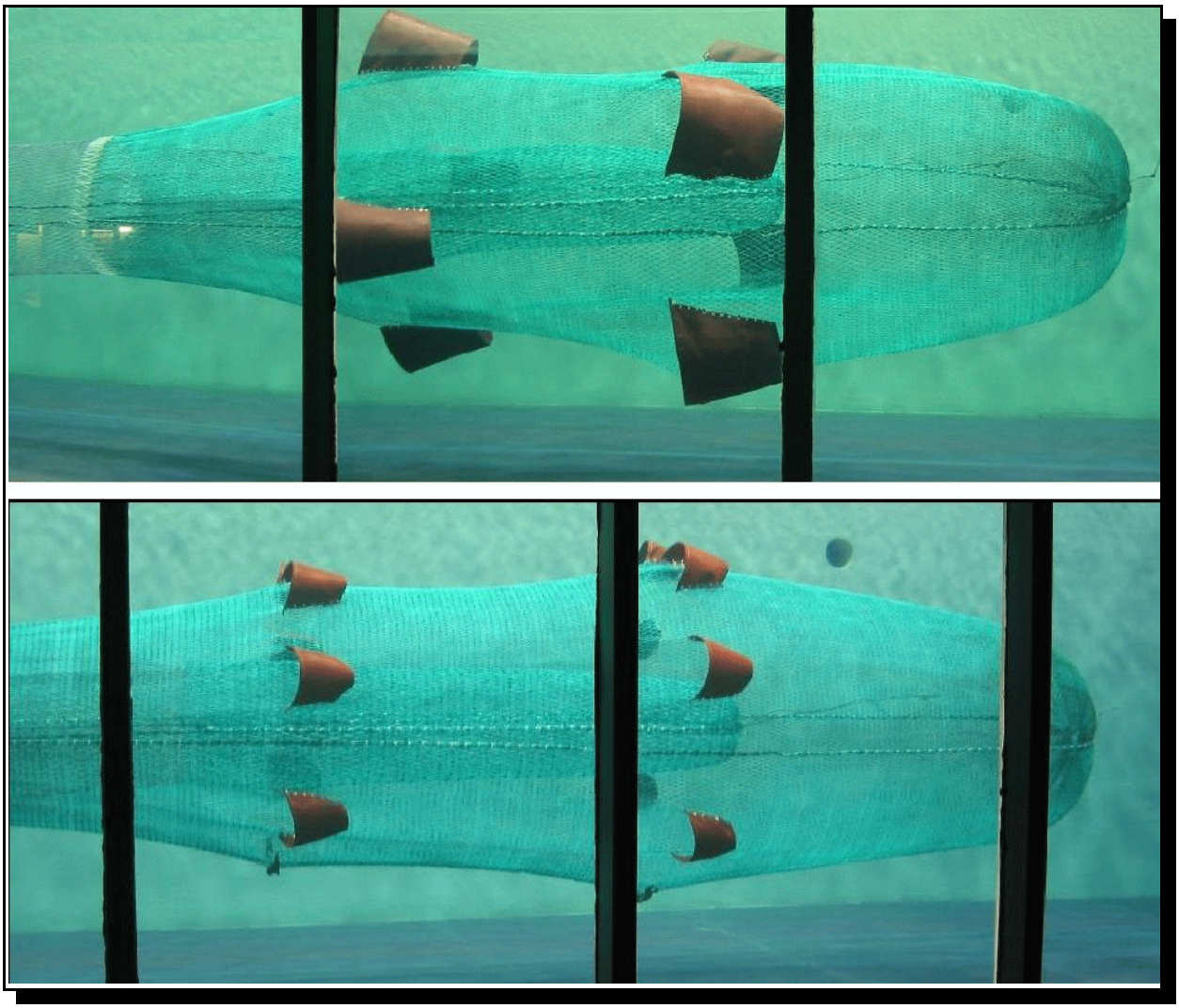

Exhibit 2. Two designs of the kite-assisted codend covers as seen in the flume tank. Top: eight larger kites as tested at the beginning of experiment. Bottom: twelve smaller kites, as later adopted for sea trials.

2.3 Sea Trials

Sea trials were carried out in May/June 2003 onboard F/V "Stormy Weather", a 45' commercial trawler based in Hampton Harbor, New Hampshire. Four fishing days were completed with

underwater observations using a self-contained video recording package (McMarine Instruments, Brier, WA) on fish, codend and the codend cover, along with trawl geometry monitoring using NetMind system (Northstar Technical, St. John's, NF). Sea trials were conducted off New Hampshire at depths between 30 and 60 fathoms. The trawl was towed at 2.8 knots with towing durations of one hour. The codend and the cover were separated at the joint when retrieved, and they were winched in by left and right net drums of the twin-drum fishing vessel (Exhibit 3).

Exhibit 3. The trawl codend with the kite-assisted codend covered being retrieved after one-hour-tow.

3. RESULTS

3.1 Kite and Cover Design

The final design of the kites and the cover suitable for the Gulf of Maine inshore multispecies trawl codend is shown in Exhibit 1. Kite arrangements and the number of kites were shown to be adequate for the purpose of covered codend mesh selectivity studies. Underwater observations indicated that the addition of a strengthening rope (or lastridge rope) on the seams of the cover helped greatly expansion of meshes of the cover, resulting in larger circumference of the cover.

3.2 Operational Performance

Sea trials on fishing grounds indicated suitability of the cover for the covered trawl codend mesh selectivity studies. Underwater video images showed the fully expanded kites at 2.8 knots which is typical towing speed under commercial fishing conditions. (Exhibit 4).

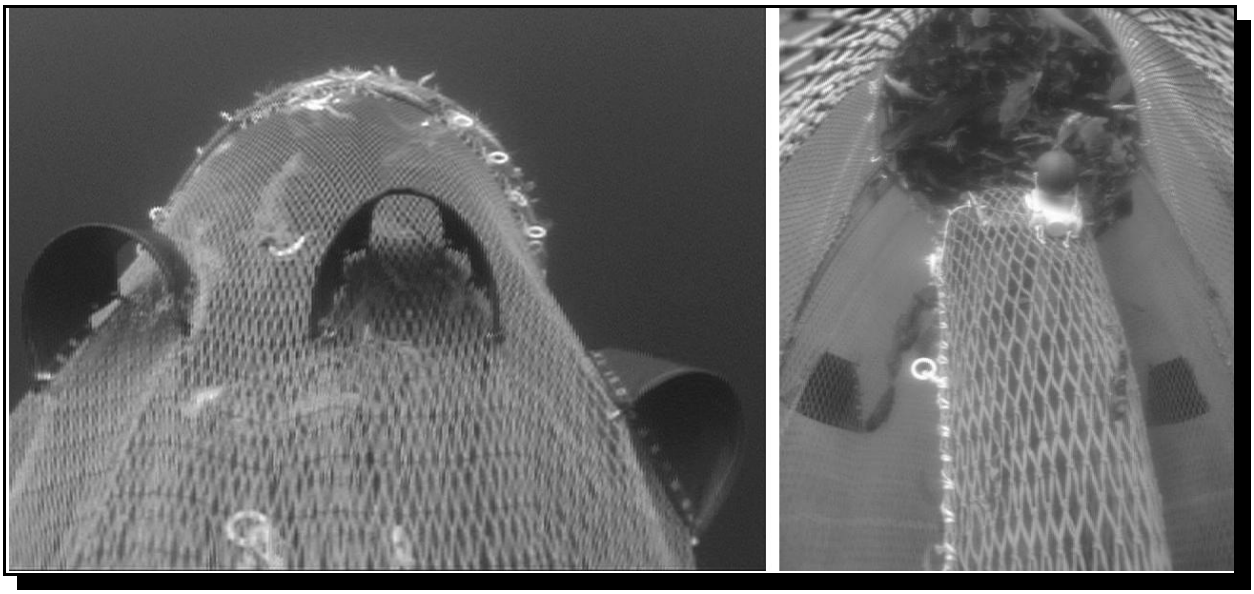

Exhibit 4. The kite-assisted codend covered as seen from the above (left), and the codend inside the cover (right) showing spaces between the codend netting and the cover with fish accumulated at the far end of the cover.

Typical door spread was 210' which tended to decrease by a maximum of 15% when a large amount of catch was retained in the cover. Decreasing door spread due to catch accumulation in the codend as tow progressed is typical in commercial operations, though this phenomenon was more pronounced here due to the small mesh cover which retained a large amount of small fish such as the red hake and small whiting.

The codend cover has since been used in a mesh selectivity study funded by the National Marine Fisheries Service Cooperative Research Partnership Initiative. Detailed results of the use of the codend cover and result of mesh selectivity can be found in a separate report (He, *et al.*, 2003). Examples of fish retained by the codend and the cover are shown in Exhibit 5 where the number of fish of various size groups is shown for yellowtail flounder and haddock, two of the most important commercial species in Gulf of Maine. Examples of length frequency distribution for six species from the 6.5" diamond mesh codend and selectivity curves for American plaice from data obtained in a subsequent project are shown in Exhibit 6 and Exhibit 7 (He, *et al.*, 2003).

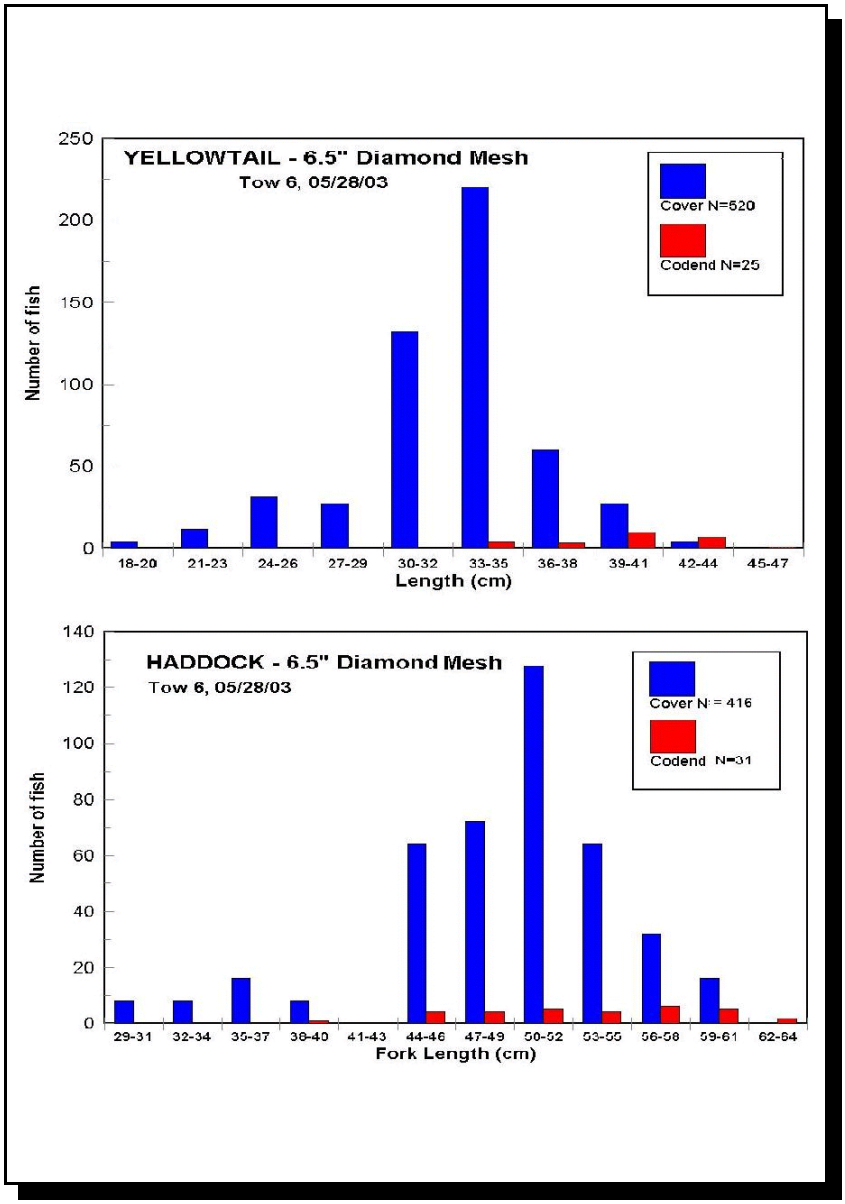

Exhibit 5. Example of yellowtail flounder (*Pleuronectes ferruginea*) (top) and haddock (*Melanogrammus aeglefinus)* (bottom) retained in the 6.5" diamond mesh codend (blue) and in the cover (red) during Tow 6 on 05/28/03.

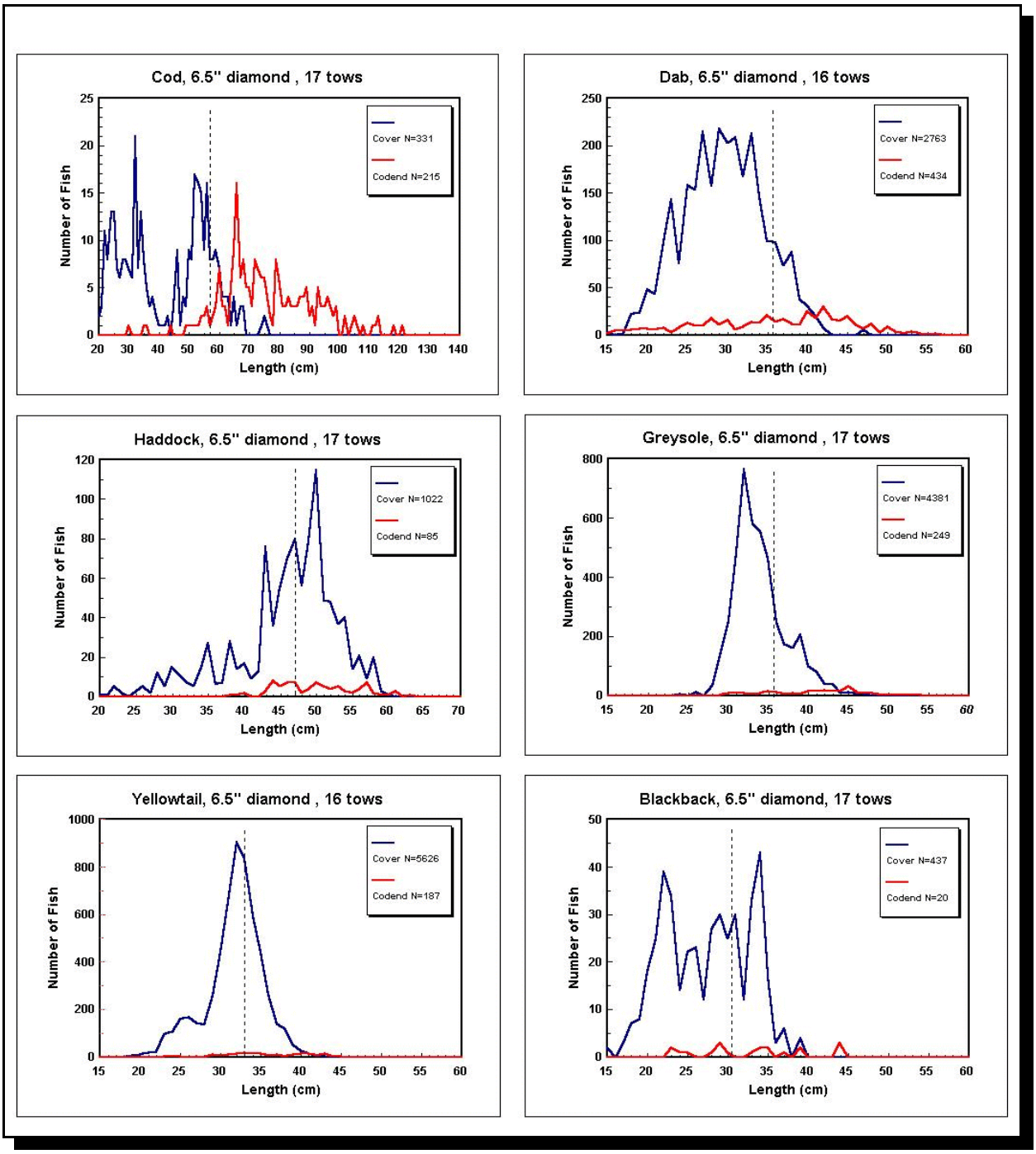

Exhibit 6. Example of length frequency distribution of six species for 6.5" diamond codend. (He, *et al.*, 2003).

American Plaice (Dab)

Mesh	6d	6.5d	6.5s	7d	7s
m	0.41	0.42	0.54	0.32	0.37
L50 (cm)	38.2	40.6	32.9	43.1	39.1
L25 (cm)	35.6	37.9	30.9	39.7	36.1
L75 (cm)	40.9	43.2	35.0	46.6	42.1
SR (cm)	5.3	5.3	4.1	6.8	5.9
SF	2.5	2.5	2.0	2.4	2.2

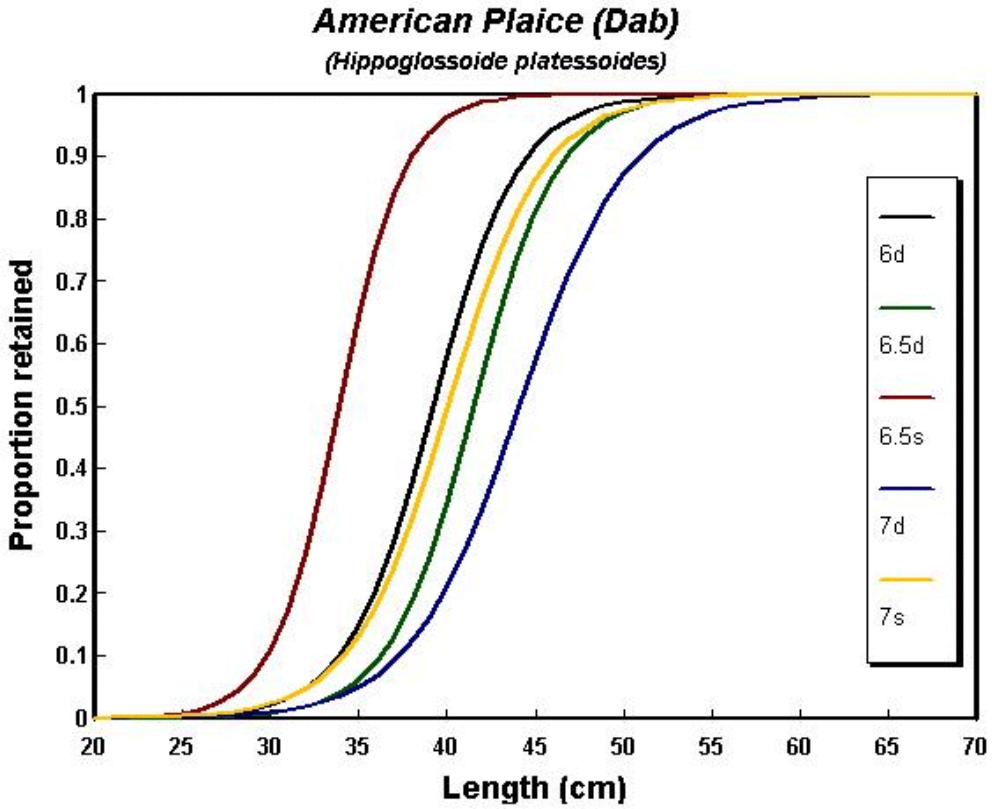

Exhibit 7. Example of selectivity curves for American plaice (Dab, *Hippoglossoide platessoides*) from data collected using the kite-assisted codend cover. Codend types: 6d - 6" diamond, 6.5d - 6.5" diamond, 6.5s - 6.5" square, 7 d - 7" diamond, and 7s - 7" square. (He, *et al.*, 2003).

4. IMPACTS AND APPLICATIONS

The codend cover design has been used in a codend mesh selectivity project funded by the National Marine Fisheries Service Cooperative Research Partnership Initiative. That project tested eight different codends over a period of two years, and has resulted substantial data in trawl codend selectivity. A manuscript on the codend cover design, flume tank tests, and sea trials has been submitted for publication in a scientific journal.

5. CONCLUSIONS

The codend cover met requirements for retaining fish escaped from the trawl codend using the covered codend method for mesh selectivity studies. The cover can be handled with the usual handling equipment onboard Gulf of Maine inshore trawlers with a usual compliment of crew. The kites are durable and easy to maintain, and can be individually replaced if required. The use of the kite-assisted codend cover in a selectivity project following this project demonstrated its suitability. The codend cover design is recommended for use in other codend selectivity studies of the similar size codend.

6. ACKNOWLEDGMENTS

The project is financially supported by the Northeast Consortium, a join initiative of the University of New Hampshire, University of Maine, Massachusetts Institute of Technology and Woods Hole Oceanographic Institution. We would like to thank Carl Harris and Harold DeLouche of the Fisheries and Marine Institute for their contribution to the design and testing of the codend cover in the flume tank, and crew of F/V “Stormy Weather” for their assistance during sea trials.

7. LITERATURE CITED

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