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**Annual Progress Report #3**

**Design and Test of a High Opening Raised Footrope Trawl for  
Haddock and Pollack for the inshore Gulf of Maine**



*Submitted to:*



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

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# **Design and Test of a High Opening Raised Footrope Trawl for Haddock and Pollack for the inshore Gulf of Maine**

by

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*Submitted to*

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# **Design and Test of a High Opening Raised Footrope Trawl for Haddock and Pollack for the inshore Gulf of Maine**

*Summary.* This project focuses design and test of a trawl targeting haddock and pollack in the Gulf of Maine suitable for implementing “B” Days-At-Sea use. Key features of the new trawl are high headline opening and the raised footrope with long drop chains. The substantial increases in haddock and pollack biomass in Gulf of Maine, and much slower increase in cod stocks provide basis for use of such trawls in the multispecies fishery to reduce fishing pressure of cod. The initial phase of design and flume tank tests and full scale gear construction has been completed. Sea trials have just completed with analysis of data continuing. Preliminary analysis of data from sea trials indicates that a 3.6' drop chain rigging with 49 floats has the best potential of reducing cod catch while maintaining haddock and pollock catch. More work is needed to fine tune the design to consistently maintained acceptable catch of haddock and pollock and significantly reduce cod catch.

## **Introduction**

The recent report of the New England Fisheries Management Council indicated tremendous increases in overall biomass of twelve managed groundfish stocks in the northeast United States, even though the growth was not uniform among managed species or stocks. Among those stocks, haddock spawning biomass showed the greatest increase (Howard, 2003). Haddock stocks have shown tremendous recovery and they are not experiencing overfishing. Pollack is not “overfished” nor experiencing “overfishing” according to the overfishing definition and data provided by the New England Fisheries Management Council (Howard, 2003). Cod stocks, both in the Gulf of Maine (GOM) and on Georges Bank, on the other hand, are still “overfished” and still experience “overfishing”. Various management measures implemented and/or being considered are aimed at reducing the mortality of cod thereby aiding recovery of the stocks. One of the measures proposed in Amendment 13 to the Northeast Multispecies Management Plan is to reduce fishing effort by reducing Days-At-Sea (DAS) and by creating a so-called “B” DAS category. Fishermen may use “B” DAS to target species such as haddock and pollack with minimum catch and discard of other species such as cod. This project intends to design and test of such a haddock trawl for targeting haddock and pollack for use as “B” DAS gear in the inshore and nearshore otter trawl sector.

Worldwide decline in marine fish stocks has generated great interests in developing species selective fishing gears targeting “healthier” stocks while leaving “depressed” stocks to recover.

There are a number of approaches to separate species during fishing processes in trawls. Physical separations include mesh sizes and shapes, grids and inclined mesh panels. Behavioral separations include separator trawls, towing speeds, headline and fishing line height, among other means. Selective fishing using species-specific behavioral differences requires good understanding of behavior of the species to their physical differences (Wardle, 1983).

In the early 1980s, underwater observations carried out by researchers in Aberdeen, Scotland revealed distinct behavior of cod, whiting and haddock when approached by trawls (Main & Sangster, 1982). Haddock was observed to swim up and attempted to escape over the headline of a trawl, while cod stayed relatively low, and whiting lays in between haddock and cod. This finding resulted in a prototype separator trawl where a horizontal separator panel was installed to divide the trawl into the top and the bottom compartment. In this way, haddock and cod might be separated into the upper and lower codends respectively. Since then, a number of separator trawls were tested in Europe and in Canada (Main & Sangster, 1985; Galbraith & Maine, 1989; Boudreau & Tait, 1991; Cooper, 1992; Engas *et al.*, 1998). However, “the proper insertion of a horizontal panel in a trawl is not an easy task” (Cooper, 1992). This device thus “suffers in being overly complex and very hard to regulate for within legislation” (Anon. 2004). The shape and condition of the panel may change with towing speed and trawl door functioning. Any change of the door spread or wing spread may cause slack netting in the panel, resulting in meshing of fish.

Alternative to the separator trawl, fishing lines may be raised off the seabed so as to retain only the top part of the separator trawl. This design has tested and applied in shrimp trawls (Hannah and Jones, 2000; P. Walsh, pers. comm). In the Newfoundland shrimp fishery, fishing lines are raised as much as 3' through the use of long drop chains or toggle chains (H. DeLouche, pers. comm.). Raised footrope whiting trawls (McKiernan *et al.* , 1999) have been used for harvesting whiting in New England to reduce the catch of flounders. Similar sweep arrangements have been tested in squid trawls (Glass *et al.*, 1998; Glass, 2000). It is therefore feasible to test similar, but even higher raised footrope trawl for haddock and pollack to reduce flounders and cod in the regulated mesh fishery in Gulf of Maine.

## **Goals and Objectives**

The goal of the proposed research is to design and develop a practical trawl suitable for “B” DAS targeting haddock and pollack and to reduce or eliminate cod and flounder catches in the inshore western Gulf of Maine. The specific objectives are:

- to design a haddock/pollack trawl with high headline height and long drop chains to raise the footrope to reduce catch of cod, flounders and other benthic species while retaining haddock and pollock;
- to conduct flume tank tests and full scale sea trials to demonstrate its success in species selection, and suitability and practicality for commercial operations;
- to disseminate means and methods of species selective fishing technologies through a close partnership with the fishing industry, and through UNH Cooperative Extension and NH Sea Grant Extension.

## **Project Plan and Experimental Design**

Conceptual design of a high rise haddock trawl. The conceptual design of a trawl for haddock and pollack utilizes differences in behavior between haddock/pollack and other groundfish species. Exploiting the behavior that haddock and pollack tend to escape upwards at the mouth of the trawl and cod stays relatively low when exhausted, we designed a high vertical opening trawl. The design consists of long drop chains between the fishing line and the sweep (raised footrope), creating a space for cod, flounders and other benthic animals to escape or fall under the fishing line (Fig.1). The trawl will incorporate large meshes in the wings and belly to reduce drag of the net and allow the same vessel to tow a high opening trawl. Trawls with large mesh belly windows were demonstrated to reduce catch of benthos in the Belgium flatfish beam trawl fishery (Fonteyne & Polet, 2000). Our design will be expected to reduce benthos and trash catch in the codend, reducing potential effect of trawling on the benthic organisms.

The length of the drop chains is one of the major factors to be tested during sea trials. Recent separator trawl tests in Scotland indicated good separation of haddock to the upper part of the trawl using panels 0.8 m (31") directly above the sweep line (R.S.T. Ferro, pers. comm.).

Flume tank tests. Design and rigging of the haddock trawl was tested in a flume tank at the Memorial University of Newfoundland in Canada, where geometry and rigging were determined. The length of the drop chains tested in the flume tank was 5'. Both Industry partners participated

in the flume tank tests, along with the principal investigator, in December 2004.

Sea trials. Sea Trials started in the Fall of 2005 and continued in 2006 and 2007. F/V “North Star”, a 45' trawler based in Portland, ME was used for the first year of the sea trials. Comparative fishing trials started in spring of 2007 with alternating tows comparing the experimental rigs with fishing line 3.6' and 5' from the sweep and a control with the fishing line tied to the sweep. Gear rigging and adjustment is shown in Table 1.

Data collection and analysis. The length of commercial species was measured and discard species counted from each tow. Fork lengths were used for haddock and pollock, and the total lengths were used for all other species. Weight of haddock, pollack, cod and flounder species was determined from the control and experimental tows. Catches of each species from comparative tows are analyzed using paired t-test.

## **Work Completed to Date**

The following items have been completed:

- Conceptual design of the raised footrope haddock trawl
- Trawl model construction and flume tank tests involving industry partners
- Design modification and full scale net plan production
- Full scale trawl construction
- Sea trials completed in June 2007

The following items will be carried out:

- Data Analysis
- Final report
- Publication and outreach

## **Preliminary Results**

### ***Gear design and test***

A high opening haddock trawl 268 x 165 was designed. The net plan of the post-test full scale trawl is shown in Fig. 2. Twelve rigs were tested in the flume tank, including 5' drop chains with and

without a rockhopper sweep, no drop chain (Fishing line tied to the sweep), variations in bridle rigging, use of kites, addition and subtraction of floats, and variations in towing speed. Photographs showing various designs tested in the flume tank are shown in Fig. 3 and Fig. 4. Test results is shown in Fig. 5. Rig. 2 was the final rig used in full scale construction.

### ***Full scale trawl construction and gear modification.***

A full scale trawl was constructed by D & E Enterprise of Scarborough, ME. The full scale gear was based on the tank test results with modifications after testing. Before spring 2007 sea trials, the large mesh netting (330 mm) was replaced by regular 6" mesh size netting using 1:2 ratio.

### ***Sea trials***

Sea trials started in the Fall of 2005, and are continuing in 2006 and completed in the spring of 2007. Three fishing days were completed in October, 2005. Fishing was very poor and sea trials were terminated. The gear operation was very satisfactorily with no operational difficulties using usual deck machinery. A few pollack were caught. No cod were caught in the trawl.

Another three days were fished at the end of April 2006. Fish was again very poor with no substantial catch of all species, except tow which caught 99 lbs of cod and 5 lbs of haddock. Sea trials were again suspended. Fishing trials are continuing in June 2006, another three fishing days were completed. Fishing was more encouraging with catch amounts of major species listed in Table 1. Catch rates of a pollack as much as 862 lbs. per hour tow ere obtained with the new trawl. This high catch rate of pollack was not seen by the industry partner for many years.

During this period we also tried to compare the same net with the chains tie-down to represent regular sweep fishing gear. While "tied-down" net does seem to catch more cod, much more comparative fishing will be carried out. In addition, a large number of pollack was meshed in the square, indicating they did attempt to escape through large meshes. It is decided at that point that large mesh panels in the front part of the net should be replaced with regular 6" netting before further sea trials in the fall.

During the fall 2006, another three-day fishing trials were carried out with the modified experimental trawl. The modified trawl had the top panels of large mesh replaced by regular 6" mesh

in 1:2 ratio. Fishing was poor, and sea trials were suspended.

Before the 2007 sea trials, all large mesh netting, except those in the wing tip was replaced with regular 6" netting. During the spring of 2007, structured alternating tows were made to compare two experimental designs of raised footrope with one design with the footrope tied-down to the sweep. The specifications of the gear are listed in Table 1. A total of 25 fishing days were completed which is divided into four session for analysis purposes:

Session 1: 05/22/07, Tow 1-4. Exploratory fishing.

Session 2: 05/23/07 - 06/01/07, Tow 5-36. 16 pairs of tows, 5' raised footrope trawl vs. tied-down trawl as control

Session 3: 06/02/07 - 06/09/07, Tow 37 - 56. 10 pairs of tows, 3.6' raised footrope trawl, but the number of floats was not reduced. It is suspected that the sweep of the trawl may have been lifted of bottom. Catch was very poor.

Session 4: 6/14/07 - 6/27/07, Tow 65 - 100. 17 valid pairs of tows. 3.6' raised footrope trawl with 49 floats vs. tied-down fishing line control trawl. The number of floats was 9 less than that used in Session 2.

Catch of major species is summarized in Table 2. Preliminary analysis indicates that the 5' raised footrope trawl with 49 floats trawl from Session 2 reduced cod catch by more than 92% (average 1.9 cod/tow exp vs 25.2 cod/tow control). Haddock catch was low for both experimental and control trawl during that session, but there was a consistent reduction of haddock catch. Pollock catch was good with an average catch of 12.5 fish/tow for the experimental trawl and 19.1 fish/tow for the control, a reduction of 34%. Tow by tow comparison is plotted in Fig. 6.

Results from Session 4 indicate a cod reduction of 63% with less than 9% reduction in haddock catch. Pollock catch was very fluctuating, but overall there was a reduction of pollock catch of 46% during the entire session. This is large reduction is mainly due to a very large tow of 228 pollock in Tow 86 with the control trawl. If that pair (Tow 85 and Tow 86) is removed from comparison, the reduction of pollock is only 25%. Tow by tow comparison is plotted in Fig. 7.

Preliminary analysis indicate that the 3.6' drop chain seems more practical for reducing cod catch while maintaining haddock and pollock catch. More refinement of the rigging in terms of floatation may be need before the gear is adopted for commercial or semi-commercial use.

### **Partnership between Fishermen and Researchers**

This project is a joint effort between two commercial fishing vessels from Maine and the University of New Hampshire, with participation of Memorial University of Newfoundland. There were numerous opportunities for cooperation and collaboration between scientists (from UNH and MUN) and fishermen from the start of the proposal stage, to gear design and flume tank testing in Newfoundland. Fig. 8 shows Capt. Vincent Balzano rigging a model bridle at the flume tank shooting deck.

### **Impacts and Applications**

The design and preliminary results will be presented at the International Haddock Symposium to be held in Portsmouth, New Hampshire this fall.

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Table 1. Gear rigging

Gear	Control: Tied-down	Exp A: 5' RFT	Exp B: 3.6' RFT	Comment
Gear description	foot rope tied down to the sweep	5' raised foot rope trawl	3.5' raised- foot rope trawl	
Chain length	6"	5'	3.6'	
Flotation	30	48	39	8" floats
Sweep adjustment	even	-2 links	-2 links	

Next page:

Table 2. Tow by tow catch of major commercial species (in numbers).

**Raised footrope haddock trawl, spring 2007 sea trials**

Pair #	Date	Cod				Haddock				Pollock				Total H+P	
		Tow #	Sub-L	Legal	Total	Sub-L	Legal	Total	Sub-L	Legal	Total	Sub-L	Legal		Total
Session 1: Exploratory fishing, 5' drop chain, 48 floats															
5/22	4	0	0	0	0	1	1	0	0	0	0	0	0	0	1
Session 2: 5' drop chain, 48 float															
5/23	5	1	3	4	0	2	2	0	0	2	2	2	2	2	4
5/24	6	2	1	3	0	1	1	0	0	25	25	25	25	25	26
5/25	11	0	2	2	0	0	0	0	0	0	0	0	0	0	0
5/26	13	0	1	1	0	0	0	0	0	13	13	13	13	15	
5/27	16	0	7	7	0	0	0	0	0	9	9	9	9	9	
5/28	18	0	2	2	0	0	0	0	0	14	14	14	14	14	
5/29	19	0	3	3	0	0	0	0	0	39	39	39	39	39	
5/30	24	2	0	2	0	2	2	0	0	21	21	21	21	21	
5/31	23	0	0	0	0	1	1	0	0	25	25	25	25	27	
6/1	33	1	0	1	0	0	0	0	0	26	26	26	26	27	
6/2	36	0	3	3	0	1	1	0	0	2	2	2	2	2	
6/3	30	0	0	0	0	0	0	0	0	19	19	19	19	19	
6/4	31	0	0	0	0	0	0	0	0	0	0	0	0	0	
6/5	33	1	0	1	0	1	1	0	0	0	0	0	0	0	
6/6	53	1	0	1	0	0	0	0	0	5	5	5	5	5	
6/7	56	0	1	1	0	1	1	0	0	0	0	0	0	0	
Session 3: 3' 6" drop chain, 48 floats															
6/2	38	0	3	3	0	1	1	0	0	1	1	1	1	1	2
6/3	39	0	3	3	0	1	1	0	0	10	10	10	10	11	
6/4	42	0	0	0	0	0	0	0	0	0	0	0	0	0	
6/5	43	0	3	3	0	1	1	0	0	1	1	1	1	2	
6/6	45	0	3	3	0	7	7	0	0	41	41	41	41	48	
6/7	46	1	0	1	0	6	6	0	0	32	32	32	32	38	
6/8	51	0	0	0	0	2	2	0	0	7	7	7	7	9	
6/9	52	0	1	1	0	3	3	0	0	0	0	0	0	0	
6/10	53	1	0	1	0	8	8	0	0	0	0	0	0	8	
6/11	56	0	1	1	0	0	0	0	0	0	0	0	0	0	
Session 4: 3' 6" drop chain, 38 floats															
6/14	65	0	5	5	0	3	3	0	0	3	3	3	3	6	
6/15	66	0	1	1	0	0	0	0	0	3	3	3	3	3	
6/16	70	0	6	6	0	3	3	0	0	0	0	0	0	0	
6/17	71	0	1	1	0	0	0	0	0	0	0	0	0	0	
6/18	74	0	19	19	0	8	8	0	0	1	1	1	1	9	
6/19	77	0	5	5	0	3	3	0	0	0	0	0	0	3	
6/20	78	0	18	18	2	3	5	0	0	3	3	3	3	8	
6/21	80	1	3	4	0	2	2	0	0	0	0	0	0	2	
6/22	84	4	16	20	2	22	24	0	0	13	14	14	14	38	
6/23	83	6	21	27	0	14	14	0	0	1	1	1	1	15	
6/24	85	4	7	11	2	8	10	1	72	73	83	83	83	104	
6/25	87	15	14	29	0	13	13	1	66	67	80	80	80	244	
6/26	90	13	21	34	0	14	14	3	20	23	37	37	37	85	
6/27	91	2	2	4	0	6	6	1	18	19	25	25	25	83	
6/28	94	9	10	19	6	31	37	0	9	9	48	48	48	30	
6/29	95	2	18	20	4	19	23	1	7	8	12	12	12	10	
6/30	97	0	1	1	0	1	1	0	3	3	4	4	4	2	
6/31	100	7	15	22	0	7	7	0	4	4	11	11	11	30	

Note: Tow 18, experimental net, two middle chains left tied-down, Tow 48, haddock, 20 lbs, estimated 5 fish. Tow 72/73, 15 min plus 45 minute combined as one tow. Tow 78, pollock 12 lbs, estimated 2 fish. Tow 86, subsample of 4 trays out of 12 trays.

Tow #	Sub-L	Legal	Total	Haddock				Pollock				Total H+P
				Sub-L	Legal	Total	Sub-L	Legal	Total	Sub-L	Legal	
Control												
Tied-down fishing line, 30 floats												
1	1	3	4	0	0	0	0	0	0	0	0	0
2	4	8	13	1	3	4	0	1	1	1	1	5
3	2	8	10	0	2	2	0	0	0	0	0	2
Tied-down fishing line, 30 floats												
6	6	26	32	0	10	10	0	1	7	7	11	11
7	4	21	25	0	0	0	0	7	7	7	7	11
8	7	48	55	0	4	4	0	7	7	31	36	28
9	8	54	62	0	5	5	0	3	3	26	29	33
10	4	22	26	0	3	3	0	30	30	58	62	46
14	4	11	15	0	4	4	0	0	0	46	46	1
15	4	11	15	0	0	0	0	1	1	7	7	10
17	2	12	14	0	4	4	0	0	0	29	34	21
20	0	10	10	0	0	0	0	0	0	0	0	0
21	16	49	65	1	5	6	0	1	1	1	1	7
22	1	6	7	0	1	1	0	9	9	10	10	10
28	2	12	14	0	5	5	0	29	29	34	34	21
27	0	11	11	0	1	1	0	20	20	21	21	0
29	1	3	4	0	0	0	0	0	0	0	0	0
32	5	20	25	3	2	5	0	0	0	0	0	5
34	4	17	21	0	4	4	0	34	34	38	38	0
35	3	14	17	0	1	1	0	6	6	7	7	0
Tied-down fishing line, 30 floats												
37	13	36	49	0	3	3	0	52	52	55	55	3
40	1	7	8	1	1	2	0	1	1	1	1	3
41	4	40	44	0	16	16	0	150	150	166	166	0
44	0	5	5	1	0	1	0	0	0	0	0	1
47	0	7	7	0	5	5	0	21	21	26	26	7
48	1	10	11	0	5	5	0	2	2	2	2	7
49	12	54	66	0	13	13	0	0	0	13	13	0
50	5	15	20	2	17	19	0	33	33	52	52	0
54	9	28	37	0	18	18	0	1	1	1	1	19
55	8	16	24	2	11	13	0	0	0	0	0	13
Tied-down fishing line, 30 floats												
67	0	14	14	0	0	0	0	0	0	0	0	0
68	0	11	11	0	1	1	0	1	1	1	1	2
69	8	32	40	0	9	9	0	1	1	10	10	0
72/73	6	6	6	0	1	1	0	0	0	0	0	1
75	1	25	26	0	7	7	0	1	1	8	8	0
76	9	30	39	2	7	9	0	0	0	0	0	9
78	7	99	106	1	18	19	0	2	2	21	21	0
81	9	21	30	1	14	15	0	9	9	24	24	0
82	26	78	104	0	20	20	0	1	1	21	21	0
86	4	20	24	0	16	16	6	222	222	244	244	0
88	14	18	32	3	23	26	3	19	19	22	22	0
89	17	65	82	0	15	15	0	50	50	65	65	0
92	9	18	25	1	4	5	2	76	78	83	83	0
93	17	45	4	12	3	15	3	12	12	15	15	30
96	12	15	27	1	7	8	0	2	2	2	2	10
98	3	3	6	0	0	0	0	2	2	2	2	0
99	6	44	50	0	13	13	0	17	17	17	17	30

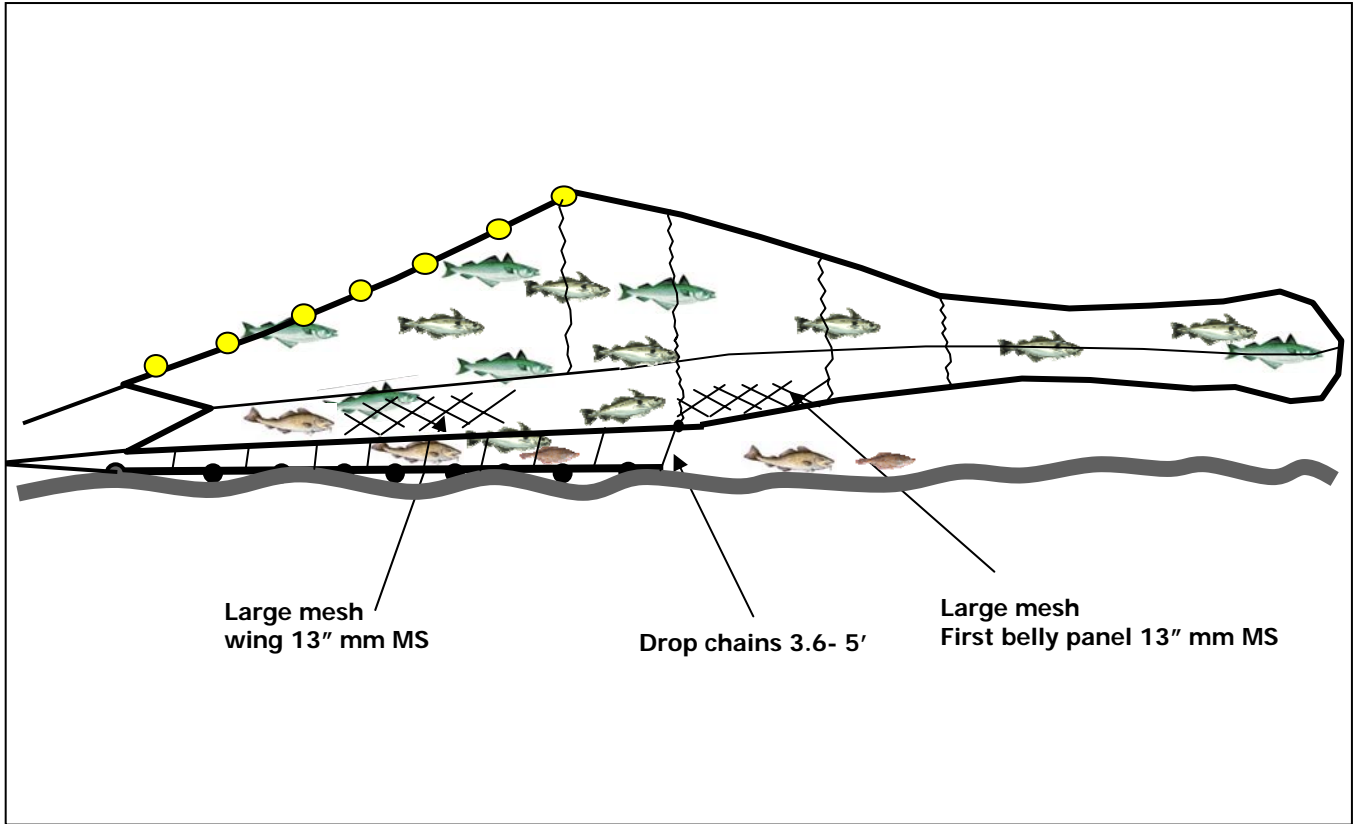


Fig. 1. Schematic drawing of the raised footrope haddock trawl.

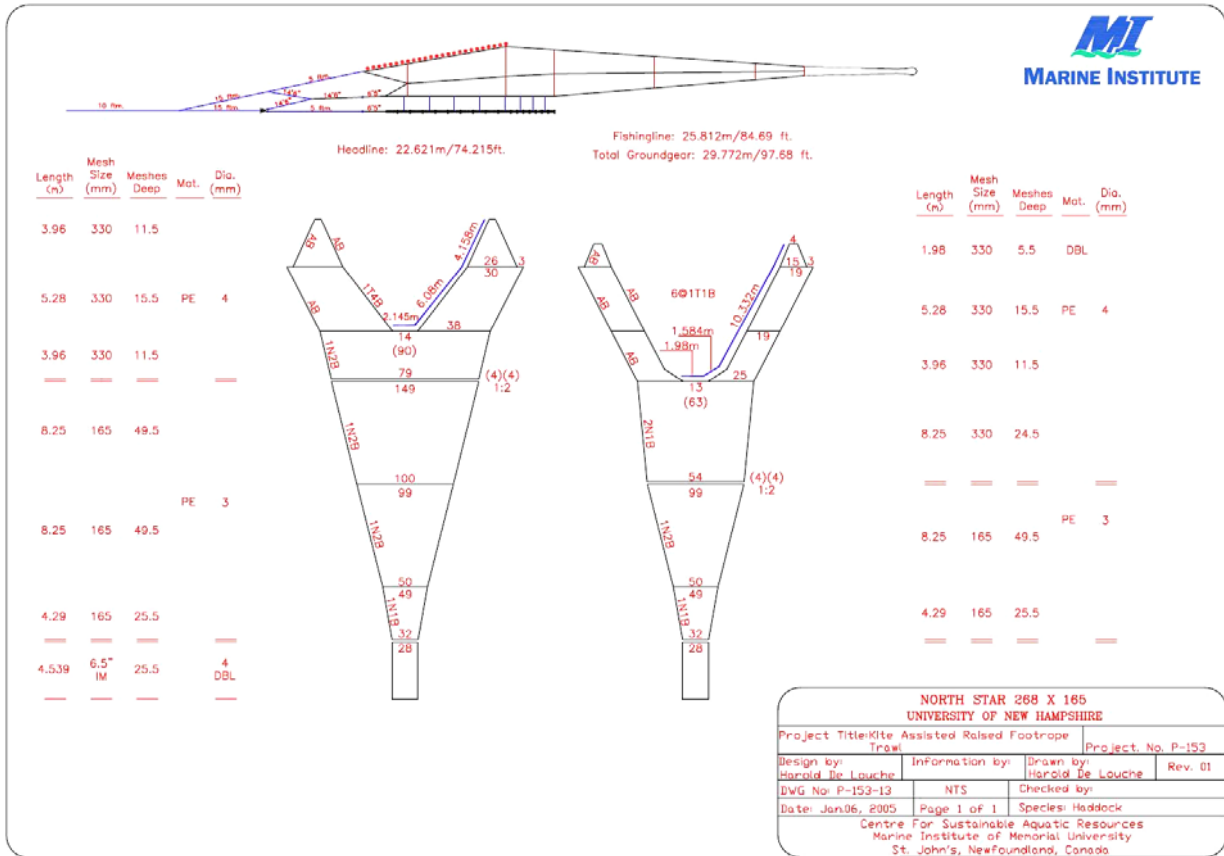


Fig. 2. The net plan used for construction of the full scale gear.

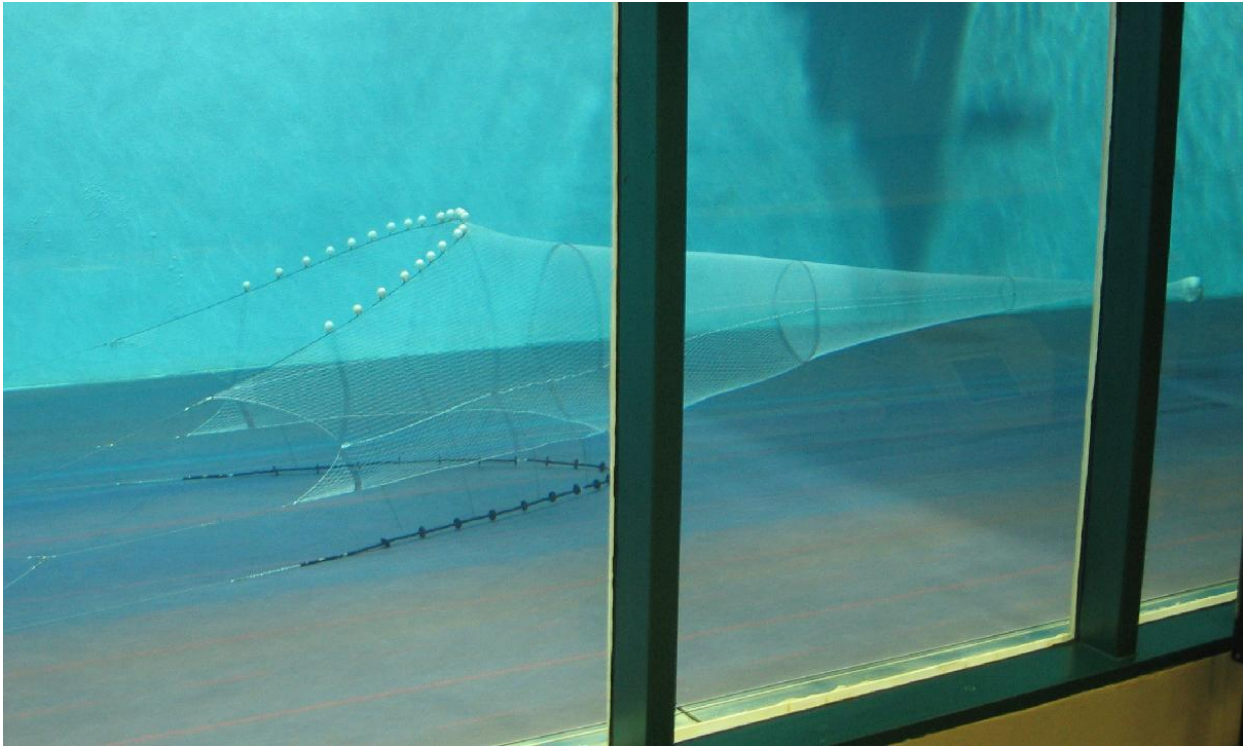


Fig. 3. The model of the raised footrope haddock trawl in the tank.

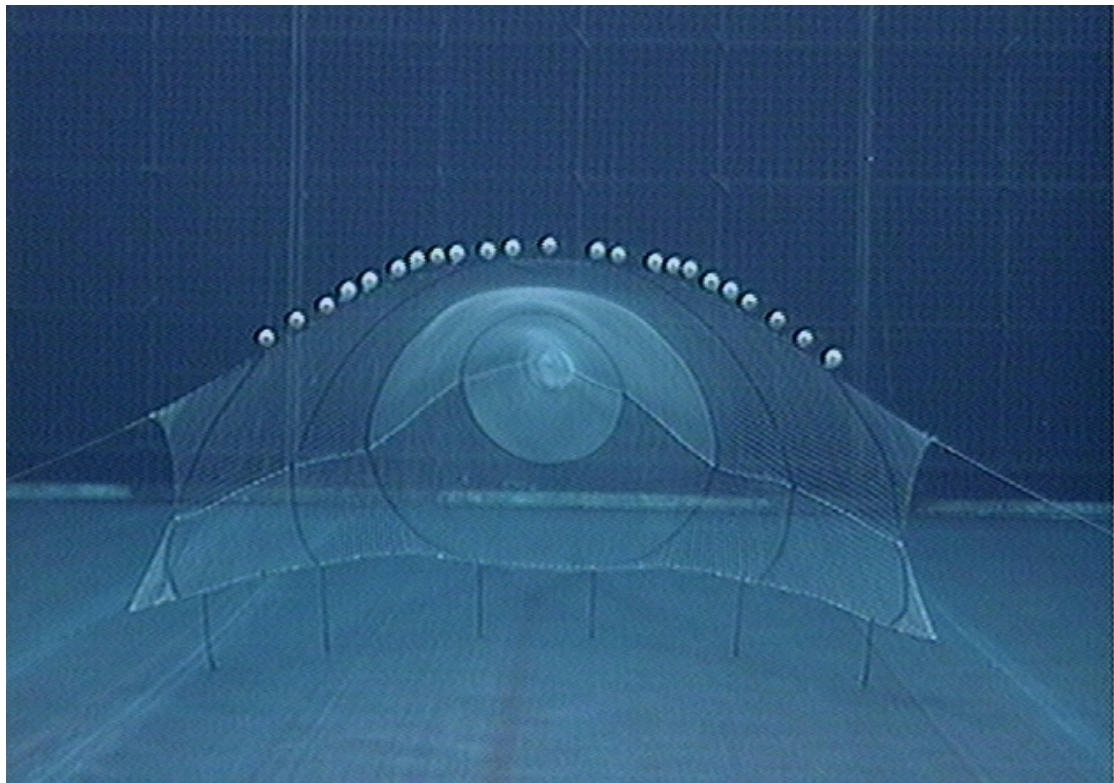
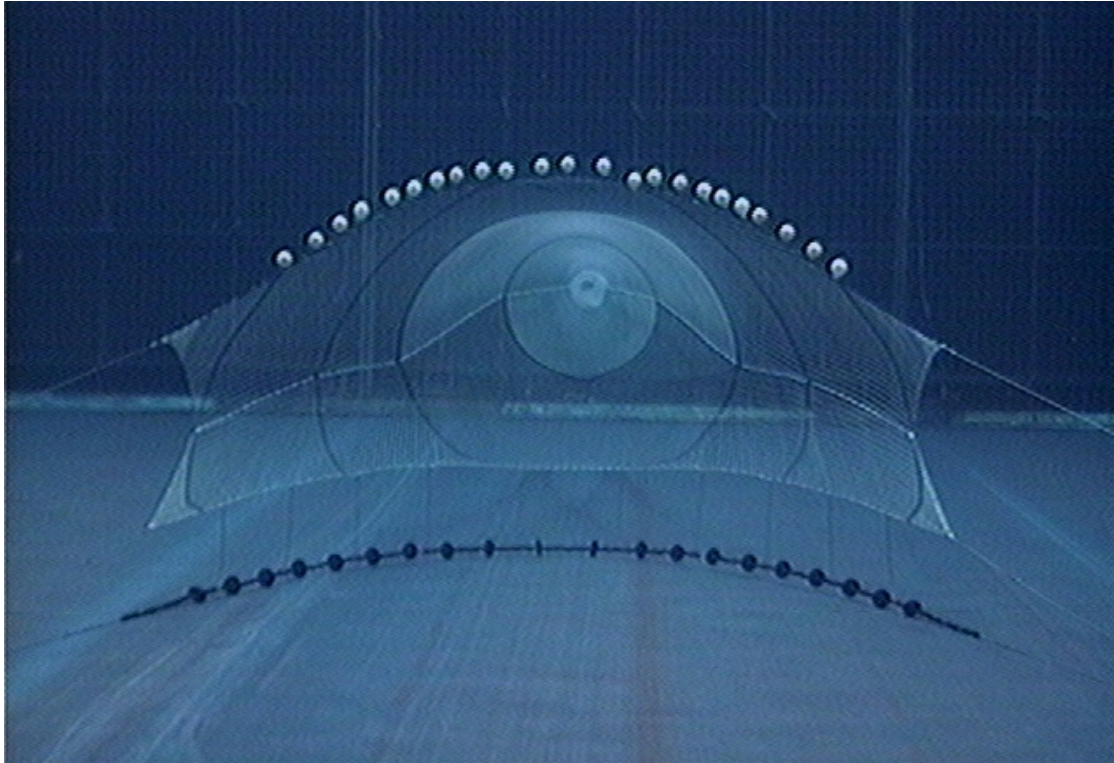
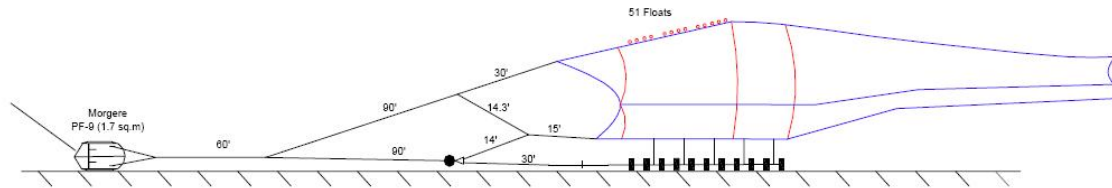


Fig. 4. The frontal view of the model of the raised footrope haddock trawl (top) and "sweepless" trawl (Bottom) in the tank.



Rig #	2	3							
Tow speed (kts)	2.7	2.7							
Door spread (ft)	141	140							
Upper wingend spread (ft)	37.3	36.9							
Lower wingend spread (ft)	42.3	42.2							
Headline height (ft)	21.7	22.5							
Fishingline height (ft)	4.5	4.5							
Fishingline height at bosum (ft)	5.2	5.6							
Wing opening (ft)	12.8	13.2							
Bridle length (ft)	See above								
Ground Cable (ft)	60	60							
Port tension (tonnes)	0.5	0.5							
Stbd. tension (tonnes)	0.5	0.5							
Total tension (tonnes)	0.98	0.99							
Mouth area (sq.ft)	862	890							
Mouth drag (lbs per sq. ft)	2.5	2.4							
# of 8" floats (5.9 lb lift)	51	51							
Total buoyancy (lbs)	300.7	300.7							
Bridle Angle (degrees)	15.6	15.6							

Rig 2: Modified V-bridle rigging

Rig 3: 1' added to the headline (footgear slightly off bottom)

Fig. 5. Measurement of geometry and force of two rigs of the model trawl. Rig 2 is the rig used for full scale construction.

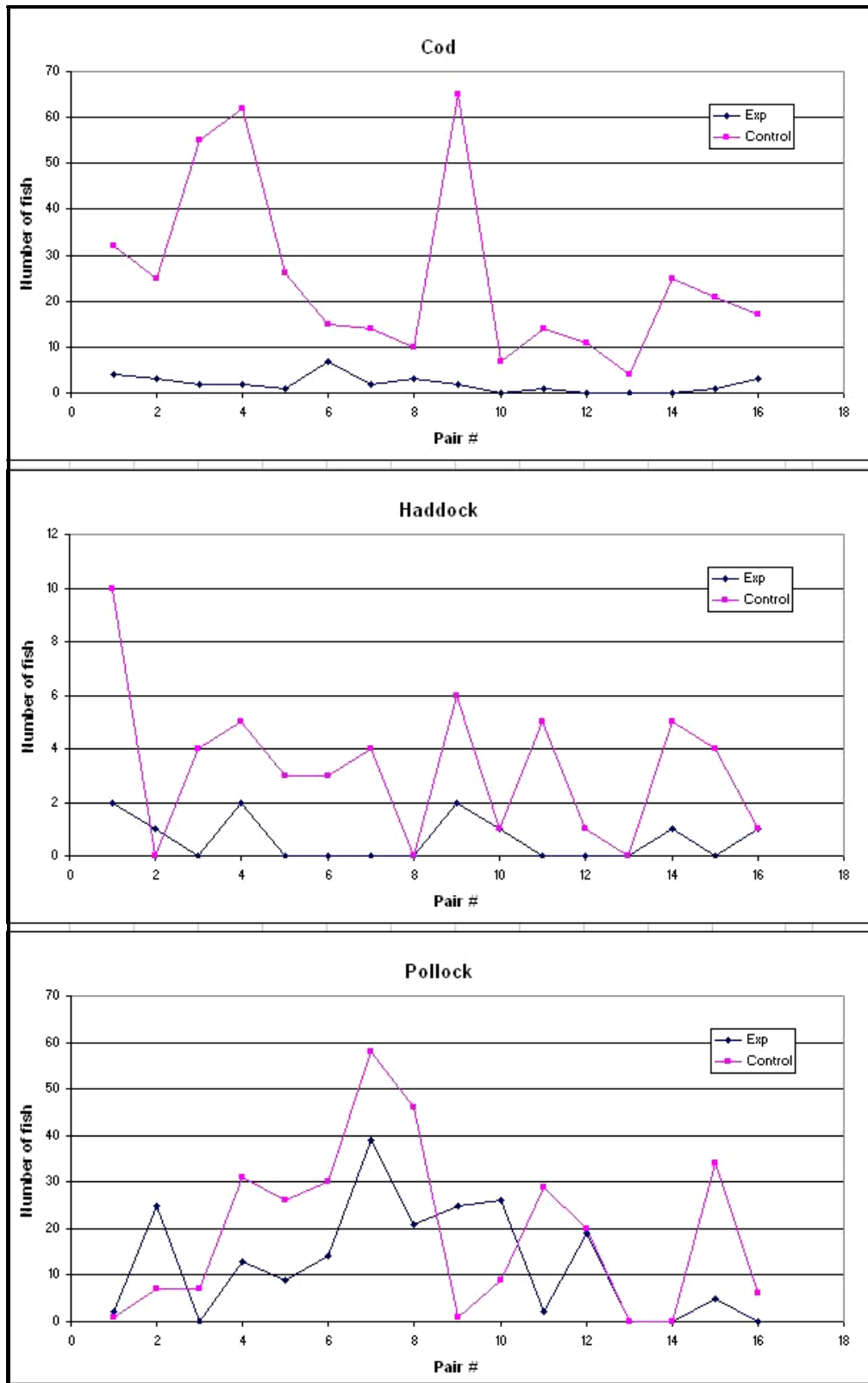


Fig. 6. Catch of three major species during Session 2 – 5' drop chain vs. tie-down fishing line (control)

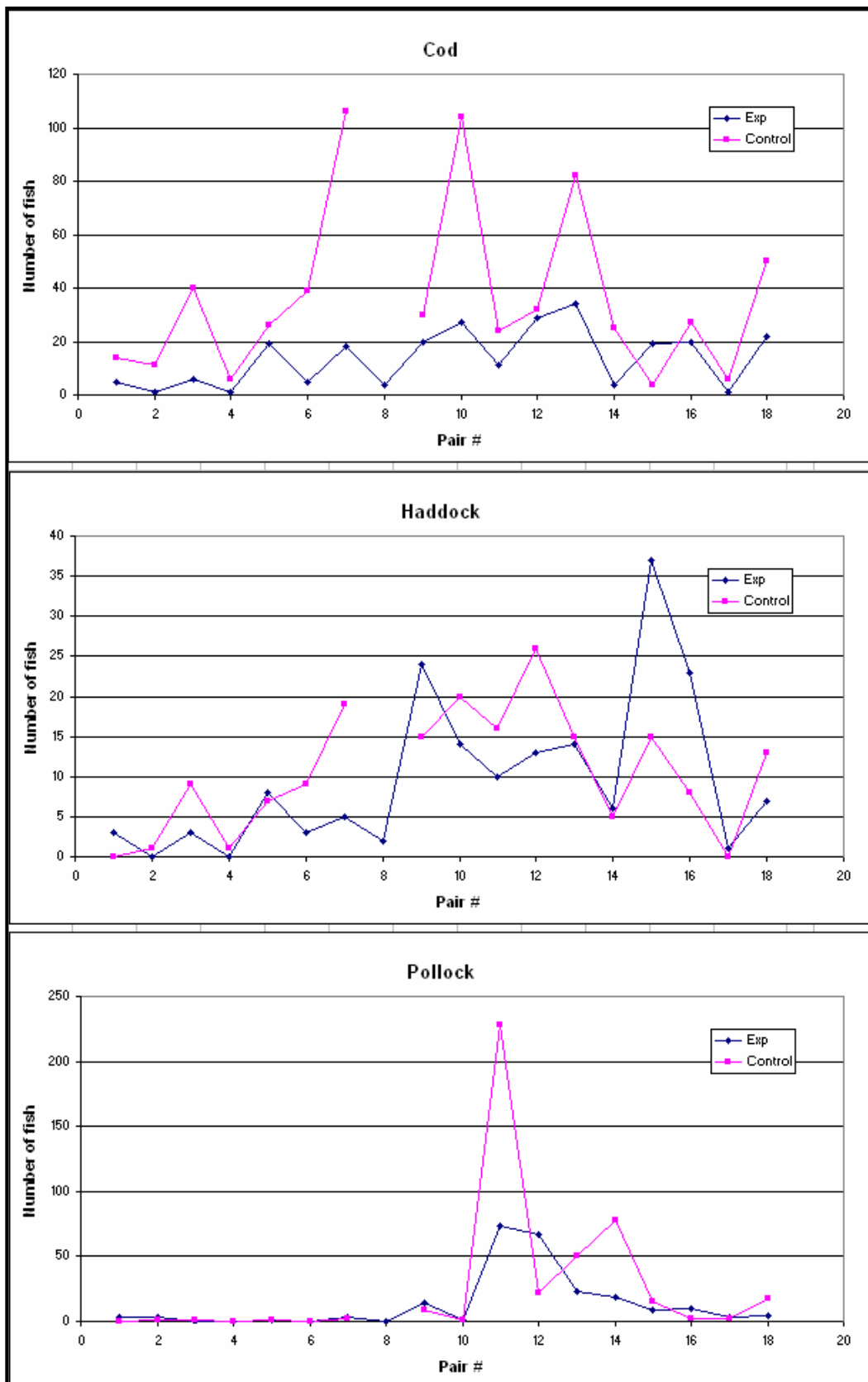


Fig. 7. Catch of three major species during Session 4 – 3.6' drop chain vs. tie-down fishing line (control)