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Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Region
Management Division
State-Federal Relations Branch

Final
~~Annual~~ Report

STATE: Massachusetts

PROJECT NUMBER: *3-IJ-~~177~~* 184

GRANT NUMBER: NA16FI1201

PROJECT TITLE: Interjurisdictional Fisheries Management Support Program.

PERIOD COVERED: ~~July~~ Aug 1, 2001 - ~~June 30~~ July 31, 2002.

PREPARED BY: Michael Pol

APPROVED BY: Paul Diodati, Director

DATE: October 16, 2001

STATUTORY FUNDING AUTHORITY: Interjurisdictional Fisheries Act, (Title III of P.L. 99-659).

Signed: Paul J Diodati

Paul Didodati

STATEMENT OF WORK

I.A. State: Massachusetts

B. Award No. NA16FI1201

INTRODUCTION

Interjurisdictional Fisheries Act of 1986 projects are carried out to gather information and conduct activities that support management of United States multi-jurisdictional fisheries. These projects respond to fishery research, habitat, and law enforcement needs under the Magnuson-Stevens Act, Atlantic Coastal Fisheries Cooperative Management Act, Great Lakes Fisheries Commission's Strategic Plan, and the individual multi-jurisdictional State and interstate marine fisheries commission fisheries management planning programs.

The Interjurisdictional Fisheries Management Support Program in Massachusetts has evolved from one that assisted fishermen in improving their fishing techniques into a conservation engineering effort that concentrates on fisheries technology as a means to further the conservation of living marine resources and support sound fisheries management. This program, which functions within the Massachusetts Division of Marine Fisheries (DMF) Conservation Engineering Program, was comprised of a Program Coordinator (Aquatic Biologist III - H. Arnold Carr), one Aquatic Biologist II (Michael Pol), and one seasonal Fisheries Technician (Fisheries Supervisor - Vincent Manfredi). The Fisheries Technician assists the full time staff by boarding contracted or cooperating commercial fishing vessels, sampling the vessel activities and catch, and assisting in data processing. H. Arnold Carr retired on 15 March 2002.

Project personnel focused on two objectives: a) research on conservation engineering, and b) technical assistance. The former objective involves identifying and researching fishing gear and practices that can be made more selective to the marine resources encountered by the gear and less impacting to the environment. The first objective also involves researching and promoting changes or modifications in fishing practices made necessary by action or intended action by DMF or New England Fishery Management Council (NEFMC). The second objective requires communicating with various governmental agencies, institutions and individuals with information on the application of fisheries technology in relation to management and conservation.

OBJECTIVE A: Conservation Engineering

Two at-sea efforts were undertaken this year by this program: exploring means to reduce the scup *Stenotomus chrysops* bycatch in the inshore squid *Loligo pealeii* fishery of late Spring; and monitoring the small mesh exempted and experimental whiting *Merluccius bilinearis* fisheries that occurred in waters adjacent to Cape Cod during the Fall Program.

Squid Scup Inshore Fishery

This program, in concert with Manomet Center for Conservation Sciences, continued to work on means to reduce the bycatch of scup while targeting squid. Program personnel, including the Fisheries Technician, tested two scup-excluding modifications to a trawl extension during July and September 2001. Primary funding for this testing was through a MARFIN grant; the participation of the Fisheries Technician was funded through the IJ program

A final report was completed for the MARFIN grant, and is included as Contribution #10 of the Division of Marine Fisheries Technical Report Series, Scup Bycatch Reduction in Loligo Squid Fishery by M. V. Pol, H. A. Carr, M. J. Szymanski, V. M. Manfredi, and C. W. Glass. The title page and executive summary of this report are attached as Appendix I.

Exempted and Experimental Whiting fishery
DMF has continued to dedicate time and resources to the fall whiting fishery. Part of this fishery is now an approved small mesh exempted fishery following approval of Framework 35. In addition, an area east of Cape Cod was opened as an experimental fishery. The exempted fishery was the result of years of effort by this program, the Division, and whiting fishermen. The Aquatic Biologist II served on the Whiting Monitoring Committee for the NEFMC; the Program Coordinator served on the Whiting Plan Development Team.

Sea-sampling activity by this program was limited to one trip, and providing back up sampling coverage to the Fishery Dependent Investigation branch of DMF.

OBJECTIVE B: TECHNICAL ASSISTANCE

The Conservation Engineering staff responded to phone calls, email, and other requests for information on fishery technology throughout the year. Copies of videos were distributed to industry members, media, and other interested parties. Project personnel also attended a number of formal meetings, workshops, and other related fishery events.

ICES
The Aquatic Biologist II was appointed to the International Council for the Exploration of the Seas (ICES) Working Group on Fishing Technology and Fish Behaviour (FTFB) as Mr. Carr's replacement. Mr. Pol attended the 2002 FTFB meeting in June at Sete, France and presented a paper describing research using gillnets and trawlnets to separate flatfish from cod (Appendix II). Mr. Pol also presented the USA National Report to FTFB (Appendix III). This report allows scientists from other ICES nations to follow current gear and fish behavior research in the US. The report is compiled by soliciting input from the gear research community. Mr. Pol also represented the USA on the ICES Study Group on the Measurement of Mesh, whose meeting preceded FTFB's meeting in France. The title page and executive summary of the draft report of this group is attached (Appendix IV).

Other Meetings and Activities
Program personnel traveled to Maine to assist Maine Department of Natural Resources testing of a "raised rockhopper" trawl net during July 2001. The focus of our efforts was the use of our underwater camera system and net mensuration systems to measure the net's attitude and reaction to the bottom.

The Program Coordinator was invited to a Workshop on The Effects of Fishing Gear on Marine Habitats of the Northeastern United States from 23-25 October, 2001 in Boston, MA as an expert on bottom impact.

The IJ program provided partial support for the Program Coordinator to travel to the Memorial Institute Flume Tank in Newfoundland in January 2002. This trip was also supported through a Northeast Consortium program. The intent of the program was to test modified gear designs, and to bring fishermen and scientists together to exchange ideas.

Program personnel received training in the use of a non-linear video editing system from HB Communications at the end of January 2002. This computer-based system allows for the production of polished videos concerning any aspect of the Conservation Engineering program, drawing on our extensive library of over 600 tapes of mostly raw footage. This system allows the editing or transfer of video onto several traditional media (for example, VHS videotape) and newer methods (for example, Quicktime). This flexibility broadens our ability to provide technical assistance.

The Program Coordinator and the Aquatic Biologist II attended the Maine Fishermen's Forum on 28 February - 2 March 2002. Mr. Carr was a presenter for a session describing Conservation Engineering's cooperative work with the Maine Inshore Trawl Survey. Mr. Carr's and Mr. Pol's experiences with cooperative gear research were solicited for several sessions. They also attended a discussion of the legal and insurance implications of using commercial vessels for research that was highly informative. This information was shared with Massachusetts fishermen.

Mr. Pol received management training in preparation for greater responsibility, including of this grant, in March-April 2002.

APPENDICES

Appendix I	Scup Bycatch Reduction in Loligo Squid Fishery
Appendix II.	Cooperative design and testing of gillnets and trawl nets to target flatfish and avoid Atlantic cod *Gadus morhua.*
Appendix III.	Progress Report to the ICES Fish Behaviour and Fisheries Technology Working Group, April 2001 (U.S. National Report)
Appendix IV.	Report Of The Study Group On Mesh Measurement Methodology

Appendix I: Scup Bycatch Reduction in Loligo Squid Fishery

Scup Bycatch Reduction in *Loligo* Squid Fishery

Contribution #10 of the Division of Marine Fisheries Technical Report Series

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16 July 2002

II. Executive Summary

Gear modifications to reduce scup bycatch in the *Loligo* squid fishery in Nantucket Sound have been the focus of joint research efforts by the Massachusetts Division of Marine Fisheries (DMF) and the Manomet Center for Conservation Sciences (MCCS) since 1996. Effective trawl net modifications have been developed to reduce bycatch of scup except when large schools of scup enter the gear. To combat this problem, two extension modifications were developed and tested on two commercial vessels and show potential for reducing scup bycatch when large schools are encountered. During 14 days of field testing in June-July and October 2001, scup catches averaged 223-475 lb/tow. The vee and ring excluders removed scup at mean rates ranging from 87-100% with no clear difference in performance between the two modifications. However, small (less than10 cm FL) scup were not excluded.

Squid reduction rates ranged from 7-69% with the vee excluder tending to remove more squid. In general, squid reduction rates were higher and more variable than desired, but excluded squid were mostly small and unmarketable, and at low densities.

Underwater footage demonstrated that scup used fisheyes to escape the excluder and appeared unharmed.

Excluders were practical and easy to deploy. Further testing is needed and is planned to determine the effect of excluders on larger squid and on very large schools of scup.

Appendix II: Paper presented to FTFB

This paper not to be cited without prior reference to the author

International Council for Exploration of the Sea
Fish Capture Committee

Working Group on Fishing Technology and Fish Behaviour
Sete, France, 6-8 June 2002

Cooperative design and testing of gillnets and trawl nets to target flatfish and avoid Atlantic cod *Gadus morhua*.

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Abstract

Management measures in US Northwestern Atlantic waters have limited fishing for all species largely due to the status of Atlantic cod *Gadus morhua* stocks. Development and testing of trawl and gillnet gear that segregates cod from flatfish was conducted cooperatively with commercial fishermen. Improved species selectivity of gillnets was attempted by lowering floatline heights by 1) replacing the floatline with another leadline; and 2) adding lead to the floatline ca. every 10 meters. Trawls were modified by 1) moving the headline far back following a Faroese design; 2) replacing 15.2 cm diamond mesh in the top of the net with 20.3 cm square mesh; and 3) shortening the legs of the net so that headline height off the bottom was ca. 0.5-1.0 m. The gillnet designs and the third trawl design sought to exploit the tendency of flatfish to remain very close to the bottom. Trawl designs 1 and 2 took advantage of the behavior of cod rising slowly when pursued by trawl nets. Testing of all designs is in progress; preliminary results of gillnet testing show that the experimental nets perform similarly to standard flatfish gillnets. Results from trawl testing show dramatic (75-95%) reduction in cod catch rates with designs 1 and 2; losses of legal-sized yellowtail flounder *Limanda ferrugineus* ranged from 16-64%. Testing of trawl nets is continuing.

Introduction

A US Federal court judge on 26 April 2002 in Washington DC issued (and later revised) a remedial action to force the US National Marine Fisheries Service (NMFS) to comply with legislation that requires several stocks to be rebuilt within a limited time frame (Stevenson 2002). The stock of greatest concern is Gulf of Maine Atlantic cod *Gadus morhua*. To protect this stock (and others), the number of days of fishing allowed was decreased by 25-40%, minimum landing size was increased to 55.9 cm, and the minimum mesh sizes of gillnets and trawl nets was increased to 165 mm. Furthermore, large areas of US Northwest Atlantic waters were closed to all fishing for groundfish species (Figure 1).

Permanent and seasonal closures of fishing grounds are not a new management tool for this area. Experience has shown that closing large areas to fishing to protect one species is not an optimal solution. Although exploitable stocks of flatfish are present, the lack of monetary resources to fund fishery observers or enforcement officers, and the lack of species-selective fishing gear result in this painful solution. Consequently, the potential value of a species-selective gear design has been great, and has grown greater since the Judge's decision.

Prior to the Judge's decision, limits had been imposed on the amount of cod that could be landed each day; this limit led to high, unquantified levels of cod discard, hindering the rebuilding the limits had been designed to facilitate. Recognizing the need for species-selective gear, we developed some preliminary gillnet and trawl designs for catching flatfish, and avoiding cod. At the same time, funding became available for cooperative research: research that brought together fishermen and scientists to conduct scientific investigations. Three of the authors (Ribas, MacKinnon, Scola) came forward with cod-avoiding gear designs that they had developed based on fishing experience. Funding was pursued and captured.

Field testing of two experimental gillnets and three experimental trawl nets began in 2000, and has periodically continued until May 2002. The two gillnet designs both try to avoid cod by reducing the vertical profile of the net, thereby reducing the exposure of webbing to cod. One design replaces the floatline with another leadline so that the gillnet consists of two leadlines, with webbing inbetween. The second experimental design adds lead to the floatline approximately every 10 m (30 ft). These nets were compared with two typical industry floatline designs, one targetting flatfish that uses a self-buoying floatline, and one that uses plastic floats.

The three trawl designs were tested against the same standard net. One trawl design, named the "topless" net, based on a net tested in the Faroe Islands (Thomsen 1992) moves the headrope as far aft as is possible, with nearly the entire top half of the net removed. The second design replaces the top half of a trawl net built of 15.2 cm diamond mesh with 20.3 cm square mesh. The third design, the "lowrider," restricts the opening of the net by limiting the amount of twine and shortening the legs.

These projects met the goal of combining fishing experience with scientific knowledge to develop species-selective gear. Our objective was to test the experimental designs for effectiveness using field trials onboard commercial vessels.

Materials and Methods

Four types of gillnets were constructed (Table 1); the construction characteristics largely followed current industry practice. Each gillnet was 91.4 m long.

The standard cod net (or "stand-up" or "open" gear) (Net A) was constructed of light green 17.8-cm monofilament mesh webbing with a diameter of 0.57 mm, twenty-five meshes deep. The floatline consisted of 91.4 m of 0.95-cm twisted polyethylene (PE) floatline with one deepwater gillnet float ca. every 2 m, or fifty floats per net. The leadline was 91.4 m of 22.7 kg/182.8 m leadline.

The standard flatfish net (Net C) was constructed of light green 17.8-cm monofilament mesh webbing with a diameter of 0.47 mm, twenty-five meshes deep. The floatline consisted of 91.4 m of 1.3-cm foamcore float line (Foamcore line has built-in floatation.) The leadline consisted of 91.4 m of 22.7 kg/182.8 m leadline.

The flatfish-modified net (Net B) was constructed of light green 17.8-cm monofilament mesh webbing with a diameter of 0.47 mm, twenty-five meshes deep. The floatline consisted of 91.4 m of 1.3-cm diameter foamcore floatline, just as the standard flatfish net, but with lead weight wrapped around the floatline every ten meters. The leadline consisted of 91.4 m of 22.7 kg/182.8 m leadline.

The second experimental design was identical to the standard flatfish net, except for one major modification. The dual leadline net (Net D) was constructed of light green 17.8-cm monofilament mesh webbing with a diameter of 0.47 mm, twenty-five meshes deep. The floatline and leadline consisted of 91.4 m of 22.7 kg/182.8 m leadline. This net had no floatline as it is normally defined. This configuration is a radical departure from known local practice, although this net is used in Nova Scotia, Canada and has been tested by Canada Dept. of Fisheries and Oceans (G. Brothers, pers. communciation).

The standard flatfish, flatfish-modified, and dual leadline nets were identical except for the construction of the floatline. The standard cod net followed industry practice, and differed from the other three nets in color, twine diameter, leadline weight, and hanging ratio.

Twelve-net strings of each of the four different designs were deployed at the same time and in the same general location. The geographical arrangement of the nets within the set area was rotated based on a modified Latin square design to reduce bias. In general, nets were set and hauled following normal commercial fishing practice. However, the soak times were limited to approximately overnight (~24 h), a shorter soak than standard when targetting flatfish. This shorter soak time was selected to allow more rapid testing, and to increase survival of discarded fish.

Trawl net testing was conducted partly following a paired alternate tow method; some of the tows conducted fell below the threshold for pairing, and were analyzed differently. The standard net was constructed of 15.2 cm 3 mm diamond polyethylene (PE) mesh throughout, with 50M 16.5-cm square knotless mesh in the codend, 20 M wide on the top and bottom. The headrope and footrope lengths were 12.2 and 18.3 meters. The Ribas and topless experimental nets were also constructed of 15.2-cm PE mesh with 75M 16.5-cm square knotless mesh in the codend, 25 M wide on the top and bottom. The Ribas net replaced 15.2-cm diamond mesh on the top middle of the net with 25 meshes wide of 20.3-cm square mesh from the headrope to the codend. This design had a headrope and footrope length of 18.3 m. All three codends had chaffing gear on the bottom half, consisting of unbraided strands of PE twine.

The topless net has no top wings, allowing the headrope to follow a taper of the net's gore into the top belly, reaching a length of 27.1 m. The bottom half of this net and the Ribas net are identical. The lowrider net was constructed of 15.1 cm diamond mesh PE with 16.5-cm knotless mesh in the codend. The headrope and footrope lengths were 12.2 and 18.3 m. The ground gear used for all four net designs was identical, 27.4 m of cable with 6.4 cm cookies. Two sweeps were used during this study; a sweep with 15.2 cm. cookies was used for seven days of testing up to 26 May 2001, a sweep with 10.2 cm cookies was used for four days of testing as an attempt to improve flatfish catch rates.

Testing for both the gillnet and trawl testing was conducted on commercial fishing vessels. Captains were responsible for all fishing operations, including selecting the fishing locations. Video observation of nets was conducted with an ROV for the gillnets, and with a third-wire camera and winch system for the trawl nets.

Results and Discussion

Thirty-six overnight sets of the two experimental and the two standard gillnets have been completed. Twenty-six of those sets have been analyzed. Testing was hampered at times by closed fishing areas; consequently some sets had to be discarded for lack of fish. Testing occurred in three phases: December 2000-January 2001, May 2001, and February 2002.

Catch rates (weight/24 hr/net) were compared using ANOVA, including comparisons of the standard flatfish net to the experimental nets, and the nets to each other. Cod catch rates ranged from 1.6 to 7.9 kg/24 hr/net (Table 2). Kept cod catch rates were significantly different between treatments. Specifically, the Dec-Jan testing resulted in large differences in catch between the standup cod net and the other nets (ANOVA, $F_{3,48} = 3.488$, $p = 0.023$). The standard cod net caught cod at the highest mean rate, 7.9 kg/24hr/net, while the standard flatfish net caught cod at a mean of 5.46 kg/24hr/net. The experimental nets had mean cod catch rates of 1.6 (foamcore + leads) and 2.9 kg/24hr/net (dual leadline). Comparisons of cod catch rates for the two experimental nets to the standard flatfish design yielded marginal significance ($F_{1,40}= 3.08$, $p = 0.086$) and comparisons of the individual nets to the standard flatfish design were marginally significant for the foamcore + lead design ($F_{1,40}= 3.29$, $p = 0.076$) and not significant for the dual leadline ($F_{1,40}= 1.50$, $p = 0.227$). Discard cod catch rates were not significantly different from each other (ANOVA, $F_{3,48}= 1.21$, $p = 0.32$); variability was high.

In the May 2001, testing, the cod catch rates in the cod net were also signficantly different from the other three. No difference was observed in flatfish catch rates among the three flatfish nets: the standard, dual leadline, and lead-added nets. This lack of difference suggests that flatfish, specifically yellowtail flounder and winter flounder, *Pseudopleuronectes americanus*, are equally vulnerable to all three of those designs, despite large variation in configuration and underwater profile, and that cod are not equally vulnerable.

Differences in lengths of cod caught were seen in the first phase of testing; length frequency analysis for cod suggested that the size distribution of cod caught with the standard cod net was very different from the other three nets. Ninety-one percent of cod caught with the cod net were >48 cm (approximately minimum landing size); the three other nets ranged from 23-36% >48 cm (Figure 2). The cod length frequencies from the two experimental designs were compared to the standard flatfish net using the Kolmogorov-Smirnov test. The length-distributions caught with the standard flatfish net and the foamcore + lead net were significantly different ($N_{est(std)}$= 518, $N_{est(fc+l)}$= 372, p = 0.00). The LF for the standard net and the dual leadline net were not significantly different ($N_{est(std)}$= 518, $N_{est(dll)}$= 554, p = 0.29).

The size differences between the standard cod net and the three flatfish nets was not surprising. The standard cod net was constructed with a larger twine diameter (0.57 mm) than the three flatfish nets (0.47 mm). It is common knowledge among fishermen that smaller twine diameters are "stickier" than larger ones; Hamley (1975) reported this observation, which was tested but not confirmed by Holst et al. (2000). We observed, but did not quantify, that the smaller cod caught in the flatfish nets were frequently tangled, not gilled. The second phase of testing indicated that the lengths of cod were not different, suggesting that smaller cod were not present during this phase. No difference in lengths of yellowtail or winter flounder were seen during the second phase of testing.

ROV observations indicated that the dual leadlines of the experimental net lay on the bottom close to each other, with all the webbing floating in a cloud above them. The profile of the net with lead added to the floatline formed a series of arcs, with the floatline touching the bottom every 10 m where the lead had been added. The cod standup gear with floats brought the net to its full height, approximately 4.5 meters. The unmodified flatfish net had a lower profile than that, approximately three meters.

These results provide some verification for the theorized difference in flatfish and cod behavior. Larger cod were caught less frequently in the gillnet with floatlines closer to the bottom. Underwater video from other projects shows cod occasionally picking small food items off the sea bottom. If cod of all sizes interact with the bottom in this manner, then larger cod must be less vulnerable to tangling than small cod, either by not becoming entangled initially, or by escaping. These results also provide useful information to managers: limiting the flotation in the floatline of gillnets reduces large cod catch rates. Although the experimental nets caught more smaller cod, these fish can be avoided by selection of net location, and mortality of these fish can be reduced through short soak times.

Results from testing the topless and Ribas cod avoiding trawl nets were strongly encouraging; preliminary analysis of the lowrider net was less successful. Over 104 tows have been completed testing the topless and Ribas design, in two phases. The initial phase of testing (2000/2001) resulted in significant reductions in cod catch rates using both the Ribas and topless designs (Table 3). The Ribas net reduced cod catches by over 76% ($p_{(two\text{-}tailed)}$ = 0.04) from 73.7 kg/hr to 17.6 kg/hr. The topless design reduced cod catches over 93% (($p_{(two\text{-}tailed)}$ = 0.10) from 107.7 kg/hr to 7.1 kg /hr (Table 3). The significance level of the 93% reduction is marginal due to high variability in cod catches using the standard net; however, in 100% of tows the standard net had a higher catch rate.

In the initial phase of testing, both the Ribas and topless nets reduced the catch rates of kept yellowtail above (kept) and below (discard) minimum landing size (Table 3). The Ribas net reduced catches of kept yellowtail flounder by over 28% ($p_{(two\text{-}tailed)}$ = 0.10) from 58.7 kg/hr to 41.7 kg/hr; the topless design reduced kept yellowtail catch rates by over 41% ($p_{(two\text{-}tailed)}$ = 0.01) from 97.7 kg/hr to 57.4 kg/hr. Reduction in discard rates was statistically significant (Table 3); the Ribas net reduced small yellowtail catches by almost 50% compared to the standard net ($p_{(two\text{-}tailed)}$ = 0.02). The topless net reduced discard of yellowtail by 73.4% ($p_{(two\text{-}tailed)}$ = 0.01).

Catches of winter flounder during testing of the Ribas net were not substantial enough to permit analysis. Catches of kept winter flounder during topless net testing were not significantly different between nets ($p_{(two\text{-}tailed)}$ = 0.17; Table 3), although mean catch rates were lower with the topless net. Catch rates of discarded winter flounder were reduced nearly 79% when using the topless net ($p_{(two\text{-}tailed)}$ = 0.01).

The second phase of testing is ongoing, with the addition of the lowrider design. Current results, analyzed with a two-sample t-test (without pairing) from March-April 2002 are not fully analyzed, but preliminary findings support the cod reduction effect of the Ribas and topless nets. These two nets again reduced cod catches, the Ribas design by almost 53% (from 53.0 to 25.0 kg/hr), the topless by 75.2% (108.6 to 26.9 kg/hr) (Table 3). Again, marketable yellowtail flounder was also reduced, as was discard yellowtail (Table 3). Three boats were used in this phase of the testing; data have not yet been analyzed separately by vessel, although we believe we will find a large difference in performance between vessels.

The lowrider failed to produce significant differences in catch rates. These data will be further analyzed. The inexperience of the captain with scientific testing, and unusually large initial catches may have affected this testing. The results of more thorough analysis for all three nets will set the direction for continued testing.

The trawl nets also demonstrate that cod can be separated from flatfish, although a reduction of flatfish catch rates appears to be the cost of this separation. A number of mechanisms have been suggested for this loss: increased codend escapement through reduction of mesh masking; escapement by flatfish through the top of the net; escapement over the tops of the wings. This latter theory seemed especially valid after flume tank testing showed the wings tilting outward at an angle that may lead flatfish over the tops of the wings. Underwater video revealed cod passing over and under the headrope of the topless net, but not flatfish.

Further work is planned to modify the Ribas and topless designs to reduce this loss. However, this loss may turn out to be a benefit to assist the rebuilding of some flatfish stocks. This loss, the unusual design of the topless net, and the use of non-standard mesh sizes in the Ribas net have all caused concern in fishermen. Also, the limited range of testing has hampered regulatory adoption of either design. Expansion to include deeper depths and nighttime conditions is one of our future goals. Despite all these caveats, current stock status is sufficiently desperate that the Ribas net is under consideration as a management option.

These preliminary results for both the gillnet and trawl net testing indicate several valuable points. First, gillnets and trawls could be modified so that cod were separated from flatfish. Although this separation included some costs, such as reduction of catch rates of marketable species or increased capture of juveniles, the development of these gears should continue. Second, the development of fishing gear modifications, while valuable or crucial, has a long lead time and is subject to a number of obstacles that interfere with gear adoption by managers. Third, we intend to continue to cooperatively develop research plans and proposals with fishermen. The development and testing of these experimental gears would have been impossible without the cooperation between our program and working fishermen. It is true that problems have arisen where communication between participants was not clear, or was not understood. This relationship is stronger where all the participants are capable of communicating their own ideas and are willing to work to understand the ideas of others.

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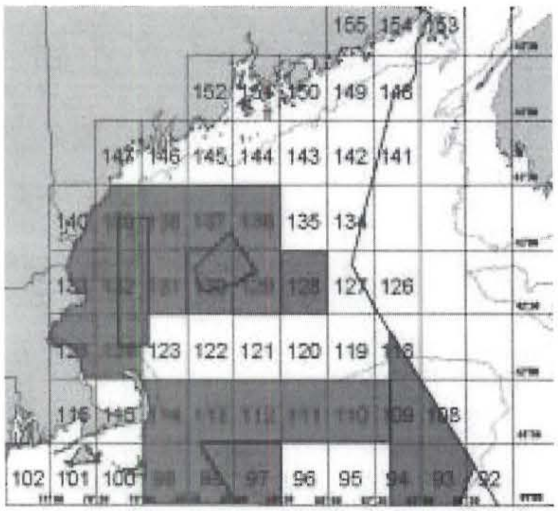


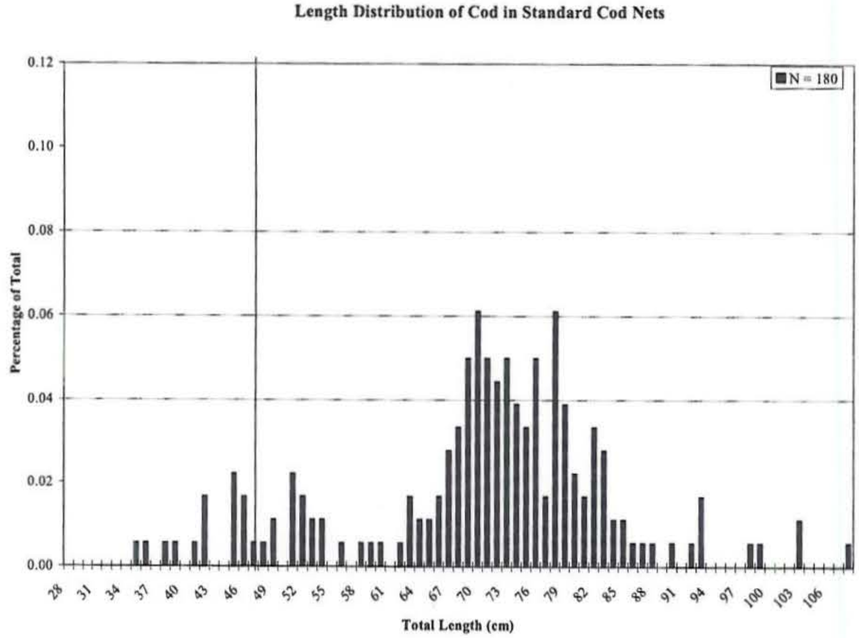
Figure 1: Area closures for May 2002 off NE US Coast. Darker blocks are closed only for certain months; lighter areas are closed permanently.

Table 1. Net characteristics of the four types of gillnets built and tested.

NET CHARACTER-ISTICS	Standard (Cod) - Net A	Standard (Flatfish) - Net C	Flatfish-Modified - Net B	Dual Leadline - Net D
Mesh size (cm)	17.8	17.8	17.8	17.8
Material	Mono	Mono	Mono	Mono
Twine diameter (mm)	0.57	0.47	0.47	0.47
Color	Light blue	Light green	Light green	Light green
Mesh depth	25	25	25	25
Floatline	0.95 cm. poly with one gillnet float per fathom	1.3 cm foamcore, no floats	1.3 cm foamcore floatline with lead wrapped every 10 m.	50 lb/600 fathom leadline
Leadline	22.7 kg/182.8 m	22.7 kg/182.8 m	22.7 kg/182.8 m	22.7 kg/182.8 m
Hanging Ratio	1/2	1/3	1/3	1/3
Net Length (m)	91.4	91.4	91.4	91.4

Table 2: Catch rates of two experimental gillnets and two standard gillnets for cod, yellowtail and winter flounders. Shaded columns indicate significant differences between Net A and the three others.

	Catch Rates (kg/24 hr/91.4 m net)								
	Cod				Yellowtail Fl.		Winter Fl.		
	Dec/Jan		May		May		May		
	Kept	Discard	Kept	Discard	Kept	Discard	Kept	Discard	
Net									
A	7.92	0.12	7.30	0.03	0.27	0.03	0.63	0.95	A Std Standup Cod gear w/ floats
B	1.59	1.14	2.61	0.20	4.32	0.69	1.80	6.11	B Exp'l - C plus lead
C	5.46	2.53	3.85	0.25	4.07	0.76	2.56	6.00	C Std Flatfish Gear w/ Foamcore
D	2.85	1.46	2.44	0.29	3.96	0.56	1.86	4.36	D Exp'l- Dual leadline



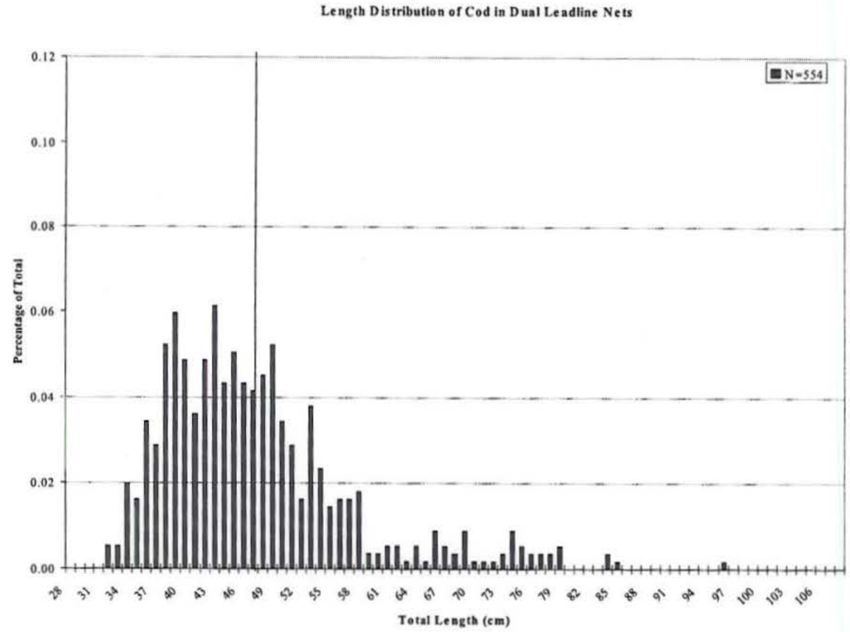


Figure 2: Length-frequencies of standard cod gillnets with floats, and a dual leadline gillnet (below). The line indicates the minimum landing size at the time of the trials. Samples sizes were 180 and 554 fish.

Table 3: Catch rates (kg/hr) for the Ribas, topless, and lowrider trawl nets, compared to a standard trawl net. The 2002 tows are preliminary data, analyzed with mean catch rates compared with a two-sample t-test. The 2000/2001 data are paired tows, analyzed with a paired t-test.

Catch rates (kg/hr) for Three Cod-Avoiding Trawl Nets

N = 13, 14	**Standard**	**Ribas**	**% Reduction**	**Sign. (2-tailed)**
Cod	53.03	24.97	52.90%	0.15
Yellowtail				
Kept	257.59	92.95	63.90%	0.00
Discard	42.08	6.74	84.00%	0.00

N = 17, 16	**Standard**	**Topless**	**% Reduction**	**Sign. (2-tailed)**
Cod	108.58	26.93	75.20%	0.05
Yellowtail				
Kept	180.57	108.90	39.70%	0.04
Discard	35.28	11.46	67.50%	0.01

N = 6, 16	**Standard**	**Lowrider**	**% Reduction**	**Sign. (2-tailed)**
Cod	93.07	56.97	38.80%	0.52
Yellowtail				
Kept	87.17	73.74	15.40%	0.70
Discard	33.69	25.85	23.30%	0.68

March-April 2002: Preliminary analysis

N = 10, 10	**Standard**	**Ribas**	**% Reduction**	**Sign. (2-tailed)**
Cod	73.72	17.55	76.19%	0.04
Yellowtail				
Kept	58.07	41.71	28.18%	0.10
Discard	14.33	7.22	49.61%	0.02

N = 12, 12	**Standard**	**Topless**	**% Reduction**	**Sign. (2-tailed)**
Cod	107.72	7.12	93.39%	0.10
Yellowtail				
Kept	97.70	57.39	41.26%	0.01
Discard	21.35	5.68	73.40%	0.01
Winter Flounder				
Kept	16.65	11.41	31.46%	0.17
Discard	1.81	0.37	79.50%	0.01

December 2000, May-June 2001

Appendix IV: ICES FTFB US National Report

Progress Report to the ICES Fish Technology and Fish Behavior Working Group, Sete, France, June 2002.

UNITED STATES

NORTHEAST

Massachusetts Division of Marine Fisheries Conservation Engineering Program

H. Arnold Carr (retired) and Michael Pol

Testing of Low-Profile, Low Cod Bycatch Gillnets - Phase II
Additional testing was conducted of two experimental gillnets designed with low vertical profiles against a standard cod *Gadus morhua* gillnet and a standard flatfish gillnet. One experimental net replaces the floatline with another leadline; the second adds lead to the floatline every 30 ft. Thirty-five overnight sets have been completed. Preliminary results indicated that catch rates of cod and commercial flatfish in the experimental nets were not different from standard flatfish gillnets. "Stand-up" cod gillnets using floats on the floatline caught cod at a greater rate and flatfish at a lower rate than the other three designs. The standup gear also appeared to catch larger cod. Data are still being analyzed.

Groundfish Trawlnets Designed to Reduce the Bycatch of Cod
Testing of two experimental trawl nets provided encouragement that Atlantic cod *Gadus morhua* could be separated from flatfish species. The Ribas and topless nets both modify the top half of a trawl net; the Ribas net by using 8-in (20.3 cm) square mesh; the topless net (based on a Faroese design) by removing much of the twine in the top of the net. Reductions of cod catch rates (kg/hr) exceeded 76% for the Ribas net; the topless design reduced cod catches over 93%. Yellowtail flounder *Limanda ferrugineus* catches, both kept and discard, were also reduced. Underwater video showed cod exiting the nets through the top mesh and through the gap made by the removal of twine. Testing was recently expanded to three vessels; data have been preliminarily analyzed.

Improving the Selectivity and Utility of Demersal Hook Fishing
Artificial baits using attractants made from seafood processing waste continued. Several bait formulas with different attractants and matrices were tested using underwater cameras to observe reactions of captive cod *Gadus morhua* in raceways and in more natural conditions. A preliminary conclusion is that cod react toward many bait formulas, but are highly selective when actually ingesting artificial bait. This work is a collaboration with Susan Goldhor of the Center for Applied Regional Studies.

Scup Bycatch Reduction in Squid Fishery
Two extension modifications were developed and tested on two commercial vessels and show potential for reducing scup *Stenotomus chrysops* bycatch in a *Loligo pealeii* fishery

when large schools of scup are encountered. During 14 days of field testing in June-July and October 2001, a vee-shaped panel in the extension and a ring-grid both removed scup at mean rates ranging from 87-100%. Both excluders were used to direct scup through lateral fisheyes. When small (less than 9 cm FL) scup were present, they were not excluded, suggesting that these modifications may not be appropriate at all times.

Juvenile Mortality Reduction in Demersal Longline Cod Fishery

MaDMF, in collaboration with Marianne Farrington, New England Aquarium, tested two methods of improving survival of hooked juvenile cod *Gadus morhua*: removal using a flip technique and post-capture holding in potassium-supplemented sea water. The flip technique resulted in less physical injury but no increase in survival after 72 hr of holding. Addition of potassium to counter a stress reaction also showed no increase in survival.

Development of an Acoustic Scallop Dredge

In situ observations suggested that bay scallops *Argopecten irradians* react to the sound of outboard engines. Bay scallops and sea scallops *Placopecten magellanicus* held in aquaculture facilities and in the field were subjected to recordings of outboard engine noise with mixed results. Limited testing of DC pulses may lead to further research on the use of electricity.

Manomet Center for Conservation Sciences
Marine Conservation Program

Dr. Chris Glass

Bycatch Reduction Program

Squid/Scup Fisheries

Offshore

Research continued during 2001-2002 on bycatch reduction and improved selectivity in Atlantic longfin squid fisheries in the Mid-Atlantic region. As was demonstrated in 2000-2001, improved selectivity for larger squid can be achieved through the use of larger mesh (2 ½"). However, developing methods and strategies to reduce bycatch and discard of scup has become a priority. Adding escape windows to induce escape behavior in scup showed positive results for the inshore longfin squid fishery in Nantucket Sound during 2000. Research on the escape window continued with trials testing a 5 ½" square mesh escape window configuration of 45 meshes behind the body of the net and ahead of the codend.

Multispecies Groundfish Fisheries

Codend Selectivity

Preliminary trials conducted in the Gulf of Maine groundfish fisheries indicate that composite codends (that is, codends fabricated with both square and diamond meshes) may be effective in reducing bycatch and discard of a range of groundfish species.

During these preliminary trials, hauls were conducted in January, April and June 2001, comparing composite codends (6 ½" square mesh over 6" diamond mesh; 6 ½" square mesh over 6 ½" diamond mesh) and a 6" hexagonal mesh codend to industry-standard (6" diamond or 6 ½" square) mesh configurations. Using a covered codend technique, selectivity for individual species could be compared for each codend configuration. For a given population of cod, composite and hexagonal codends increased the selective efficiency of trawl gear. This is demonstrated by an increase of L_{50} from ~57 cm for a standard 6" diamond codend to ~65 cm for composite codend mesh configurations, resulting in an approximately 62% reduction in the bycatch of sub-legal cod. While the selective efficiency for cod was increased, the catch of legal sized flatfish (yellowtail flounder, winter flounder, dab) remained relatively unaffected.

Ex-It Fish Excluder

During September and December 2001, on two commercial fishing vessels, preliminary trials were conducted to test the effectiveness of the Icelandic bycatch reduction device, Ex-It, in reducing the inadvertent catch of undersized fish in the Northwest Atlantic multi-species groundfish fishery. Though originally designed to test 3 different grid spacings (50 mm, 60 mm, 70 mm), this project has yielded substantial information on the selectivity of the 60 mm bar spacing for two areas in the Gulf of Maine. At the time this study was conducted, the minimum landing size for cod was 48 cm, however this limit has been increased to 56 cm. Results indicate that for cod, the L_{50} was less than minimum landing size at 47 cm, while for haddock (minimum landing size is 48 mm) the L_{50} were both 53 cm. Flatfish were more variable with yellowtail and winter flounder exhibiting L_{50}'s greater than minimum landing size (33 cm and 30.5 cm respectively) while dab and gray sole exhibited L_{50}'s close to minimum landing size (35.5 cm). The results also suggest that the selective efficiency of the Ex-It may differ by both season and area. Work will continue to assess the selectivity of the Ex-It system in this multispecies fishery for the 50 mm and 70 mm bar spacings.

Future Program for 2002-2003

George's Bank Yellowtail Program

A new cooperative research program will begin that will attempt to demonstrate that George's Bank yellowtail flounder can be targeted without significant bycatch of cod and haddock in Closed Area II. The program will study reaction behaviour of target and non-target species and is designed to demonstrate that yellowtail flounder can be fished during particular times of the year without significant bycatch and discard of other species, particularly cod and haddock.

Square Mesh Escape Window for Scup Bycatch Reduction

Building on promising results from past trials with the scup escape window in the longfin squid fisheries, work will be continued to test scup escapement using square mesh escape panels. Work will be continued with the offshore longfin squid fishery.

Composite Codend for Groundfish

As the Gulf of Maine groundfish fishery continues to be a contentious issue, we will continue to provide data on gear modifications that enable bycatch reduction. Recent results show that composite codends significantly reduce bycatch, however, it is important to continue to test composite codends in multiple locations and at different times of the year.

University of New Hampshire

Pingguo He

A project was started to design and test a double grid selectivity device to reduce cod bycatch in flatfish trawls in northeastern United States. The design involves an inverted primary grid and a secondary guiding grid to allow roundfish to swim through the primary grid and out of the net. A "self-clearing" mechanism was also tested in the flume tank to reduce the problem of grid clogs. Sea trials will be continued this spring and fall. A semi-pelagic shrimp trawl was designed in cooperation with Fisheries and Marine Institute in Canada. Sea trials will be conducted in Gulf of Maine pink shrimp fishery in the winter of 2002/2003.

Maine Dept. of Marine Resources.

Daniel F. Schick

The Department of Marine Resources (DMR) continued testing of several gear types for improving the size selectivity and reducing bycatch in the whiting (silver hake) fishery in the Gulf of Maine. For several years, the Maine whiting fishery used a 1-3/4" diamond mesh cod end and a 40 mm bar space 'Nordmore' grate under experimental fishery status and while the bycatch of regulated species was low, the size of whiting retained was too small to meet management goals. To increase the size of whiting selected by the gear, research conducted in 2000 tested two grate bar spacings, 50 mm and 65 mm, and two cod end mesh sizes, 2.6 inch diamond and 2.2 inch square, against two control nets, both with 1-3/4" diamond cod end and one with a 40 mm bar space grate. The best combination of cod end mesh and bar spacing for retaining the desired size distribution of whiting and reducing the bycatch of Atlantic Demersal Finfish 'regulated' species was the 2 inch bar space grate and either the 2.2 inch square mesh cod end (the 2.2 inch square mesh is measured as diamond mesh, stretched corner to corner and measured along the longest axis) or the 2.6 inch diamond mesh cod end. Both cod ends were roughly equivalent in performance.

The next gear tested in 2000 was a modification of the raised footrope used in the Massachusetts whiting fishery where the footrope is raised some distance above the chain sweep and connected to the sweep with dropper chains. The chain sweep was replaced with a roller frame and two dropper chain lengths, 30" and 42" were tested. The control net was a roller frame net with 1-3/4" diamond cod end and no grate. Separate trials were conducted with one trial using the 2.2" square mesh cod end paired with the 2.5 inch bar space grate and the other trial using the 2.6" diamond mesh cod end paired with the same grate. The results showed significant losses in bycatch, especially of flatfish, and little loss of whiting of the desired size compared to the control net and compared to the losses with the grate/cod end combinations without the raised footrope. The 2.2" square mesh cod end produced a greater escapement of small whiting than did the 2.6" diamond mesh cod end with either the 30" or 42" dropper chains. It was only through the use of the raised footrope with the larger bar space/cod end combination that the catch met the 5% maximum bycatch of regulated species.

In 2001, research tested the difference in catch and bycatch between a net with a raised footrope with 30" dropper chains to a roller frame and a net with a raised footrope with 30" dropper chains, but with no roller frame. Both nets had a 50 mm bar space 'Nordmore' style grate and a 2.6" diamond mesh cod end. These were tested against a control net with the same bar space grate and same cod end, but with the footrope rigged down on top of the roller frame. The raised footrope with no roller frame produced 2.9% and 3% bycatch of regulated species by weight in two separate trials of 6 and 10 tows, respectively, well under the 5% limit. The control net caught 19% and 4.6% bycatch of regulated species by weight in the two separate trials. The raised footrope with the roller frame produced 4.3% and 8.8% bycatch of regulated species by weight in two separate trials of 6 and 9 tows respectively. The control net caught 19.3% and 8.5% regulated species by weight in the two trials.

The added reduction in bycatch of regulated species through the use of the raised footrope net with no roller frame when using the 50 mm bar space grate and 2.6" diamond mesh cod end configuration tested in 2000 qualifies this net configuration for use in a whiting fishery in the Gulf of Maine. What remains to be done is to change the regulations as to where this gear can be used.

Work in progress in 2002 is to test a 45 mm bar space grate with a 2.6" diamond cod end in the raised footrope net with no roller frame and a 50 mm bar space grate with a 3" diamond cod end in the same net. Both trials are aimed at improving the size selectivity for whiting and further reducing bycatch.

Massachusetts Institute of Technology Sea Grant College Program
Center for Fisheries Engineering Research (CFER)

Clifford A. Goudey

CFER Director

Center for Fisheries Engineering Research (CFER) conducts research and provides technical expertise aimed at solving engineering problems associated with commercial fishing. Current CFER projects include:

Project Title: Oceanographic and Fisheries Data Collection and Telemetry from Commercial F/Vs
Sponsor: National Ocean Partnership Program
Description: The Fleetlink system has been developed and demonstrated on three commercial fishing vessels. The system includes meteorological and environmental sensors, a P.C. controller and interface, satellite telemetry and Web based data dissemination. The system provides email communications for the boats and the means for entering and telemetering catch results for marketing and management purposes. The sensor data is intended to improve marine weather and fisheries resource predictions. More details are found at http://www.fleetlink.org/.

Project Title: Sea Grant Technology Program in Sea Scallop Mariculture
Sponsor: Sea Grant Program

Description: This project is developing and demonstrating a towed sled for assessing the size and distribution of sea scallops on the seabed. Sled mounted camera, lights, computer, data storage, and batteries are combined with image processing software for identifying, sizing, and counting scallops in-situ. The system can be used from commercial trawlers using a normal tow wire. Data and images are downloaded at the end of each tow.

Project Title: Establishing a Groundfish Study Fleet to Improve Stock Assessments
Sponsor: NMFS/RSC and MIT Sea Grant
Description: A study fleet of twelve vessels has been formed to report fine-scaled data on the catch and bycatch associated with the Gulf of Maine groundfishery. Inexpensive hardware has been developed to allow the electronic logging of catch, discards, and GPS position. Data is sent to a central archive via telephone line and the end of each trip. A Web-based system is used for data entry of vessel and gear specifications and for the retrieval of GIS-based data products by fishermen. The reporting system currently is available commercially from Thistle Marine LLC of Ellsworth, Maine (see: http://www.thistlemarine.com/products.asp#HMS110).

Project Title: Adopt-a-Boat: Commercial Fishing Vessels in K-12 Education
Sponsor: Northeast Consortium
Description: The Adopt-a-Boat program is a collaborative project between the fishing industry and educators. The goal is to use commercial fishing boats as a vehicle for teaching the complexities of marine resource utilization, marine ecology, and life as a fisherman to K-12 students and facilitate the presentation of a balanced picture of commercial fishing. In its first year we have established twelve vessel/classroom partnerships and facilitate their collaborative activities with logistic support, communications, and other state-of-the-art technologies. For more information visit the project Web site: http://www.adoptaboat.org.

Project Title: The Development and Demonstration of a Whale-Free Buoy for Commercial Fishing
Sponsor: Northeast Consortium
Description: A tapered inflatable buoy is being developed and evaluated as a way of reducing the risk of marine mammal entanglements in passive fishing gear. By eliminating the normally abrupt transition between the buoy line and the buoy, the line and buoy can be shed during an encounter.

Project Title: Commercial Trials of Flexible Trawling Devices Including Soft Trawl Doors
Sponsor: Northeast Consortium
Description: This project is exploring the application of flexible hydrodynamic devices as a way to control the shape and depth of trawls. The goal of the research is to reduce habitat impacts by relying less on heavy weight and rigid doors and to generate wider mesh openings for improved selectivity. Based on previous model tests, prototype devices will be tested aboard commercial trawlers to determine the effect on trawl shape and depth, contact with the seabed, and the influence on fish behavior.

Project Title: A Preliminary Evaluation of Stretch-Mesh Catch Controls
Sponsor: Northeast Consortium
Description: This project is evaluating a concept aimed at reducing the waste of resources associated with regulatory discards. The normal nylon or poly twine used in the codend extension will be replaced with bungee cord of the appropriate strength. Under normal fishing conditions where small or modest hauls are experienced, a trawl rigged with this "Stretch-Mesh" section will fish similar to a conventional net. However, when loaded, the selectivity of the trawl will be changed and only fish unable to pass through this enlarged mesh section would be retained.

Project Title: A Preliminary Evaluation of Inshore Groundfish Pots
Sponsor: Massachusetts DMF/Northeast Consortium
Description: We are looking at pot fishing for groundfish as a more ecologically defendable harvest method compared to current techniques. Preliminary work with 15 pots is occurring in the area of mid-coast Maine. Several important fishing parameters will be evaluated including mesh size, bait, soak time, tide, and time of day. We are also seeking to optimize such things as funnel design, bait location, and the use of funnel valves or triggers.

Project Title: An International Workshop on Passive Acoustics Applications in Fisheries
Sponsor: MIT Sea Grant, ONR, NURC, SMAST/UMass
Description: A workshop was convened 8-10 April 2002 to bring together a group of international experts in passive acoustics as it applies to fisheries, marine conservation issues and the identification of essential fish habitats. The "hands-on" workshop included thirty presentations on techniques and their application to fisheries issues worldwide. Proceedings are being prepared. More information can be found at: http://web.mit.edu/seagrant/acoustics/index.html.

SOUTHEAST

National Marine Fisheries Service
Southeast Fisheries Science Center

Cooperative Research on Development of Gear Modifications and Fishing Practices to Reduce Turtle Takes in the U.S. Atlantic Pelagic Longline Fisheries.
The Southeast Fisheries Science Center in cooperation with the U.S. Pelagic longline fishing industry is investigating the feasibility of gear modifications and/or fishing practices to reduce the incidental capture of endangered and threatened sea turtles by pelagic longline fishing gears. NOAA Fisheries gear specialists are working with fishers to gain insight into fishing gear and practices and to develop mitigation measures to reduce turtle interactions with sea turtles. Prototype mitigation techniques are being developed using captive reared turtles in controlled experiments and evaluated on commercial vessels in the Atlantic pelagic fishing grounds. Studies include evaluation of dehooker and line cutter prototypes to allow removal of fishing gear from turtles, bait types and hook designs developed to reduce hooking of sea turtles, satellite tags to determine distribution and behavior of sea turtles and operational changes in fishing practice to reduce turtle interactions.

Appendix IV: Draft report of ICES Mesh Group

REPORT OF THE

STUDY GROUP ON MESH MEASUREMENT METHODOLOGY

Sète, France
3-5 June 2002

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

Palægade 2-4 DK-1261 Copenhagen K Denmark

MEETING OF THE STUDY GROUP ON MESH MEASUREMENT METHODOLOGY (SGMESH) – Sète, France, 3-5 June 2002-06-12

EXECUTIVE SUMMARY

In 2001-2002 the SG activities were concentrated on defining new measuring forces for mesh opening measurements. The present 4 kg measuring force to be used with the ICES mesh gauge was defined in 1962 when the this instrument was adopted.
According to textile practices a 4 kg measuring force is appropriate for meshes made of single twines with a linear density of around R8000tex. The mesh opening of netting made of thinner twines is over-estimated, whereas meshes of thicker twines are underestimated. The SG performed a series of mesh measurements on selected netting materials representative for presently used codends. It appeared that the ICES 4 kg mesh gauge underestimates the mesh openings for most of these nettings. Based on these results and on the inventory drawn up by the SG of netting materials used presently for fishing nets codends, the SG proposes new measuring forces for specific groups of nettings. The proposed new measuring forces are 100 or 130 N (approx. 10/13 kg) for larger meshes (e.g. > 55 mm) but remain 40 N (approx. 4 kg) kg for smaller meshes made of thinner twines. Before formulating a final advice, these measuring forces will be tested on the previous measured netting samples and compared with the results obtained by other methodologies. The tests must assure that transition to the new forces will not be detrimental to codend selectivity and therefore deliver results similar to the present procedures set down in technical measures legislation.

The inventory of netting materials was updated with data from Spain and Italy.

The SG confirmed its earlier view to maintain the definition of mesh size as given in the international standards (ISO/CEN). The SG drafted specifications for a suitable mesh measurement methodology. The SG further recommends the use of one single methodology, using a longitudinal gauge, for scientific, enforcement and industrial purposes. A standardization of mesh measurement practices will eliminate bias due to different methodologies.

An ICES Cooperative Research Report on the SG's activities, results and recommendations will be drafted.

The SG will have its final meeting in March 2003 in Oostende (Belgium). R. Fonteyne (Belgium) was reconfirmed as chairman for a second term.