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COMPLETION REPORT

COOPERATIVE INDUSTRY-BASED AT-SEA EXPERIMENT TO TEST THE PERFORMANCE OF A HADDOCK-SEPARATOR TRAWL IN CLOSED AREA I - GEORGES BANK

CONTRACT # EA133F-04-CN-0039

SCHOOL FOR MARINE SCIENCE AND TECHNOLOGY
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INTRODUCTION

The Challenge of Reducing Cod Bycatch in the Haddock Fishery

A suite of management measures implemented in 1994 by the New England Fishery Management Council under the Northeast Fishery Management plan helped initiate rapid rebuilding of the haddock resource on Georges Bank (Brodziak et al. 2005). The measures which led to haddock rebuilding included year-round closures of large portions of Georges Bank (Closed Area I, Closed Area Nantucket Lightship and Closed Area II), reduction of fishing pressure in adjacent open areas due to severe cuts in allowable days-at-sea, and an increase in mesh sizes to minimize retention of juvenile fish.

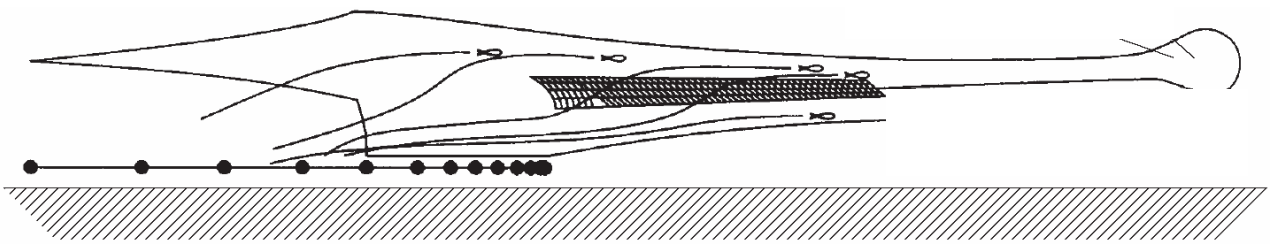
In contrast to the rebuilding of haddock in response to fishing regulations, the restoration of Georges Bank Cod stock is slow (O'Brien et al. 2005). One reason the Georges Bank cod stock is slow to rebuild is the continued overfishing and the difficulty of avoiding cod in multispecies fisheries. Cod and haddock are often caught together in the demersal trawl fishery. As a result of the strong rebuilding of haddock, fishermen are eager to resume traditional fisheries that target haddock. However, before a directed trawl fishery for haddock can be accomplished, the development of a more selective trawl is necessary in order to responsibly harvest the haddock resource without jeopardizing the recovery of cod. The Groundfish Committee of the New England Fishery Management Council (NEFMC) advised that an experimental fishery needs to be conducted before a Special Access Program (SAP) for a haddock fishery inside Closed Area I can be approved. To date, information on the performance of a separator trawl has been relatively limited in U.S. waters.

Haddock Separator Trawl

Past experiments show that species of fish exhibit varying behavior when they encounter the mouth of a trawl net underwater (Glass et al. 2005). Haddock stop swimming when they become exhausted and rise upwards as they turn back to face the net. Cod on the other hand are more inactive. They also stop swimming and simply allow the net to overtake them, swimming neither up nor down. Several studies have demonstrated effective separation of cod and haddock using separator trawls in the North Sea (Arkley and MacMullen 1996) and the Barents Sea (Engås et al 1998). This study examined the feasibility of using a net panel or "haddock separator" (Figure 1) to specifically reduce by-catch of cod in Closed Area I on Georges Bank.

The objective of this study was to evaluate cod bycatch in haddock separator trawls. The results serve the interests of all Georges Bank groundfish fishermen by giving the New England Fishery Management Council a management opportunity to develop a Georges Bank haddock fishery that fits into Amendment 13 allowing the use of "B" Days-at-Sea. The crafters of Amendment 13 intended for Category B days to be used to target healthy stocks of fish like haddock without impacting overfished stocks like cod. Overall, the data collected will improve the information available for groundfish stock management on Georges Bank and provide specific performance parameters of a haddock separator trawl.

Figure 1. Haddock separator panel (adapted from Engås et al 1998).



APPROVED WORK PLAN

This at-sea experiment was carried out in a close collaboration between the School for Marine Science and Technology and owners of commercial fishing vessels. Twenty-seven days-at-sea were spent testing experimental haddock separator trawls. Experimental Fishing Permits (EFPs) issued by NOAA Fisheries allowed sampling inside Closed Area I from June through December, but excluded sampling from January to May to protect spawning activity of cod and haddock. NOAA Fisheries specified a limit on the total number of tows and total amount of fish landed.

Vessel Selection

The performance of the haddock-separator trawl was compared to a conventional groundfish trawl fished side-by-side as an experimental 'control.' Two commercial fishing vessels with comparable characteristics were used to simultaneously trawl the bottom and collect samples of fish. Vessels were selected to participate in this study based on similarity of three important criteria: 1) vessel characteristics (length, GRT, HP); 2) fishing gear type (net type and dimensions); and 3) ability to work in tandem on the fishing grounds. Selecting vessels with similar characteristics minimizes potential bias in catch rate comparisons. Since it is virtually impossible to eliminate all bias, the goal is to control fishing conditions as much as possible. Vessel characteristics, were similar for each of the four vessels selected for the project (Table 1).

Table 1. Vessels were selected for the project based partly on their similarity in key characteristics

	Vessel Name	Net Type	Vessel Length	GRT	HP	USCG Doc. No.	Fed. Permit #
1	*F/V Sao Marcos II*	Experimental	82'	169	620	603986	410180
2	*F/V Fisherman*	Control	82'	166	720	605059	410186
3	*F/V Isabel S*	Experimental	83'	181	850	938786	410469
4	*F/V Tropico*	Control	82'	165	960	609937	410210

In addition to vessel characteristics, it was important for the vessels to be able to work successfully in tandem. The effectiveness of experimental trawls was evaluated relative to control nets by using two vessels, towing simultaneously, side-by-side on the fishing grounds.

Vessels in the groundfish fleet typically work independently, but side-by-side fishing required the selection of vessels that had experience, expertise and a history of working together. Such familiarity was needed to avoid collisions at sea, facilitate radio communication, and coordinate fishing operations (e.g., synchronized sets and hauls). Therefore, the four vessels included in the project were formed into two teams. Team 1 was made up of the *F/V São Marcos II* and *F/V Fisherman*. The captains of team 1 have fished together for decades. They normally schedule their fishing trips together, (i.e., leave port together, fish the same grounds together, and return home together). Working habits were similar for the *F/V Isabel S* and *F/V Tropico* which made up Team 2. The four vessels selected to participate in this study represented the best possible match in terms of the similarity in vessel characteristics, gear type, and experience working as a team.

Collaborative Planning

An organizational meeting held at SMAST on October 11, 2005 with participating fishermen and SMAST personnel.

Attendee	Affiliation
Peter Cura	FV *Fisherman*
Robert S. Lane	FV *Isabel S*
Tom Lees	FV *Tropico*
Tony São Marcos	FV *São Marcos II*
David Martins	SMAST-U. Mass. Dartmouth
Joachim Groeger	SMAST-U. Mass. Dartmouth
Steven Cadrin	SMAST-U. Mass. Dartmouth

Topics of discussion included:

- Determine cruise dates. Team 1 in October Team 2 in December
- Review study area, issue exact coordinates N. and S. habitat closures
- Fixed gear presence or absence, identify, obtain coordinates or request removal
- Gear configuration, review net plans
- Look over underwater video equipment, discuss optimal attachment methods and locations
- Analytical design for comparing the experimental separator trawl configuration with the control or unmodified trawl.

Net Description

Vessels modified their standard 2-seam trawl net designed to catch cod and haddock for this experiment by adding a haddock separator panel. Therefore, the experimental nets are essentially conventional groundfish nets that are modified by including a separator panel and an opening below the panel to release cod (Figure 1). Consistency between paired vessels was maximized by matching net dimension (e.g., footrope length, ground cable length, size of the fishing circle, etc; Table 2).

Table 2. Gear characteristics of the trawls used

Fishing Vessel	Net	Headrope Length	Footrope Length	Ground Cable Length	# Meshes Fishing Circle	Mesh Size of Fishing Circle	Mesh Size of Panel	Mesh Size Codend Diamond	Separator Height
São Marcos II	Exp	106 ' 2 "	130'	150'	360	6"	6"	6.5"	4'
Fisherman	Ctrl	110'	130'	150'	360	6"	6"	6.5"	4'
Isabel S	Exp	129'	143'	240'	410	6"	6"	6.5"	4'
Tropico	Ctrl	124'	128'	240'	410	6"	6"	6.5"	4'

Area of Operation

The goal of this project was to test the possibility of harvesting haddock in Closed Area I with minimal cod bycatch. If successful, the experiment could pave the way for a future B day program in western portions of Georges Bank closer to fishing ports. Current B day programs are only allowed in eastern regions of the bank, (including a portion of Closed Area II) requiring greater steaming time and thus greater fuel expenditure and higher cost in terms of the number of regulatory days spent at sea. In the past an attempt was made to establish a haddock separator trawl B day program, in Closed Area I. It was not approved by the Council and NOAA Fisheries, because information on cod bycatch was inadequate. This program was set up to provide data to evaluate an access program in Closed Area I. The North and South Habitat Closed areas within Closed Area I were off limits to sampling as a condition of the EFP. Activity was therefore restricted to the center portion of CAI (Figure 2).

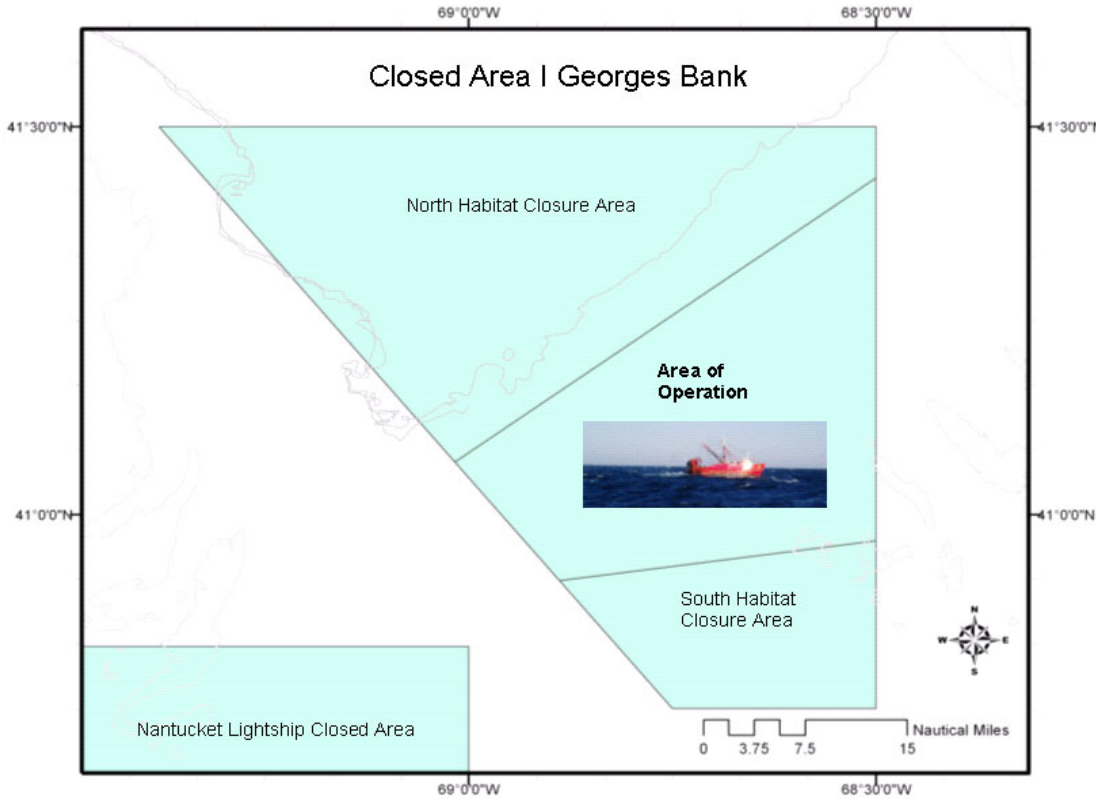


Figure 2. Closed Area I showing the area of operation situated between the North and South habitat closures areas.

The presence of fixed gear was determined prior to arrival on the fishing grounds. Fixed gear would present an obstacle to towing an otter trawl freely in the study area. Members of the Offshore Lobstermen's Association were contacted for information. A line of communication was established and maps were exchanged (Figure 3).

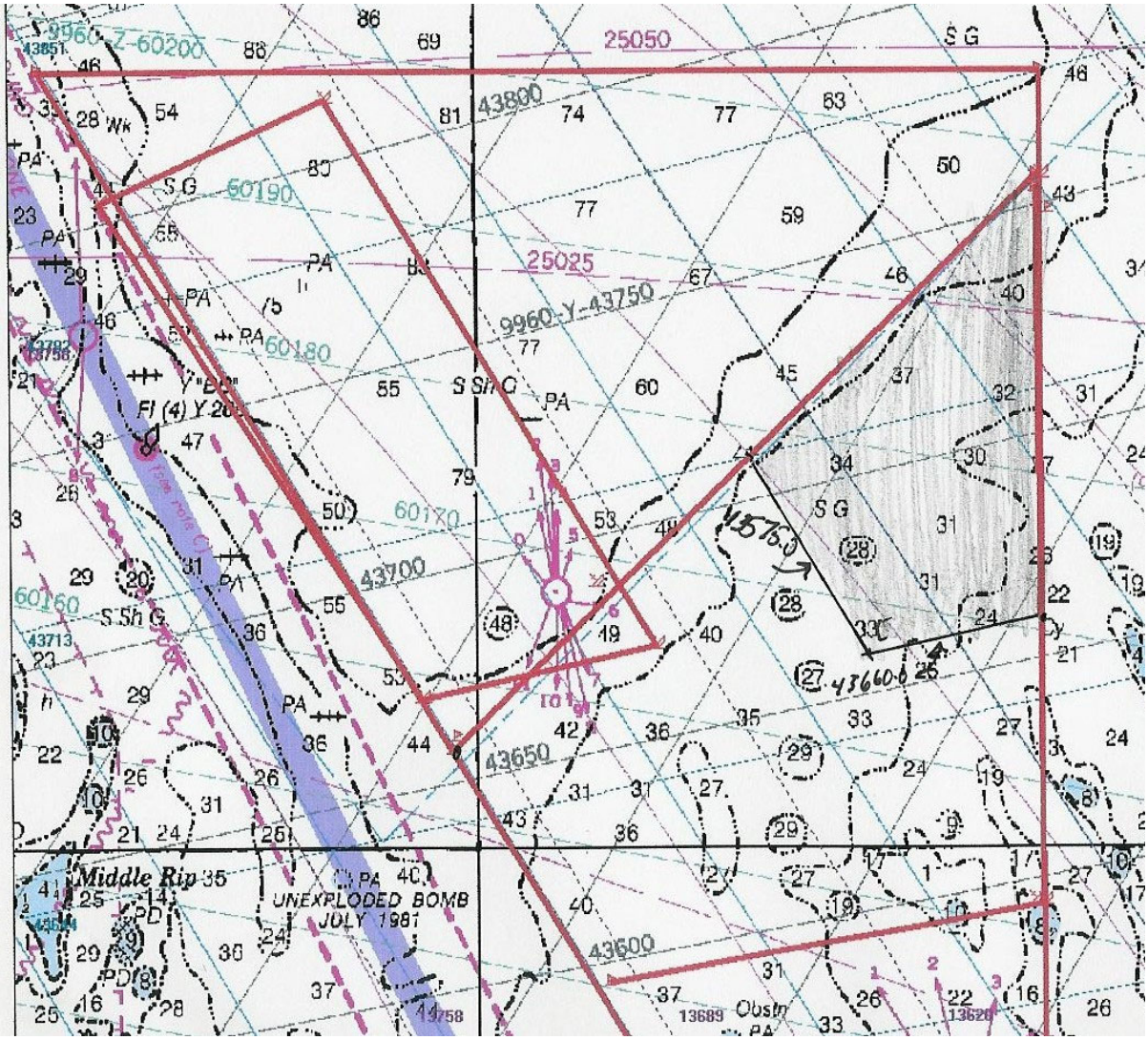


Figure 3. Chart depicting presence of lobster gear (grey shaded area). Image provided by member of Offshore Lobstermen's Association.

Field Protocol

One SMAST technician and one observer contracted by NOAA Fisheries were on board vessels. The SMAST technician was assigned to the vessel operating the separator trawl, while the NOAA Contract observer was aboard the vessel deploying the normal commercial trawl. Each technician maintained accurate records of environmental and biological parameters related to the experiment such as position, date, time, fish caught, fish length and weight, water depth, weather conditions, and underwater video operations.

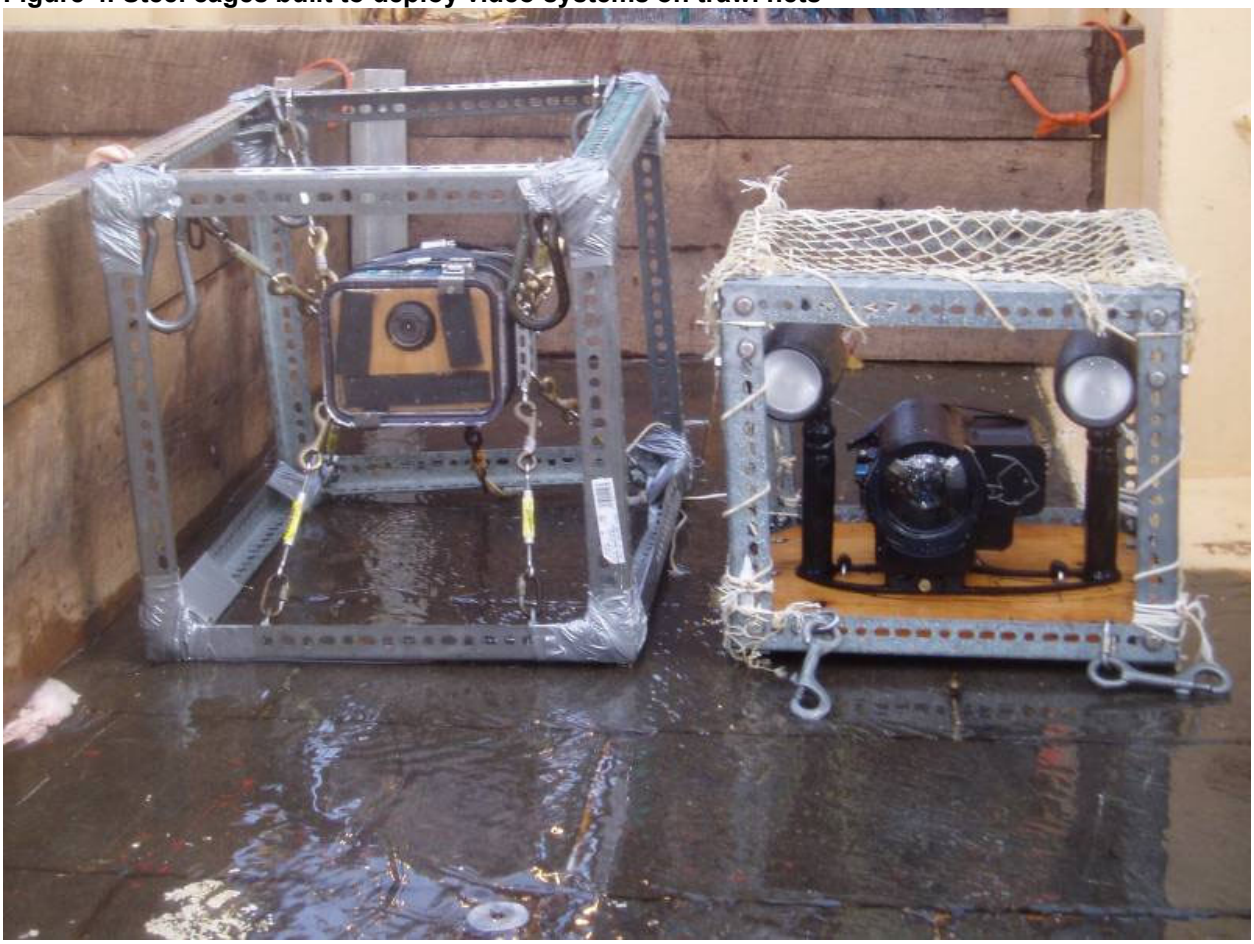
Field protocols were modeled after the National Marine Fisheries Service Observer Program (NEFSC 2006). Tow information was recorded on logsheets (e.g., location, time, depth, wire out, weather) for each haul event. Haul events were defined to include the set, major turns, and the haulback. The time and location of the start of the tow were recorded when the winches were locked and the vessel was put in gear, while the time and location for the haul-back were recorded at the time the net began to be raised. Once the codend was brought on board, the catch was released into a checker box or directly onto the deck for processing.

Technicians measured size distribution of the catch by recording length frequencies of kept and discarded fish species. Following length and weight sampling with the help of crew, all sub legal fish were returned to the sea as quickly as possible. Legal sized fish were retained and subsequently landed. Fishes to be kept for sale were culled from the catch and placed either into standard fish baskets or fish boxes. Many species marketed by fishermen are processed in various ways according to market demands (e.g., gutted, headed). NEFSC correction factors were applied to convert the weight of processed fish to an estimated whole fish weight.

Logbook data were keypunched, audited and maintained in a relational database. Data will be provided to NMFS for stock assessment and management purposes. Data, database descriptions, and metadata (e.g., sampling protocols) will be provided to other scientists or managers upon request, while maintaining confidentiality of information from individual vessels.

Underwater video cameras enclosed in specially designed housings were mounted on the trawl in order to visually document how the separator panel works, and to record the fishes' behavior in relation to the panel. Both a color and black and white video camera were attached to the net at various locations and angles including the headrope, top belly, wing and on the separator panel itself when the weather and lighting conditions allowed. Steel frames were built to safely attach both underwater video systems to the trawl headrope (Figure 4). The cameras were not deployed on overcast days or during rough weather conditions. During cruise 1 approximately 8.5 hours of footage were collected (approximately 5.5 hours using black and white low light camera, and approximately 3 hours using Sony digital color camera). In cruise 2, approximately 4.5 hours of Sony digital color video were captured and only 1.5 hours of black and white low light video.

Figure 4. Steel cages built to deploy video systems on trawl nets



Analytical Design

The experiment was designed to test performance of the separator trawl for the objective of reducing cod bycatch while targeting haddock. Therefore statistical comparisons were based on proportion of cod-to-haddock catch (*P*):

1) $$P_{h,v} = \frac{C_{h,v}}{H_{h,v}}$$

Where *C* is cod catch (discard and kept, live weight), *H* is haddock landings (live, kept weight) in all hauls *h* with haddock catch from vessel *v*. Such ratios are more robust to minor differences among vessels and fishing gear than absolute catch observations. The experimental design is a paired comparison of a control net (*c*) and an experimental net (*e*) fished side-by-side. Proportion of cod-to-haddock catch was compared using a difference statistic (*D*):

2) $$D_h = \frac{C_{h,e}}{H_{h,e}} - \frac{C_{h,c}}{H_{h,c}} = P_{h,e} - P_{h,c}$$

The null hypothesis was no difference in proportion of cod-to-haddock catch. The hypothesis was tested using a paired-*t* test, in which the statistic *D* was assumed to have a *t* distribution, and the null hypothesis was that the average difference was not different than zero (i.e., no difference in proportion of cod-to-haddock catch):

$$3) \qquad H_o : \frac{\sum_{h=1}^{h=n} D_t}{n} = 0$$

Based on the expectation of lower proportion cod-to-haddock catch in the experimental trawl, the alternative hypothesis was that the average was significantly less than zero:

$$4) \qquad H_1 : \frac{\sum_{h=1}^{h=n} D_t}{n} < 0$$

Ancillary analyses included statistical comparisons of catch by species, in which paired *t*-tests were used to test the hypothesis of equal catch of other commonly caught species (e.g., winter flounder, monkfish, yellowtail flounder and lobster). Different treatment effects between the two field trials (October 2005 and December 2005) were tested using two-tailed, pooled *t*-tests of either proportion cod-to-haddock differences or catch differences of other species. If there was no significant difference, observations from the two field trials were pooled for more powerful hypothesis tests.

Work Schedule

The field schedule was determined in part by the time of year fishermen felt that haddock would be most abundant in Closed Area I. Fishermen advised that haddock presence was related to water temperature. They believed the chances for success would be greatest when the water temperature was relatively cool. We targeted the fall months Oct. Nov. and Dec. to schedule cruises prior to expiration of the Experimental Fishing Permit on Dec. 31, 2005 (Table 3).

The first experiment was conducted from October 18 to October 23 2005 with Team 1 made up of FV *São Marcos II,* carrying the experimental separator trawl configuration, paired with FV *Fisherman* towing a control or unmodified trawl. A total of 32 side-by-side tows were completed (Figure 5). One pair of tows was eliminated because the video camera was secured to the middle of the separator panel, closing the lower section and altering the net's performance.

The second and final cruise was conducted from December 12 to December 20 with Team 2 made up of FV *Isabel S* carrying experimental separator trawl configuration, paired with FV *Tropico* towing the control unmodified trawl. A total of 39 side by side tows were completed (Figure 5). One pair of tows was excluded because of a hang in the experimental tow. Another pair of tows was used to demonstrate the effect of reducing the height of the separator panel from 4.0 feet to 1.5 feet by tying the panel closer to the footrope; these tows were also excluded from data analysis.

Figure 5. Tow locations from two separator trawl experiments (note that some paired tow locations overlap and appear as a single symbol).

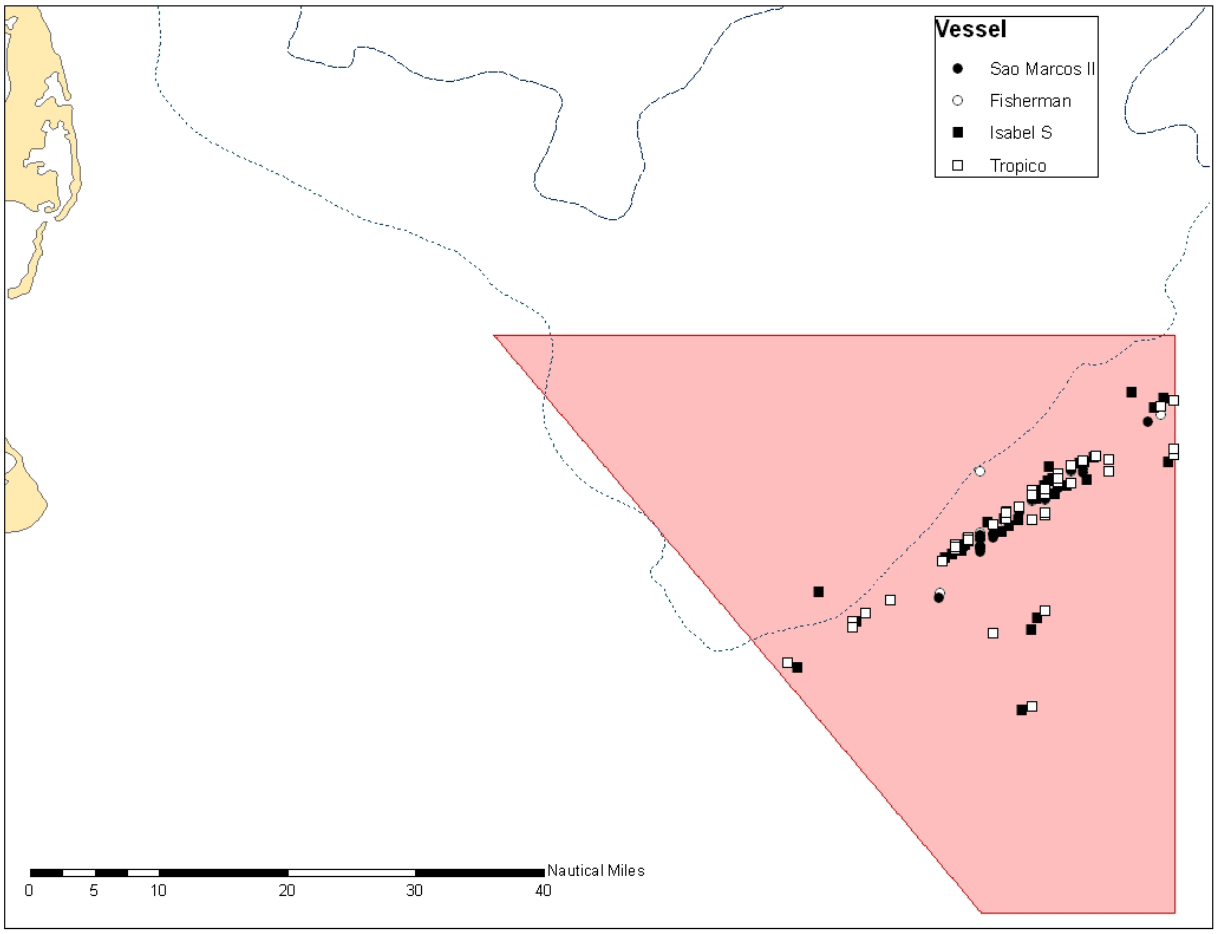


Table 3. Work schedule.

Cruise #	Vessels	Net Used	Dates	# days	# tows completed	# analyzed
Team 1	Sao Marcos II	Experimental	Oct 18 to Oct 23	6	32	31
	Fisherman	Control				
Team 2	Isabel S	Experimental	Dec 12 to Dec 20	8	39	37
	Tropico	Control				

After completion of field work, logbook data was keypunched audited and analyzed. Video data was downloaded and processed.

RESULTS

Catch of cod was less in the haddock separator trawl compared to catch of the control net. However, there also was a reduction in the catch of haddock and other species in the separator trawl. A summary of cod and haddock catches are illustrated in Figures 6 and 7. Total catch is summarized in Appendix A.

Figure 6. Cod and haddock catches from experiment 1 (Sao Marcos II and Fisherman) and Experiment 2 (Isabel S and Tropico).

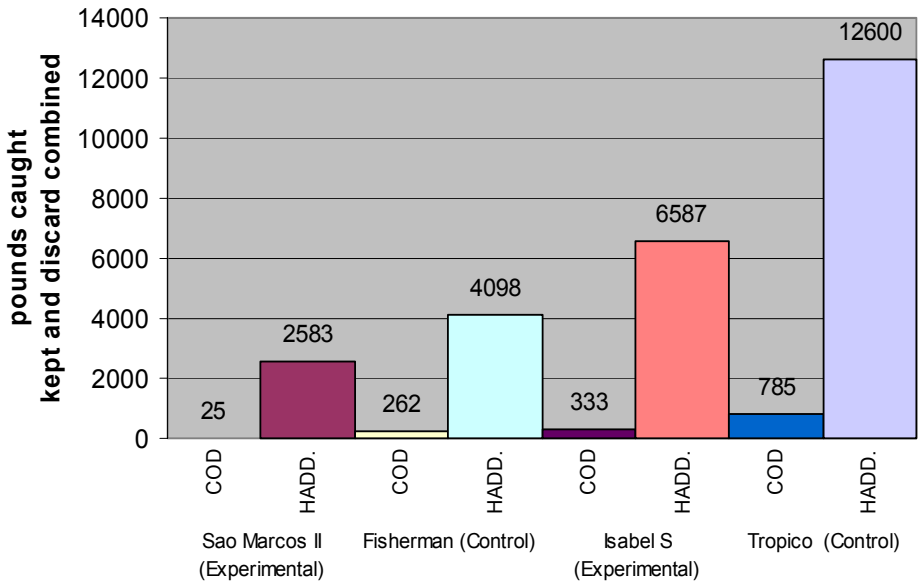
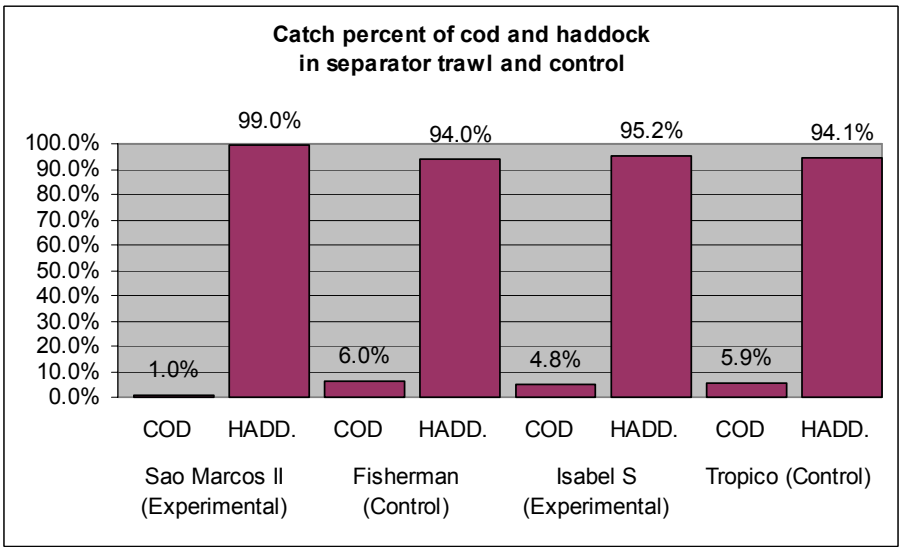


Figure 7. Proportional cod and haddock catches from experiment 1 (Sao Marcos II and Fisherman) and Experiment 2 (Isabel S and Tropico).



Data Analysis

Cod-to-haddock ratios were observed from 59 paired tows. Results indicated significantly lower cod-to-haddock ratio in the experimental trawl, with 42.9% cod-to-haddock in the control net and 11.4% cod-to-haddock in the experimental net (a difference of 31%, P=0.036). The difference in cod-to-haddock catch was not significantly different between the October and December trials (P=0.975).

Haddock catch was significantly less in the experimental trawl (P<0.005), and the mean difference in catch per haul (109 lb more in the control net) was not significantly different between the October and December trials (P=0.156). Seasonal effects on catch of other species were significantly different (P<0.002), so the two field trials were analyzed separately. Catch per haul was significantly less in the experimental trawl for all other commonly caught species: winter flounder, monkfish, yellowtail flounder, and lobster (P<0.001).

Table 4. Average difference in catch per tow between the experimental separator net and the control net (negative values indicate that the separator trawl caught less than the control net).

Species	October		December	
winter flounder	-1751	lb	-241	lb
monkfish	-324	lb	-76	lb
yellowtail flounder	-9	lb	-53	lb
lobster	-9	lb	-45	lb

Video Recording

The underwater video system was tested aboard *FV Trident* from April 18 to April 22 during a normal commercial fishing trip. Underwater video images were successfully captured (Figure 8).

Figure 8. Video frame from testing of underwater video system.

Overall, video results from experimental tows were mixed. There was insufficient light at the bottom during most of the video attempts made during the first experiment and the resulting video images were too dark to discern either the net or presence of fish. Better images were gathered during the second experiment, perhaps due to less turbid water and more light due to the slightly shallower location. A SMAST graduate student studying optic sampling techniques and fish behavior will examine video footage in more detail to help interpret results.

CONCLUSIONS

The project demonstrated that haddock can be caught using a separator panel with reduced bycatch of cod. Cod bycatch was 11% of haddock catch in the two field trials. However, the net appears to be less efficient for catching haddock and other groundfish species (e.g., flatfish). This study was limited in space and time, so more studies conducted over a wider area of Georges Bank and under diverse conditions and seasons are needed to comprehensively evaluate performance of the haddock separator panel.

One issue to consider in further investigations is the configuration of haddock separator trawl nets. This study essentially modified conventional groundfish nets by including a separator panel, with an opening below the panel to release cod (Figure 1). This is different than the 'trouser trawl' configuration in other haddock separator experiments, in which the lower portion of the net has a second codend with large mesh to allow escapement (e.g., Engås et al. 1998). The advantage of the trawls used in this study is that they were relatively simple modifications of existing fishing gear, which was less expensive for fishermen than constructing new nets. The configuration used in this study released cod through a large opening rather than through codend mesh, which may have less impact on released fish. A disadvantage of the trawl configuration used in this study may be that the lower section is more collapsed than if a codend were attached to it. Therefore, flume tank experiments are needed to observe the hydrodynamics of alternative trawl configurations, and trawl-induced mortality should be considered for alternative escapement devices.

When the separator panel was tied down to 1.5 feet above the footrope, the experimental net caught as more cod than the control net. This illustrates that separator panels can be easily altered to affect the cod-to-haddock ratio or increase the retention of flatfish. Enforcement of proper use of the gear will be difficult. Therefore, responsible fishing practices are needed for all participating fishermen.

The groundfish industry would benefit economically and socially from the creation of additional fishing opportunity of a Special Access Program in Closed Area I. The economic and social success of fishermen and families that depend on them is gauged by the number of fishing opportunities available in a given fishing year. Unless new gear types and fishing methods are developed to successfully target haddock without compromising the rebuilding of cod and other groundfish, there will be adverse social and economic impacts on the community well into the future. However, if these new gear types do not avoid overfished resources, delayed rebuilding of those species will prolong the severe limits on fishing.

European nations have conducted sea trials to test the haddock separator trawl as early as the 1980s (Engås et al. 1998). Cooperative research projects should continue to advance new technologies and modern fishing practices that help fishermen fish smarter, to benefit the fishing community and the resource.

PROJECT ADMINISTRATION

Approved Budget

	Request to Agency
I. Salaries	
B. J. Rothschild (contributed)	$0
Joachim P. Groeger (contributed)	$0
Technician (to be named, 1/2 time)	$25,850
Technician (to be named, 1/4 time)	$12,925
II. Subtotal Salaries	$38,775
III. Benefits	
At 24.75%	$9,597
IV. Subtotal Salaries and Benefits	**$48,372**
V. Other Direct Costs	
Vessel Time – 3 x 18 days @ $3,000/day	$162,000
Simrad trawl system (+ haul out at the shipyard)	$45,000
2 video cameras	$4,000
2 aluminum housings (for the video cameras)	$3,000
2 lights (for the video cameras)	$2,400
Travel/Outreach activities	$5,000
Other supplies (cables, etc)	$1,000
VI. Insurance for 54 days	$5,400
VII. Subtotal Other Direct Costs	**$227,800**
VIII. Indirect Costs	
At 55.3% of salaries	**$21,443**
IX. TOTAL	**$297,614**

Approved changes to the schedule and work plan
The initial proposal for this project included experiments to be conducted in winter, spring and fall, and to study net selectivity with the use of net covers. Those two factors could not be tested due to restrictions stipulated by the Experimental Fishing Permit (EFP) issued by NOAA Fisheries. A total of 54 sea days were initially approved for funding to test the trawl in Closed Area I of Georges Bank over three seasons. At the outset of the project charter fees were budgeted at $3,000 per sea day, assuming that vessels would be exempt from days-at-sea. In addition vessels would be able to keep and sell their catch.

Following passage of Amendment 13 of the New England Multispecies Groundfish Fishery Management Plan, days-at-sea were no longer exempt for some cooperative research projects. In the meantime, the value of "category A days" had risen significantly with rising fuel prices and limited number of fishing days allocated under Amendment 13 (e.g., fleet vessels were restricted to 52 category A days for the fishing year). Fishermen were reluctant to use their valuable A days to conduct research with experimental nets and preferred to reserve their A days for regular fishing trips, unless compensation were increased to an amount closer to the value of an A day.

A request was granted by NOAA Fisheries to reduce the number of proposed sea days to half (from 54 to 27) in order to double the originally proposed sea day rate of $3,000 per sea day to $6,000 per sea day. The modification also served to reduce the A day burden on each vessel and made the circumstances more amenable to participating fishermen. Modifying the conditions of the original proposal was essential to meet the changing circumstances.

Specific Problems
Overall, video results were mixed and turned out to be a greater challenge then originally anticipated. There was insufficient light at the bottom during most of the video attempts made during the first experiment, and the resulting video images from both the color and black and white camera were too dark to discern either the net or presence of fish. Better images were gathered during the second cruise, perhaps due to less turbid water and more light due to the slightly shallower tow locations. Despite diligently following instructions that came with the video camera, we have run into significant technical difficulty in importing the video taped images to computer software for video analysis. After numerous attempts, only one Mini DV tape from cruise 2 has been successfully imported. Inexplicably, the process for the remaining tapes could not be repeated. There may be problems associated with using a USB cable connection from the camera to the computer. Using a firewire I link (IEEE 1394) instead of USB cable may solve the problem. More sophisticated video editing tape players, associated cables (including firewire cable) and more advanced software were purchased to overcome the problem. Once the taped images are loaded, analysis will once again commence and results will be provided to NOAA Fisheries.

ACKNOWLEGMENTS
This project and report are products of the SMAST groundfish team. Sally Roman, Crista Bank and Adam Barkley assisted in production of the report. Joachim Groeger led the development of the project proposal. John Hoey and Rob Johnston (NEFSC) assisted with technical support and provision of observers. Sally and Rob Bland served as observers. Tor Bendiksen (Reidars Net Manufacturing) and Jerry Levin (Levine Net Manufacturing) were helpful with net design. The study benefited from discussions on fish behavior and conservations engineering with Chris Glass (Northeast Consortium), Mike Pol (MADMF), Dave Beutel (URI) and Laura Singer (GMRI). Most importantly, owners, Captains and crew of the *Sao Marcos II*, *Fisherman*, *Isabel S*, *Tropico*, and *Trident* were valuable partners in cooperative research**.**

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APPENDIX A - TOTAL EXPERIMENTAL CATCH

Table A1. Total catch of kept and discarded other species for Separator Trawl Net, October 2005

Table A2. Total catch of kept and discarded other species for Control Net, October 2005

Table A3. Total catch of kept and discarded other species for Separator Trawl Net, December 2005

Table A4. Total catch of kept and discarded other species for Control Net, December 2005

Table A5. Catch not included in Tables A1-A4.

Figure A1. Comparison of Total Catch of Haddock and Cod for all vessels

Figure A2. Comparison of catch percent of Cod and Haddock in Separator Trawl Net and Control Net for all vessels

Figure A3. Side by side total catch comparison of Cod and Haddock for Cruise 1, Control and Experimental Nets

Figure A4. Side by side total catch comparison of Cod and Haddock for Cruise 2, Control and Experimental Nets

Figure A5. Side by side total catch comparison of Winter Flounder for Cruise 1, Control and Experimental Nets

Figure A6. Side by side total comparison of Yellowtail Flounder for Cruise 1, Control and Experimental Nets

Figure A7. Side by side total catch comparison of Winter Flounder for Cruise 2, Control and Experimental Nets

Figure A8. Side by side total comparison of Yellowtail Flounder for Cruise 2, Control and Experimental Nets

Figure A9. Side by side total comparison of American Lobster for Cruise 1, Control and Experimental Nets

Figure A10. Side by side total comparison of American Lobster for Cruise 2, Control and Experimental Nets

Table A1. Total catch of kept and discarded other species for Separator Trawl Net, October 2005

F/V SAO MARCOS II SEPARATOR TRAWL NET OCTOBER 2005																			
Haul #	HAKE (red & white)	SILVER HAKE		LOBSTER	BLUEFISH		SEA RAVEN	SKATE	SPINY DOGFISH	BRN. DR SKATE	FOUR SPOT FL.	W. PANE FL	ILLEX SQIUD	LOLLIGO SQIUD		TORPEDO RAY	LH SCULPIN	OCEAN POUT	PORBEAGLE SHARK
	DISC	KEPT	DISC	KEPT	KEPT	DISC	DISC	DISC	DISC	DISC	DISC	DISC	DISC	KEPT	DISC	DISC	DISC	DISC	DISC
1	0	0	0	0	0	0	0	9	62	2	0	0.5	0	0	0	0	0	0	0
2	0	2	0	1.5	0	14	0	105	0	380	0	0	2	0	0	10	0	0	0
3	0	0	0	0	0	26	0	16	41	0	6	0	0	0	0	0	0	0	0
4	2	0	0	0	10	0	3	5	23	0	2	0	0	0	3	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
6	2	0	0	0	0	0	0	42	22	29	0	0	3	3	0	0	0	0	0
7	0	0	0	3	0	0	0	180	5	95	3	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	2	0	0	0	0	45	4	75	9	25	0	0	0	0	0	0	0	0	0
11	1	0	0	0	20	45	0	60	9	140	1	0	0	0	0	0	0	0	0
12	1	0	0	0	0	70	0	30	56	18	3	0	2	0	0	0	0	0	0
13	0	0	0	0	0	35	0	20	8	19	0	0	0.5	0	0.5	0	0	0	0
14	2	0	0	0	0	30	0	100	0	120	1	0	1	0	1	0	0	0	0
15	0	0	0	0	0	0	0	60	1	50	0.5	0	1	0	0	0	0	0	0
16	0	0	0	0	0	15	0	150	30	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	20	0	175	25	0	0	0	0	0	0	0	0	0	0
18	1	0	0	0	0	0	0	90	1.5	30	2	0	1	0	0	0	1	0	0
19	1	0	0	0	0	0	0	30	0	10	1	0	6	1	0	0	1	0	0
20	1	0	1	0	0	0	0	80	0	0	0	0	2	2	0	0	0	0	0
21	0	0	0	0	40	0	0	0	0	0	0	0	0	7	0	0	0	0	0
22	6	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
23	1	0	0	1.5	0	0	1	250	0	5	1	0	0	0	0	0	1	1	0
24	0	0	0	0	0	0	0	30	0	3	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0
29	1	0	0	0	0	30	0	30	3	4	1	0	2	0	0	0	0	0	170
30	1	0	0	0	0	64	0	0	4	3	1	0	0	0	0	0	0	0	0
31																			
32	1	2	0	0	0	24	0	20	4	0	2	0	0	3	0	0	0	0	0
TOTAL	23	4	1	6	70	418	8	1637	303.5	933	24.5	0.5	20.5	17	4.5	10	3	1	170

Table A2. Total catch of kept and discarded other species for Control Net, October 2005

F/V FISHERMAN CONTROL NET OCTOBER 2005																					
HAUL #	HAKE (red & white)		SILVER HAKE		LOBSTER		BLUEFISH		SKATE WING	SKATE	SEA RAVEN	SPINY DOGFISH	BRN. DR. SKATE	FOUR SPOT FL	W. PANE FL.	ILLEX SQUID	LOLLIGO SQUID	TORPRDO RAY	LH SCULPIN	PORBEAGLE SHARK	OCEAN POUT
	KEPT	DISC	KEPT	DISC	KEPT	DISC	KEPT	DISC	KEPT	DISC	DISC	DISC	DISC	DISC	DISC	DISC	KEPT	DISC	DISC	DISC	DISC
1	0	0	0	0	2	0	0	0	38	77	2	153	108	1	1	0	0	0	2	0	0
2	0	1	0	5	0	0	4	0	300	2500	0	60	0	7	0	0.3	0.5	0	1	0	0
3	0	1	0	1	9	0	0	0	32	1000	2	53	0	12	0	0.5	0	0	2	0	0
4	0	2	0	2	15	0	5	0	60	2000	0	218	0	0	0	0.5	1	0	1	0	0
5	0	0	0	1	7	0	14	0	42	700	0	104	0	0	1	0.5	0	0	2	0	4
6	0	10	0	2	10	0	7	0	42	2000	5	22	0	12	0	0.5	0	0	7	0	0
7	0	0	0	1	6	0	0	0	0	3000	0	15	0	5	0	0	0	0	3	0	0
8	0	1	0	2	9	2	4	0	120	1500	2	88	0	9	2	0.5	0	21	1	0	0
9	0	1	3	2	20	2	0	0	54	2500	0	31	0	2	2	0	0	0	2	0	0
10	0	2	1	0	10	0	0	0	0	2000	0	53	0	1	0	0	0	0	2	0	4
11	0	0	0	0	6	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	2	0	2	10	0	0	28	0	1000	0	217	0	4	0	0.5	0.5	0	0	0	0
13	0	1	0	0	21	2	0	20	0	1500	3	55	0	4	0	0.5	0	17	0	0	0
14	0	4	0	3	16	0	0	0	0	2000	0	25	0	16	0	0	0	0	3	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	1	0	1	22	0	0	0	0	2000	3	27	0	3	1	0	0	0	2	0	0
18	0	6	0	2	4	0	0	0	0	2000	0	15	0	4	0	1	0	0	1	0	0
19	0	1	2	2	2	0	0	7	0	1000	1	0	0	8	0	1	2	0	0	0	0
20	0	1	0	0	11	0	0	16	0	500	0	6	0	2	0	0.3	0.5	0	0	0	0
21	0	0.5	0	1	20	0	0	48	0	500	0	198	0	7	0	0.3	0	0	1	0	0
22	0	0.5	0	1	3	0	0	0	0	700	3	3	0	1	0	0.3	0	0	2	0	0
23	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	7	0	9	30	2	0	70	0	1500	2	31	0	10	0	0	1	0	1	150	0
27	12	15	1	3	7	0	0	0	0	1000	0.5	23	0	12	0	0.5	0.5	0	4	0	0
28	12	13	0	2	0	0	0	16	0	1000	0	16	0	10	0	0.5	2	0	4	0	0
29	0	2	8	8	0	0	0	96	0	300	5	33	0	23	0	0.3	2	0	2	0	0
30	0	0.5	3	0.5	0	0	0	115	0	500	0	19	0	2	0	0.5	1	0	0	0	0
31	data removed due to artifact of the camera (weighed down the separator and increaased catch of flatfishes etc).																				
32	0	2	0	1	4	0	0	18	0	300	2	0	0	7	0	0.5	0.5	0	0	0	0
TOTAL	24	74.5	18	51.5	281	10	34	434	688	33077	30.5	1465	108	162	7	9	11.5	38	43	150	8

Table A3. Total catch of kept and discarded other species for Separator Trawl Net, December 2005

F/V ISABEL S SEPARATOR TRAWL NET DECMEBER 2005

HAUL #	LOBSTER		SKATE WING	SKATE	BRN.DR. SHKATE	SEA RAVEN	LH SCULPIN	SPINY DOGFISH	ILLEX SQUID	W.PANE FL.		FOUR SPOT FL.	PORBEAGLE SHARK	LUMPFISH	HALIBUT	SILVER HAKE		TORPEDO RAY
	KEPT	DISC	KEPT	DISC	DISC	DISC	DISC	DISC	DISC	KEPT	DISC	DISC	DISC	DISC	DISC	KEPT	DISC	DISC
1	3	0	0	6	0	0	0	11	0	0	0	0	0	0	0	0	0	0
2	6	0	0	30	0	0	0	0	0	0	0	0	0	0	0	25.99	0	0
3	20	6	0	350	0	5	0	19	0	0	1	3	0	0	0	0	0	0
4	15	0	0	90	0	0	0	0	0	0	0	0	0	0	0	11.3	0	60
5	8	0	0	180	0	14	0	0	0	0	0	0	0	0	0	0	0	0
6	6	0	0	350	50	0	2	0	0	0	5	4	0	0	4	0	0	0
7	6	0	0	500	12	0	3	0	0	0	1	5	0	0	0	39.55	0	0
8	12	0	0	700	0	0	5	0	0	0	0	2	0	0	0	10.17	0	0
9	5	0	0	200	0	0	0	0	0	0	0	0	0	0	0	22.6	0	0
10	2	0	0	275	0	0	2	0	0	0	0	2	0	0	0	0	0	0
11	0	0	0	80	0	0	1	0	0	1	0	0	0	0	0	45.2	0	0
12	7	4	0	90	0	0	0	0	0	0	2	0	350	0	0	11.3	0	0
13	13	0	0	200	0	1	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	250	0	0	0	0	0	0	0	0	0	0	0	11.3	0	0
16	3	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	300	0	0	1	0	0	0	0	0	0	0	0	11.3	0	0
18	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0
19	2	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	100	0	10	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	5	0	0	1	0	0	0	0	0	0	0
22	0	2	0	150	0	5	3	0	2	3	0	0	0	0	0	0	0	0
23	12	6	0	320	15	0	2	0	0	0	0	0	0	0	0	0	0	0
24	3	0	0	150	0	0	4	0	0	0	0	0	0	0	0	0	1	0
25	0	0	0	100	0	7	3	18	0	0	1	0	0	0	0	16.95	2	0
26	0	3	7	300	0	18	2.5	7	0	0	1	0	0	3	0	5.65	2	0
27	12	0	5	175	0	0	0	0	0	0	1	2	0	0	0	0	0	0
28	0	0	0	30	0	0	0	1	0	0	0	0	0	0	0	0	0	0
29	4	0	0	14	0	0	0	0	0	0	0	1	0	0	0	24.86	0	0
30	Data excluded																	
31	Data excluded																	
32	5	3	20	300	0	4	7	3	0	0	10	0	0	0	7	0	0	0
33	4	0	10	50	0	0	2	3	0	0	0	0	0	0	0	0	0	0
34	4	2	15	500	0	0	0	0	0	0	2	0	0	0	0	36.16	0	0
35	6	0	0	123	0	0	0	15	0	0	1	1	0	0	0	21.47	0	0
36	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	13.56	0	0
38	3	0	0	0	0	3	0	0	0	0	2	3	0	0	0	0	0	0
39	0	0	0	450	0	0	0	14	0	0	0	0	0	0	0	7.91	0	0
TOTAL	161	26	57	6492	77	67	37.5	112	2	4	28	23	350	3	11	315.3	5	60

Table A4. Total catch of kept and discarded other species for Control Net, December 2005

F/V TROPICO CONTROL NET DECEMBER 2005

Haul #	HAKE (red & white)	SEA RAVEN	OCEAN POUT	LH SCULPIN	SPINY DOGFISH	SMOOTH DOGFISH	W. PANE FL.	LOBSTER		SKATE WING	SKATE
	KEPT	DISC	DISC	DISC	DISC	DISC	DISC	KEPT	DISC	KEPT	DISC
1	5.9	0	0	0	242	0	11	13.2	0	0	275
2	0	0	0	13.2	15.4	0	0	213.4	11	0	880
3	0	0	0	0	22	0	0	136.4	18	0	770
4	0	13.2	0	0	6.6	0	0	158.4	0	0	704
5	0	8.8	0	6.6	0	0	0	70.4	0	0	660
6	0	0	0	8.8	22	0	0	19.8	0	0	880
7	0	0	0	13.2	26.4	0	0	90.2	0	0	2200
8	0	0	0	0	0	0	0	35	0	160	4800
9	0	8.8	0	11	17.6	0	0	30.8	0	0	2200
10	0	0	0	4.4	15.4	0	0	33	8.8	66	1100
11	0	13.2	4.4	0	0	0	0	28.6	0	72.6	682
12	0	22	0	6.6	0	0	0	79.2	0	68.2	572
13	0	24.2	0	6.6	0	0	0	41.8	0	0	1012
14	0	8.8	0	13.2	4.4	0	0	26.4	0	0	440
15	0	22	0	0	0	0	0	17.6	0	92.4	572
16	0	0	0	0	10	0	0	11	0	50	1800
17	0	0	0	0	0	0	0	15	0	25	0
18	0	8.8	0	17.6	24.2	0	6.6	19.8	0	0	2200
19	0	0	0	0	8.8	0	0	0	0	0	242
20	0	6.6	0	0	26.4	0	0	6.6	0	0	880
21	0	0	0	0	0	0	0	52.8	4.4	110	484
22	0	4.4	0	11	22	0	0	13.2	0	0	4400
23	0	0	0	13.2	0	0	11	158.4	0	44	4620
24	0	0	0	0	0	0	0	16	0	0	1500
25	0	0	0	0	0	0	0	126	0	45	3500
26	0	0	0	8.8	17.6	0	0	39.6	0	114.4	5500
27	0	0	0	13.2	35.2	0	0	81.4	0	57.2	5060
28	0	0	0	13.2	26.4	0	0	35.2	0	0	4400
29	0	0	0	13.2	0	0	6.6	15.4	0	0	2420
30	Data excluded from the results										
31	Data excluded from the results										
32	2.68	0	0	0	0	0	0	56	0	30	3000
33	0	0	0	0	0	10	0	25	0	90	2500
34	0	0	0	8.8	13.2	0	0	19.8	0	96.8	3740
35	0	4.4	0	8.8	26.4	0	0	35.2	0	0	2200
36	0	0	0	8.8	22	0	0	35.2	0	0	440
37	0	0	0	8.8	44	0	0	26.4	0	0	770
38	0	0	0	8.8	4.4	0	0	0	0	0	660
39	0	0	0	8.8	30.8	0	0	22	0	0	550
TOTAL	8.58	145.2	4.4	226.6	683.2	10	35.2	1804.2	42.2	1122	68613

Table A5. Catch not included in Tables A1-A4.

Vessel	Species	kept (lb)	discarded (lb)
Isabel S.			
	Sea robin	0.0	2.0
	Atlantic herring	0.0	0.5
	Atlantic mackerel	0.0	0.5
	Witch flounder	0.0	1.0
	American plaice	2.5	2.0
Sao Marcos II			
	Starfish	0.0	6.0
	Atlantic herring	0.0	3.5
	Cunner	0.0	1.0
Fisherman			
	Butterfish	0.0	0.8
	Blueback herring	0.0	0.6
	Alewife	0.0	0.5

Figure A1. Comparison of Total Catch of Haddock and Cod for all vessels

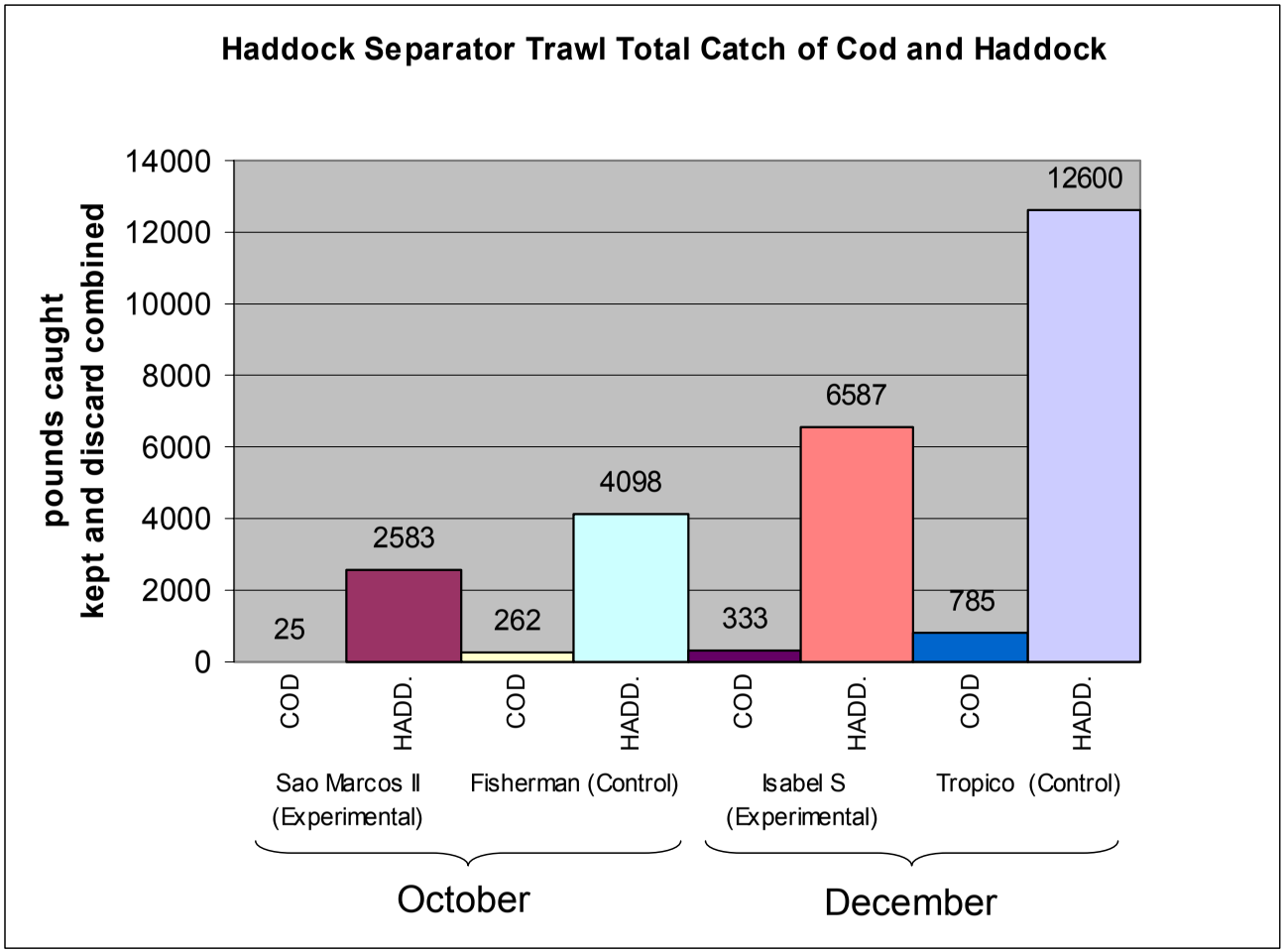


Figure A2. Comparison of catch percent of Cod and Haddock in Separator Trawl Net and Control Net for all vessels.

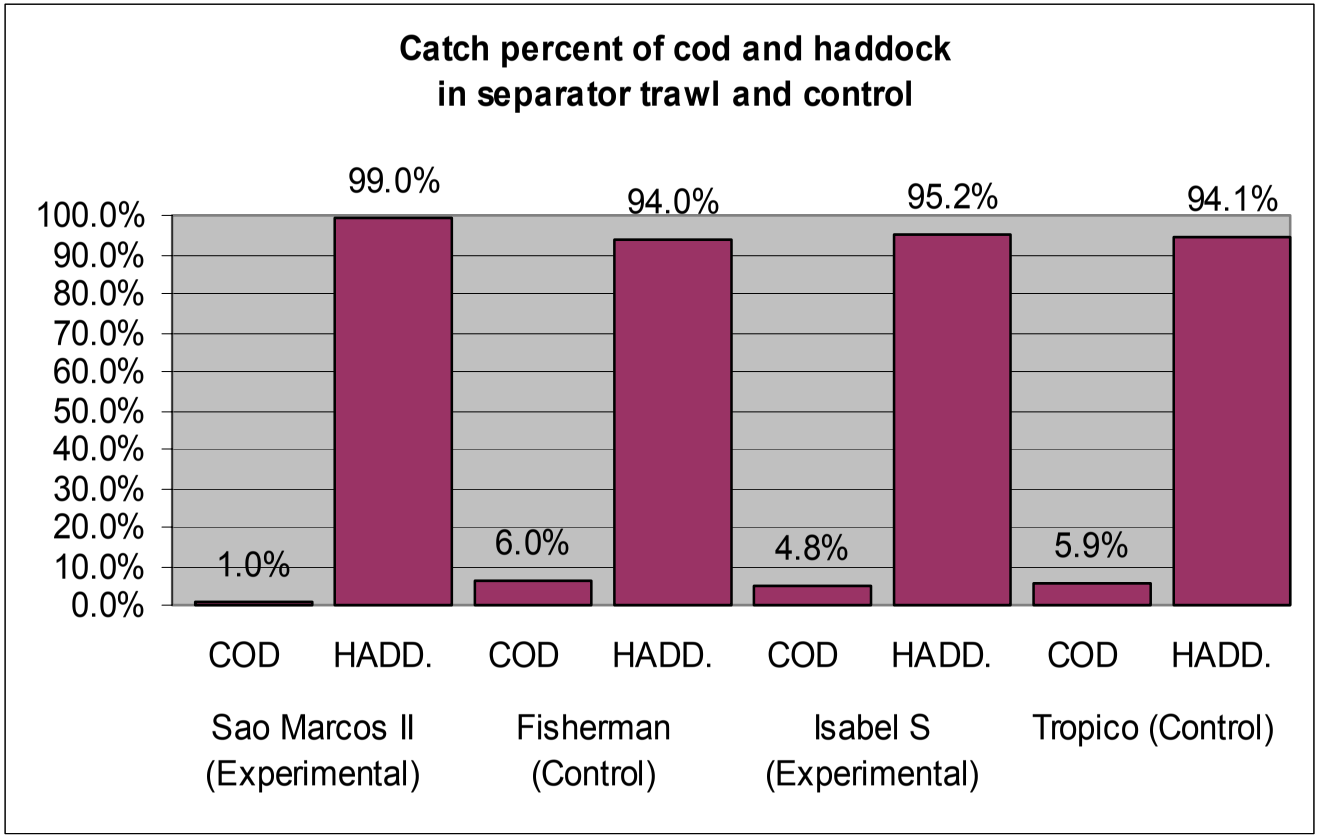
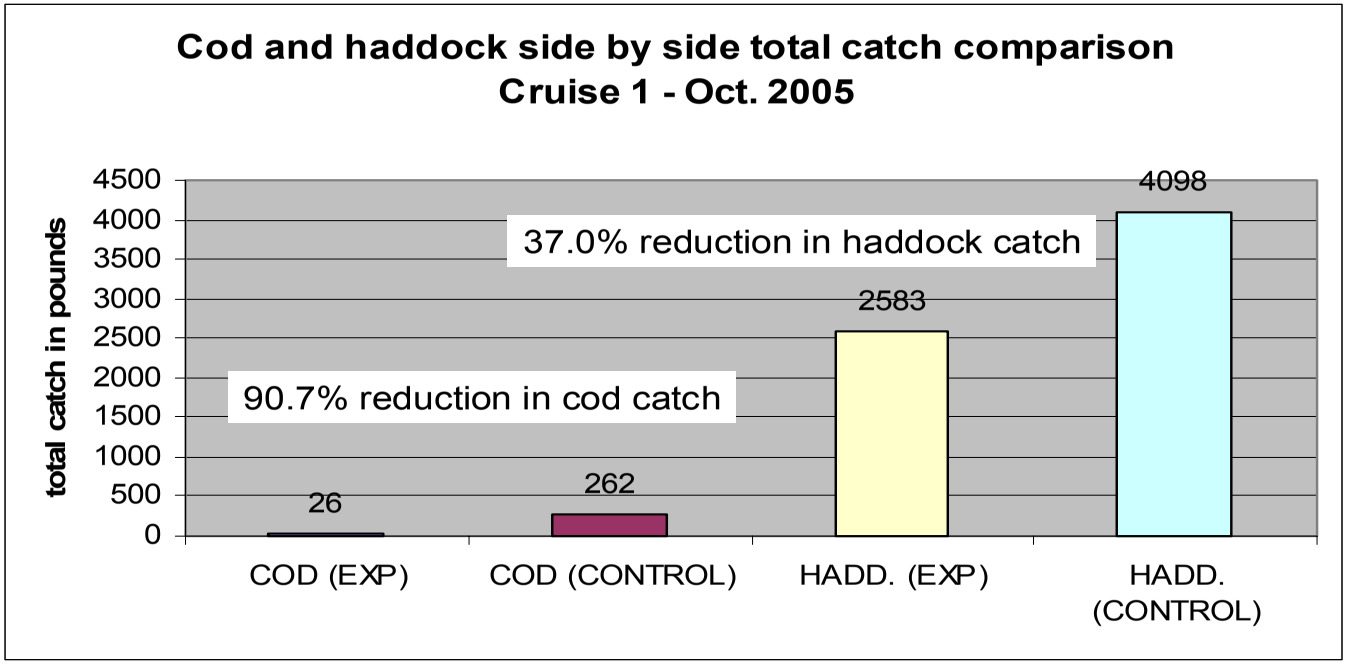
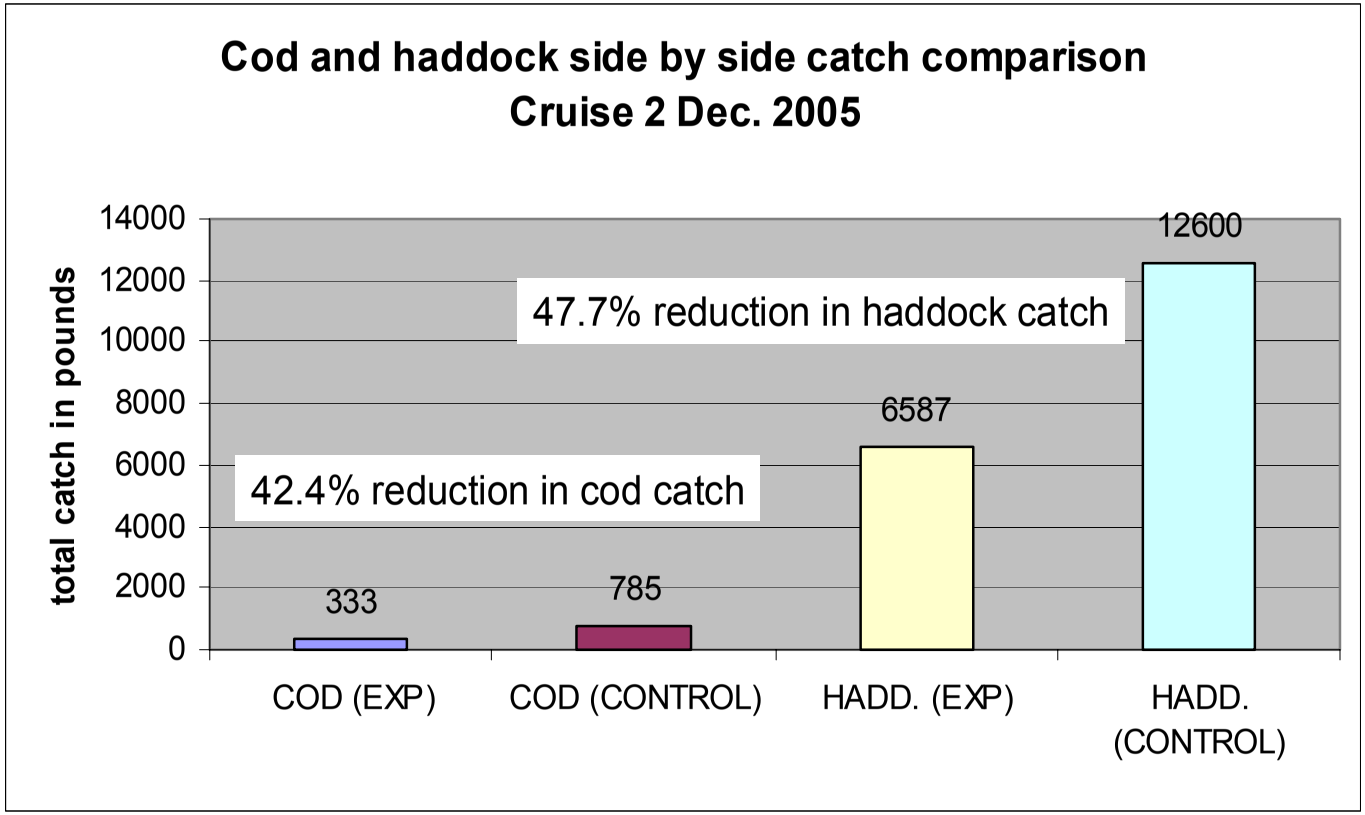


Figure A3. Side by side total catch comparison of Cod and Haddock for Cruise 1, Control and Experimental Nets



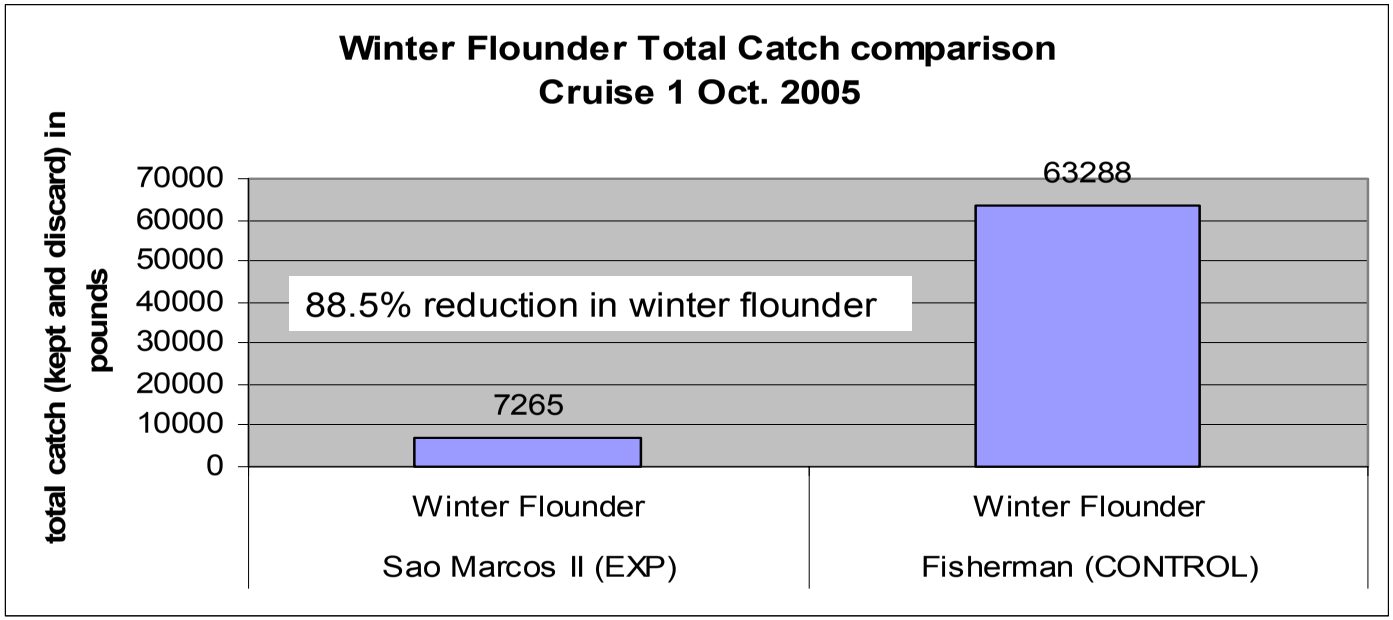
Sao Marcos II	Fisherman	Sao Marcos II	Fisherman
COD (EXP)	COD (CONTROL)	HADD. (EXP)	HADD. (CONTROL)
26	262	2583	4098
9.9%	90.7%	37.0%	63.0%

Figure A4. Side by side total catch comparison of Cod and Haddock for Cruise 2, Control and Experimental Nets



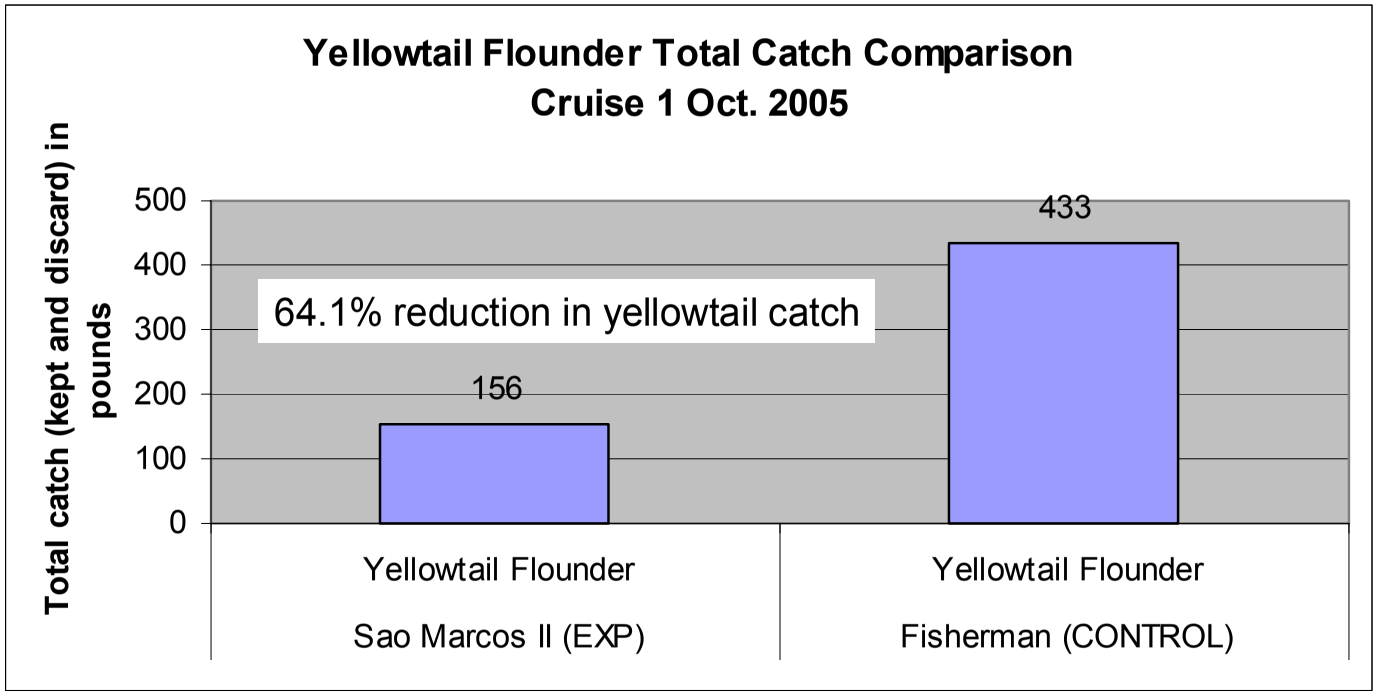
Isabel S	Tropico	Isabel S	Tropico
COD (EXP)	COD (CONTROL)	HADD. (EXP)	HADD. (CONTROL)
333	785	6587	12600
42.4%	57.6%	47.7%	52.3%

Figure A5. Side by side total catch comparison of Winter Flounder for Cruise 1, Control and Experimental Nets



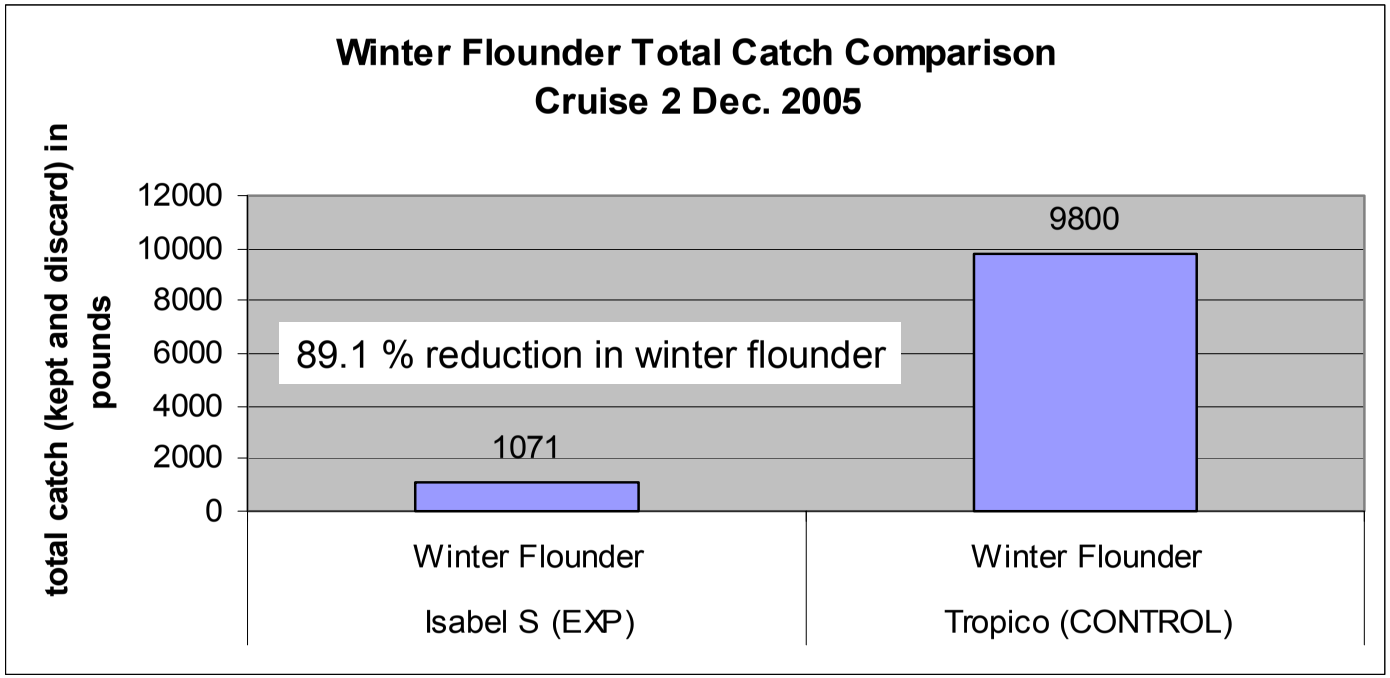
Sao Marcos II (EXP)	Fisherman (CONTROL)
Winter Flounder	Winter Flounder
7265	**63288**
11.5%	**88.5%**

Figure A6. Side by side total comparison of Yellowtail Flounder for Cruise 1, Control and Experimental Nets



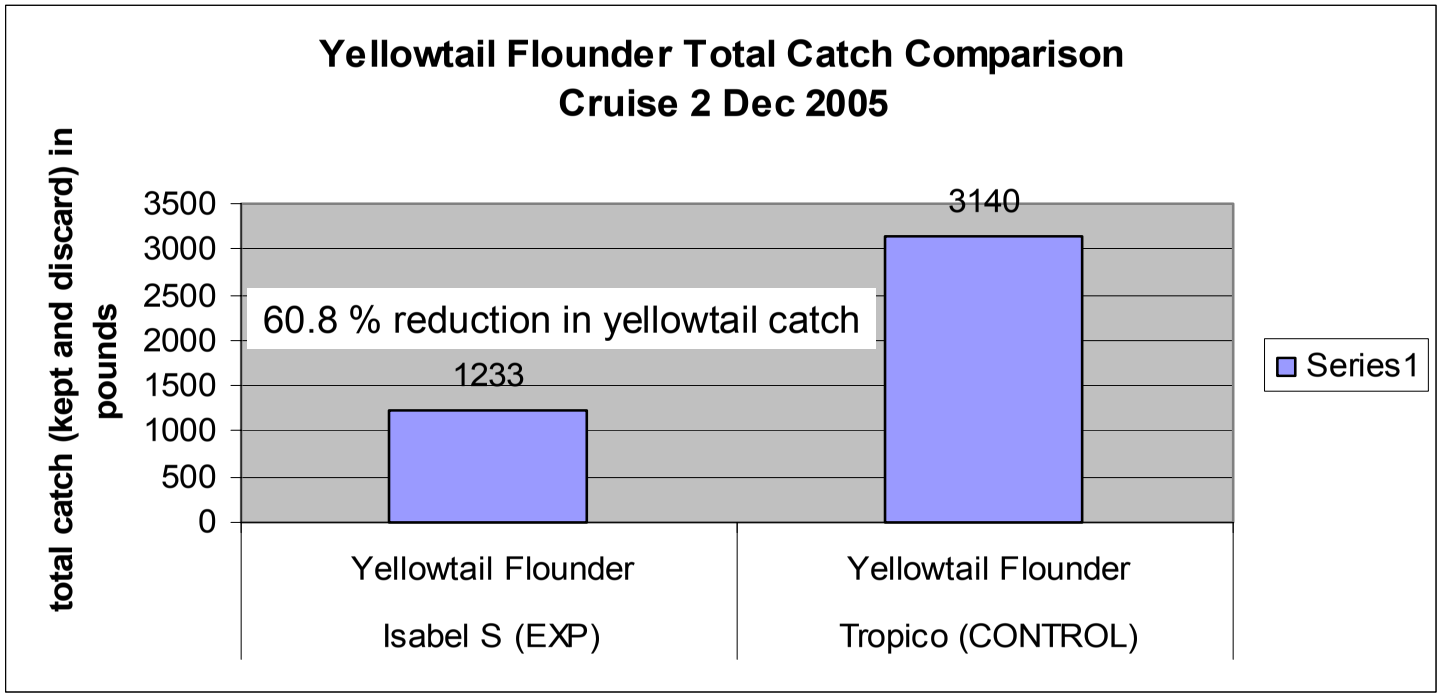
Sao Marcos II (EXP)	Fisherman (CONTROL)
Yellowtail Flounder	Yellowtail Flounder
156	**433**
35.9%	**64.1%**

Figure A7. Side by side total catch comparison of Winter Flounder for Cruise 2, Control and Experimental Nets



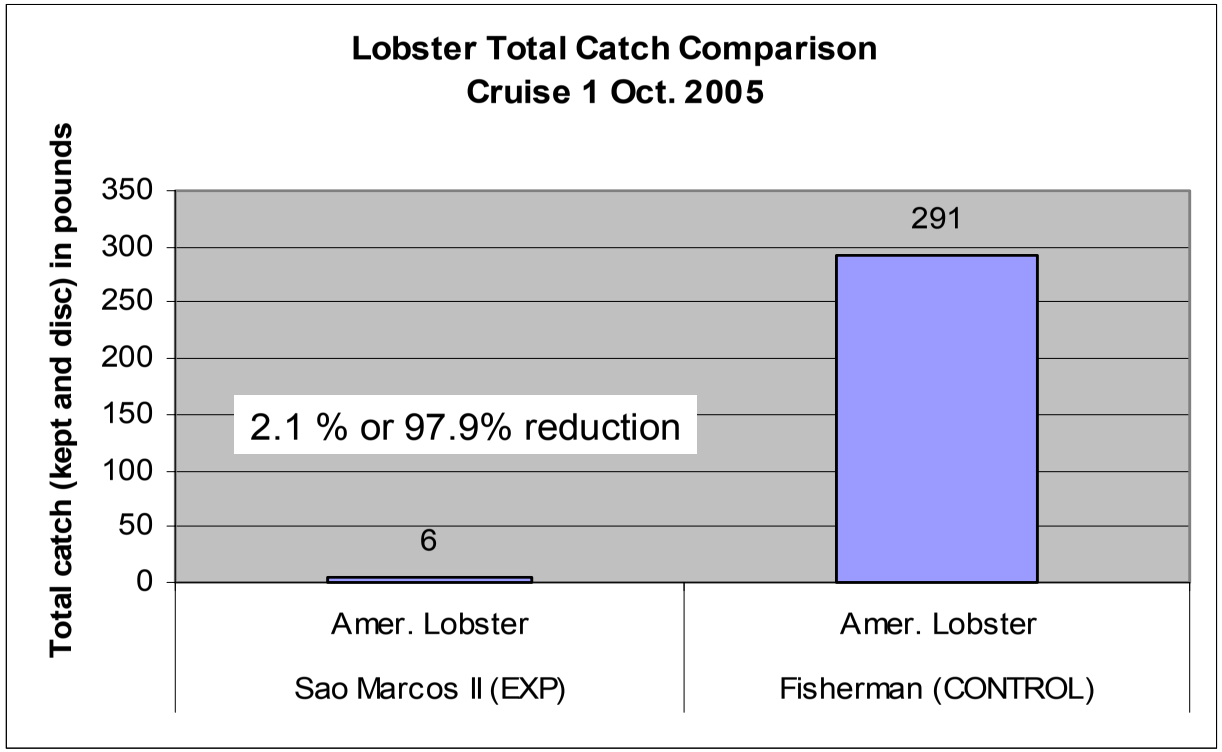
Isabel S (EXP)	Tropico (CONTROL)
Winter Flounder	Winter Flounder
1071	**9800**
10.9%	**89.1%**

Figure A8. Side by side total comparison of Yellowtail Flounder for Cruise 2, Control and Experimental Nets



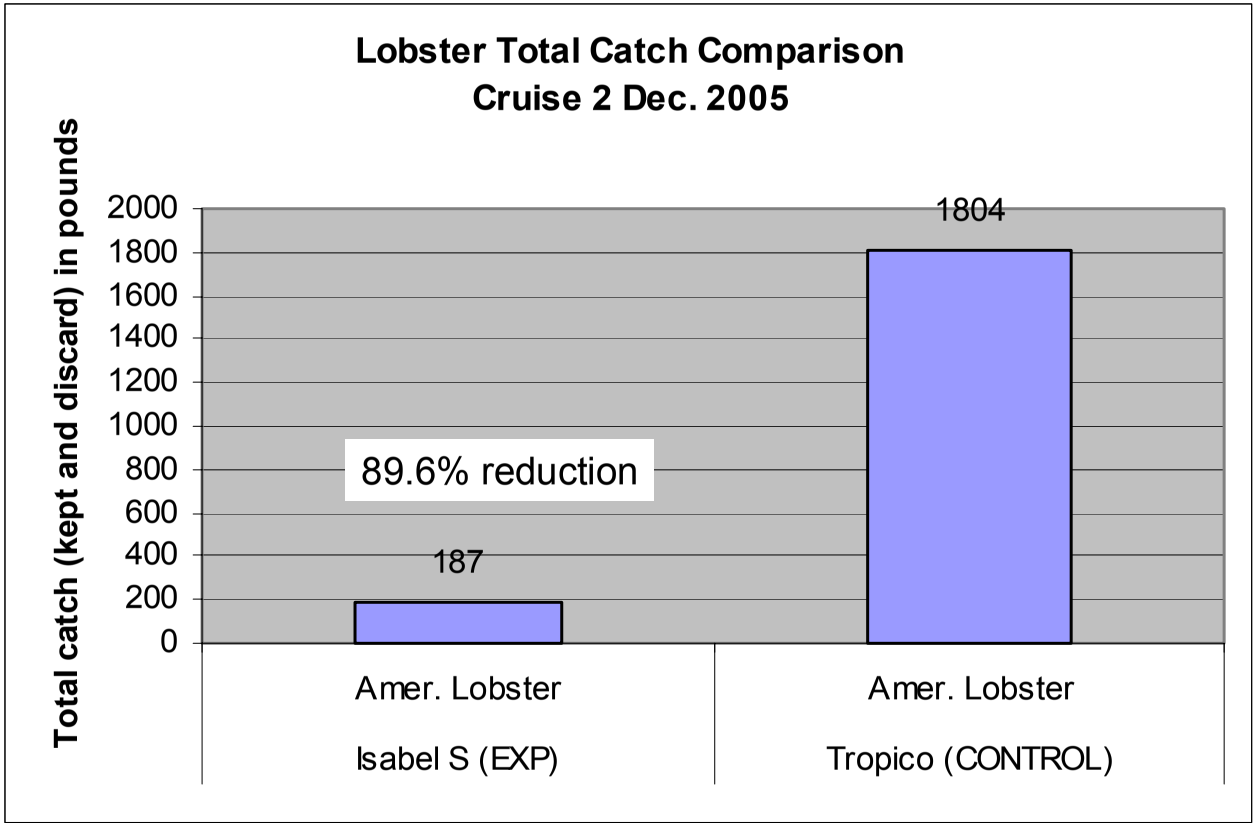
Isabel S (EXP)	Tropico (CONTROL)
Yellowtail Flounder	Yellowtail Flounder
1233	**3140**
39.2%	**60.8%**

Figure A9. Side by side total comparison of American Lobster for Cruise 1, Control and Experimental Nets



Sao Marcos II (EXP)	Fisherman (CONTROL)
Amer. Lobster	Amer. Lobster
6	**291**
2.1%	97.9%

Figure A10. Side by side total comparison of American Lobster for Cruise 2, Control and Experimental Nets



Isabel S (EXP)	Tropico (CONTROL)
Amer. Lobster	Amer. Lobster
187	**1804**
10.4%	89.6%