CAPE COD
COMMERCIAL HOOK FISHERMEN'S ASSOCIATION, Inc.
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David Goethel
Chairman, Research Steering Committee
New England Fishery Management Council
C/o Pat Fiorelli
50 Water Street, Mill 2
Newburyport, MA 01950

May 25th, 2005

Dear Dave,

I am pleased to hear that the RSC will be reviewing completion reports for two cooperative research projects administered by the CCCCHFA at its meeting on May 30th. These projects, one funded by the Northeast Consortium under a Project Development Award (*Production and Testing of an Alternative Bait Selecting for Haddock*) and one funded by the Northeast Cooperative Research Partners Program (*Using Hook and Line to Minimize Cod Bycatch in a Directed Longline Fishery on Georges Bank and in the Gulf of Maine*), have each received rigorous technical reviews facilitated by the respective funders.

It is vitally important that you and the committee realize that these projects are part of a larger effort in conservation engineering intended to provide tools to New England fishermen which will maximize the harvest of haddock while avoiding weaker stocks. These two projects take their place beside numerous other experiments using longlines, gillnets, and various otter trawls. CCCHFA has tried to provide the committee and other interested parties with as much data as possible on longline performance across an extremely wide array of times and areas in order to paint the larger picture. In addition, CCCHFA has undertaken additional analyses which aim to compare longlines to other gears, in order to compensate for an unavoidable lack of bait to bait comparisons, but also to broaden the scope of the inquiry.

The results are clear- a convergence of evidence has emerged which indicates that longline is a extremely effective means to harvest haddock while minimizing or eliminating impacts to cod and other groundfish stocks of concern. In addition to the experimental dataset of approximately 1 million hooks from throughout Georges Bank and the Gulf of Maine which you will discuss next Wednesday, there are additional millions of hooks in the commercial fishery which replicate and confirm the conclusion: longlines harvest haddock with minimal impact on cod and none on flounders.

So that this gear may be considered by the Groundfish Committee and the Regional Administrator for inclusion in existing Special Access Programs, I hope your committee will forward these two reports on Wednesday. Permit and budget complications aside, the experiments and the analyses of the results nevertheless demonstrate that this gear is proven. Thanks for your time and consideration.

Sincerely

Paul Parker
Executive Director

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
One Blackburn Drive
Gloucester, MA 01930-2298

May 23, 2007

Mr. Paul Parker
Cape Cod Commercial Hook Fishermen's Association
210 Orleans Road
N. Chatham, Massachusetts 02650

Dear Mr. Parker:

We have reviewed the supplemental analyses pertaining to your completion report for project BAA04-1-13 entitled, "Using Hook and Line to Minimize Cod Bycatch in a Directed Haddock Fishery on Georges Bank and in the Gulf of Maine". This work was supported by the NMFS Northeast Cooperative Research Partners Program and funded under NOAA Contract No. EA133F-04-CN-0042.

This information was submitted in response to our letter dated February 20, 2007, that requested a revised report, in the form of supplemental analyses, that would support the initial report's conclusion that higher catch rates of haddock, compared to cod, were due to artificial bait selectivity. Overall, our initial technical review concluded that while the initial results provided some valuable information to illustrate the selectivity of artificial baits for selectively harvesting haddock, the experimental study lacked sufficient samples to compare squid vs. artificial bait catch rates. The supplemental analysis, prepared by Jennifer Ford on behalf of the CCCHFA, compares catch ratios of cod to haddock for various types of fishing gear and bait types. It is a comparative study of existing at-sea observer data collected by NMFS and detailed catch reports assembled by the CCCHFA.

Detailed technical review comments are presented below. In summary, we conclude that the supplemental analyses, together with the initial completion report, serve to adequately fulfill reporting requirements under this contract.

The ancillary analysis provides support for the hypothesis that bycatch rates of cod in hook gear can be reduced by the use of artificial baits. Any study of this type is likely to have problems since the inferences are not based on a designed experiment, but instead, depend on the degree to which data can be matched on both temporal and spatial scales. The author appears to have carefully considered both factors in her analyses and considered the relevant factors that could affect the relative catch rates of cod and haddock. The statistical models selected also appear to be appropriate and the author has used random effects models as a basis for considering treatment effects. The use of a small additive constant (0.5) to the numerator and denominator does not appear to seriously affect the outcome, but one might want to consider the sensitivity of the conclusions to this arbitrary factor.

The results section has a few confusing aspects. There should be a table indicating the sample sizes for the various comparisons. In particular, the number of observations for each treatment combination should be listed to give the reader some idea about how "balanced" the design matrix is. All the tables should indicate the area fished (EUSCA or Area 1). The Y axis on Figures 1 and 2 are mislabeled since the negative numbers suggest it is the log of the transformed ratio of cod to haddock. It is not clear if the estimated means and confidence intervals in the tables are derived from the full model or a reduced model. In either case, it would be useful to identify the factors that were held constant when computing these means. Alternatively, are these derived from the sample data? Are they the average of the ratios or the ratio of the sums? We're assuming that they are model based.

The evaluation of catch rates with the separator trawl were inconclusive, as the author notes.

The comparison of bait performance within Area 1 hook experiments show a progressive decline in the ratio of cod and haddock with bait type: squid>herring>artificial. Again, there should be a summary table of the number of sets for each depth, area and bait type.

Overall, the report represents a fair evaluation of relative catch rates of cod to haddock. The results support the general conclusion that the bycatch rates of cod and hook gear are lower than observed in trawl gear. The study also suggests that more detailed comparative analyses might be possible using catch and observer data. Such studies will always be imperfect, since the comparisons may be influenced by uncontrolled variation. However, this weakness is compensated to some extent by considering much higher sample sizes and increased spatial scales. The results of this study are not definitive, but are supportive of the argument that cod/haddock catch rates are lower in hook gear. Assessment of the relative effects of bait type could be strengthened by including some measure of precision for the factors listed in table 4.

On the basis of approving this report, we are initiating the final procedures to close out this contract.

Sincerely,

Harold C. Mears

Harold C. Mears, Director
State, Federal and Constituent
Programs Office

A. NOAA Fisheries Northeast Cooperative Research Partners Program Completion Report Cover Sheet

Report Title: Using Hook and Line to Minimize Cod Bycatch in a Directed Haddock Fishery on Georges Bank and in the Gulf of Maine

Authors: Tom Rudolph, Yong Chen

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Associate Professor for Fisheries Population Dynamics: Yong Chen ychen@maine.edu

Contract Number: EA-133F-04-CN-0042
Final Date: September 30, 2006

B. Abstract:

The main objective of this cooperative experimental program was to confirm the appropriate bait, location, and seasonality to minimize bycatch of cod (*Gadus morhua*) while targeting haddock (*Melanogrammus aeglefinus*) with benthic longline gear inside several year round groundfish closed areas. The ultimate goal was to identify potential Special Access Programs (SAP), in which fishermen could be granted exemptions from various input controls (i.e. closed areas, hook limits, etc.) in exchange for adhering to a higher standards of monitoring and performance. Administered by the Cape Cod Commercial Hook Fishermen's Association (CCCHFA), the study was collaboratively designed and implemented by fishermen, scientists and managers. The work was supported by a combination of contract funds from NOAA Fisheries Northeast Cooperative Research Partners Program (NCRPP) and proceeds from the sale of fish caught on the research cruises. Fishing was allowed to take place in the year round closed areas under two Exempted Fishing Permits (EFP) issued by NOAA Fisheries. The combined parameters of the project objectives, funding mechanism, and permitting conditions resulted in an implementation plan that is best described as an SAP Demonstration Project, and also included study sites in open areas of the Eastern U.S./Canada Resource Sharing Area (EUSCA). As such, the investigators sought to demonstrate biologically sustainable (low bycatch, especially cod) and economically viable (high target catch- haddock) longline fisheries, especially through the use of a fabricated bait of Norwegian manufacture (Norbait™ 700E). Exempted fishing onboard seven commercial vessels took place from December 2004 through January 2006. All trips were observed by certified scientific data collectors following an enhanced NMFS sea sampling protocol with an emphasis on catch enumeration. Norbait™ 700E was found to have low catch per unit effort (CPUE) of cod across all times and areas, thus we conclude that benthic longline with Norbait™ 700E is capable of targeting haddock with low bycatch of cod. SAP opportunities for this gear are especially promising for winter months in the Western Gulf of Maine Closed Area (WGOM) and for the EUSCA including parts of Georges Bank Closed Area II (CAII).

C. Executive Summary

In October 2003, CCCHFA began experimental fishery trials in Georges Bank Closed Area I (CAI), demonstrating the use of alternative longline baits to target a healthy haddock resource without catching the depleted cod population. This project has since been translated into a management success, the Closed Area I Hook Gear Haddock Special Access Program, currently in its third year.

In 2004, CCCHFA began working with other New England fishermen on plans to replicate the study in other closed areas to create new opportunities to use hook and line. Funding was secured for this work under the 2004 Broad Agency Announcement (BAA) issued by the NCRPP. With cooperation from the Maine Department of Marine Resources (ME DMR), the ensuing project was a collaborative effort undertaken by a research team of scientists, managers and commercial fishermen, modeled on the previous work in CAI. Operating under EFP DA-448 and EFP DA-735, participating fishermen tested the efficacy of various baits, especially fabricated baits like Norbait 700E™, to target haddock with minimal cod bycatch in the following areas:

Western Gulf of Maine Closed Area (WGOM)
Cashes Ledge Closed Area (CLCA)
Gulf of Maine Rolling Closure III (RCIII, or Platts)
Eastern U.S./Canada Resource Sharing Area (EUSCA), including parts of Georges Bank Closed Area II (CAII)

EFP DA-735 did not allow access to important target areas in CAII identified by industry partners and included in the project proposal, because these areas were inside the CAII Habitat Area of Particular Concern (HAPC). These were replaced with fishing grounds outside CAII, but inside the EUSCA (see figure 1). These grounds, known as the "Strip," are located just west of CAII and warranted inclusion because they were part of the pre-existing EUSCA Haddock SAP.

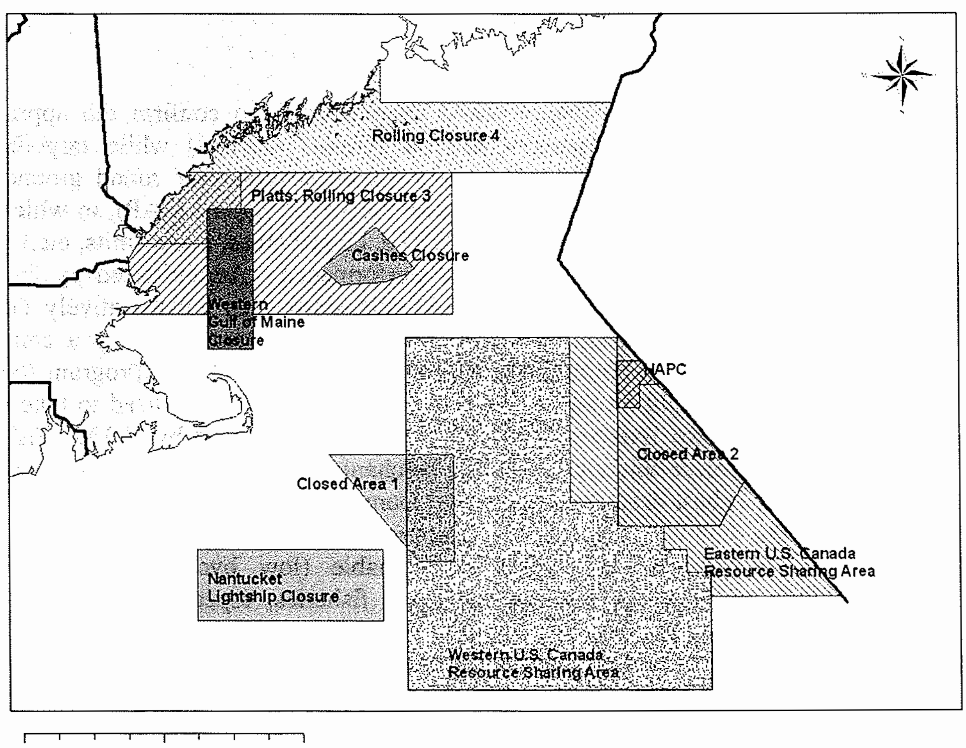

Figure 1- Map of the Project Study Area, including Year Round Closed Areas and Transboundary Resource Management Areas

Like other projects funded under this BAA, the study was treated as an SAP Demonstration Project, thus the goal was to document biologically sustainable (low bycatch of cod) and economically viable (high catch of haddock) opportunities to use hook and line. In fact, budget and permit considerations played an important role in how the proposed experimental design was translated into an operational project. Strict controls on cod bycatch attached to the EFP's, when combined with the requirement to meet an ambitious fish-sales revenue target in order to balance the budget, made it impractical to conduct the number of side by side bait trials originally proposed. The potential implications of exceeding an EFP cod cap were operationally and financially unacceptable.

Within a broad framework of areas and seasons, our industry partners chose promising locations to set bottom longline gear. Independent scientific data collectors or NMFS observers were onboard 100% of the trips and carefully enumerated and sub-sampled all catch and bycatch according to NMFS SeaSamp protocols. Project data were entered into the NMFS SeaSamp database as well as an internal CCCHFA database.

Field work took place from December 2004 through January 2006. Participating vessels sailed a total of 33 trips, sampling all four proposed closed areas and developing a dataset consisting of 332,630 hooks (Table 1). The project successfully demonstrated viable opportunities to harvest haddock with minimal bycatch of Stocks of Concern (SOC), by using demersal longlines baited with herring or fabricated baits like Norbait™ 700E. Despite the fact that revenue projections fells short, resulting in less sampling than originally proposed, the project still demonstrated the benefits of channeling fish revenue back into the research budget. $126,548 was realized towards a projected $175,210.

Area	# Trips	# Hooks	Haddock Kept, Dressed	Haddock Discards, live weight	Total Haddock Catch, live weight	Haddock CPUE	Cod Kept, Dressed	Cod Discards, live weight	Total Cod Catch, live weight	Cod CPUE
EUSCA*	13	203,148	65,124	3,274	76,864	0.38	2,866	207	3,646	0.02
WGOM	14	74,207	22,695	2,167	27,812	0.37	1,693	662	2,694	0.04
Cashes	5	42,955	3,376	1,247	5,062	0.12	1,247	205	1,701	0.04
Platts	1	12,320	1,121	227	1,494	0.12	32	37	75	0.01
Totals	**33**	**332,630**			**111,232**	**0.33**			**8,117**	**0.02**

Table 1: Summary of Project Catch Data for Haddock and Cod, by Area
All weights are in pounds
CPUE= Catch per Unit Effort (pounds per hook)
***EUSCA includes Gorges Bank CAII**

This completion report prepared by CCCHFA mainly focuses on contractual performance and the management context of the project. Scientific findings are derived from an independent analysis of project data undertaken by Dr. Yong Chen, Associate Professor for Fisheries Population Dynamics at the University of Maine School of Marine Science (UOM). Dr. Chen's efforts were supported and facilitated by our project partner agency, MA DMR. Dr. Chen's paper is attached to this completion report as Appendix A.

Several other documents are attached as Appendices to this completion report. Appendix B is the sampling manual, prepared by REMSA Inc. data collectors, which describes the field protocol used in the project. Appendix C is an interim final report prepared by CCCHFA staff in September 2005 which analyzed fabricated bait performance up to that time. This was intended to support SAP modifications contemplated by the NEFMC in Framework 42. Finally, Appendix D is a summary of all longline testing performed by CCCHFA to date, which places the NCRPP contract in context.

D. Purpose

1. Description of the Problems to be addressed:
Amendment 13 (Am 13) to the Northeast Multispecies Fishery Management Plan (FMP), implemented in 2004, provided the framework for programs designed to mitigate the effort reductions contained therein. The deep cuts in fishing opportunities imposed by Am 13 to protect weak stocks would make it difficult for fishermen to take advantage of a few stocks that were in better shape, including haddock. Managers and other stakeholders recognized a need for programs to encourage the harvest of the healthier stocks, but these programs needed to be structured to avoid increased mortality on weaker stocks.

These programs, known as Special Access Programs (SAP), would generally exempt fishermen from certain input controls if they could selectively target healthy stocks and minimize bycatch of SOC's. Amendment 13 modified the main effort control system in New England, Days at Sea (DAS), by creating 3 categories of DAS. A-DAS would allow unrestricted effort, but fishermen would be granted fewer of them under the Amendment. Many of those taken away would be converted to B-DAS, but these would be subject to strict trip limits for SOC's. Because B-DAS would form an important part of a fisherman's allocation, the most common and desirable exemption sought for potential SAP's became permission to use them. In addition, access to groundfish closed areas was sought for many SAP's. These programs would also be subject to increased monitoring of performance through higher levels of observer coverage.

Much of the SAP development effort has focused on haddock and cod. At the time this project began, Georges Bank (GB) haddock spawning biomass was about 120 thousand metric tons (mt). This represented the highest abundance of adult spawners since 1967 and a 10-fold increase since 1993. The stock was about halfway to rebuilding to its target spawning biomass of 250 thousand mt. Gulf of Maine (GOM) haddock was also rebuilding, and was not experiencing overfishing. In summary, the haddock resource was rebuilding rapidly and was considered one of the most impressive success stories in New England fisheries management. On the other hand, cod rebuilding has been universally problematic and slow, and depleted cod stocks continue to drive management restrictions today. The need for new techniques and strategies that will form the basis of SAP's targeting haddock remains high, especially in the EUSCA, where low cod and yellowtail flounder limits have limited the ability of U.S. fishermen to harvest their share of the transboundary haddock quota for three consecutive years.

Implementation of a SAP would generally need to be preceded by experimental work to demonstrate that the fishery was biologically justifiable (low SOC bycatch) and economically viable (high target catch). These studies usually took place under EFP's issued by the Sustainable Fisheries Division (SFD) of NOAA Fisheries Northeast Regional Office (NERO). A good example is the longline trials conducted by the CCCHFA in GB CAI. This work began in October 2003 under EFP DA-280, and continued through June 2005 under EFP DA-338. With 100% coverage by scientific data collectors (SDC), CCCHFA fishermen tried a variety of longline baits (squid, herring, mackerel, and fabricated) in efforts to target haddock with minimal bycatch of cod. This work led to the creation of the successful Closed Area I Hook Gear Haddock SAP, currently in its third year.

The NCRPP, recognizing the importance of these SAP opportunities, issued a BAA in early 2004. This BAA solicited proposals for cooperative research projects to demonstrate potential SAP's which might later be established for the use of B-DAS. The previous work by CCCHFA in CAI had showed that longlines with herring or fabricated baits caught haddock with very low cod bycatch. Based on this success, CCCHFA had already begun working with fishermen from other ports to prepare for expanding the research to other areas. In addition to submitting an EFP application for this work, CCCHFA and our partners applied for funding under the BAA. Post selection negotiations with NCRPP resulted in changes to the budget and scope of work, and significant difficulties were encountered in the permitting process, but by December 2004, a contract and an EFP were in hand. Over the next 14 months, longlines would be tested in a wide variety of areas and seasons, in order to identify potential SAP opportunities.

2- Goals and Objectives:
The main purpose of the experimental program was to confirm the appropriate bait, location, and seasonality for minimizing the bycatch of cod while targeting haddock in Georges Bank Closed Area II, Cashes Ledge Closed Area, the Western Gulf of Maine Closure, and the Platts Rolling Closure utilizing tub trawl (benthic longline).

Long-term Goals:

- Establish Special Access Programs or B DAS programs to harvest haddock with hook and line while minimizing bycatch of stocks of concern such as cod.
- Collect much needed fine-scale data regarding the Gulf of Maine and Georges Bank haddock stocks in collaboration with the Northeast Fisheries Science Center (NEFSC).

Objectives:

- Collect data that demonstrates the viability of a fishery for haddock using hook and line in Georges Bank Closed Area II, Cashes Ledge Closed Area, the Western Gulf of Maine Closure, and the Platts Rolling Closure that minimizes the bycatch of cod.
- Collect data in collaboration with NEFSC that further establishes mutual understanding and trust between NMFS scientists and commercial fishermen including but not limited to providing a cost effective (free) platform for the NEFSC to collect ovary samples for an ongoing fecundity project. The fecundity project will collect up to 800 female and 800 male samples.
- Maintain harvest levels of haddock under the EFP cap for each specified study site.
- Maintain harvest levels of cod under the EFP bycatch cap for each specified study site.
- Utilize herring as bait to minimize cod bycatch and test the viability and compare the efficacy of fabricated baits such as Trident and Norbait, as well as other, more experimental baits.
- Implement 100% SDC coverage (via REMSA) and collect optimal scientific data for the program.
- Generate communication, understanding and trust between fishermen from different ports, gear sectors and backgrounds.
- Ensure that fishermen outside of the program understand the program and support our goal of developing a special access program for haddock that minimizes bycatch of cod.
- Extend participation of fishermen beyond use of the vessel as a research platform by actively involving them in the research

E. Approach

1. Work Performed and Methodology

a. Narrative Summary

CCCHFA has conducted research on longline selectivity when targeting haddock since October 2003. The experimental protocol for these trips was developed in consultation with NEFSC scientists, SFD managers, the NCRPP, and REMSA Inc., and has been consistent throughout the work.

For this project, as in previous work, independently contracted Scientific Data Collectors executed an enhanced NMFS SeaSamp protocol, with the focus on 100% enumeration of the catch (hook by hook) to certify the results. Sub-sampling was done as necessary and as intensively as possible, with the focus on round weights and length measurements for **all cod** and **all sub-legal haddock**. In addition, a sub-sample of kept haddock was measured for all strings, and all bycatch was weighed and measured for one string of each fishing event (tide). All legal haddock was retained and the dealer weigh-out was observed. Some trips were also covered by Federal observers from the Northeast Observer Program (NOP), provided by the observer contractor (AIS Inc). One trip was covered by a CCCHFA staff member with two years experience as a Federal observer.

The field protocols summarized above are described in greater detail in an extensive sampling manual developed by REMSA personnel in consultation with CCCHFA staff and NEFSC scientists. This manual was written in late 2003 and was used to train and guide the data collectors in this study. It is attached to this report as **Appendix B (CCCHFA Closed Area Haddock Projects Sampling Manual)** for readers in need of an in-depth understanding of the field protocol.

Data management was also consistent with past work. Project data were entered into two different databases. The lead SDC contracted by CCCHFA entered the data into an internal Microsoft Access database designed and maintained by CCCHFA. This internal database was used for EFP monitoring and other time-sensitive work, as well as serving as a backup and error-checking tool. Concurrently, the lead SDC entered the data into the NMFS SeaSamp database under special project codes provided by the NEFSC Data Management Systems Branch (DMS). Trips observed by AIS Inc. personnel were keypunched by NOP personnel.

The work was designed and executed as a SAP Demonstration Project. This project classification was established by NERO SFD in consultation with the NCRPP in 2004 to describe projects which aim to demonstrate biologically sustainable (i.e. low bycatch, especially of SOC's) and economically viable (i.e. high target catch) fishery opportunities. Once accepted, such a fishery may then be incorporated into the management plan as an SAP, with carefully relaxed input controls, partial hard Total Allowable Catch (TAC) limits and higher standards of monitoring. Under this model, the inquiries aimed to cover a diverse array of times and locations, but within this framework, the investigators and fishermen targeted areas in which they could harvest haddock efficiently. Bycatch restrictions were imposed by the EFP's granted for the work, and a built-in budget shortfall required the realization of substantial fish revenue. These two conditions further reinforced the need to manage the project with a main objective of maximizing haddock catch while minimizing all bycatch, especially cod.

Securing and administering the two EFP's constituted a major portion of the work, as each was supported by an Environmental Assessment (EA) required by the National Environmental Policy Act (NEPA). Once EFP's were secured, the target times and areas were adjusted relative to the project proposal because the EFP often did not permit access as requested. Within the adjusted sampling targets, investigators and participating fishermen identified fishing grounds likely to hold concentrations of haddock. In most cases, fabricated bait was used to minimize cod bycatch in order to stay under the bycatch limits of the EFP's, and maximize revenue. Successful and profitable trips were followed up, while times and areas with low haddock catch were not.

Support for NEFSC ancillary data collection priorities was provided throughout the study as necessary. In depth biological sub-sampling of catch and bycatch, including length and weight measurements on haddock and other species, was performed in accordance with NEFSC needs as outlined in the SDC sampling manual. Access to this information is available to all NEFSC staff through the SeaSamp database- project codes are available from CCCHFA and DMS. In addition, the contract was used to support special haddock fecundity research led by Jon Brodziak, Ph. D. at the Population Dynamics Branch of the NEFSC. Peak spawning restrictions imposed on the EFP's did not allow Dr.Brodziak to conduct ovary collection on project trips, but project funds allocated to support his research were expended on critical supplies as budgeted.

b. Project Timeline:

2003

December 2003	Planning meetings commence

2004

January 2004	BAA EAC 04-0001 issued
February 2004	EFP application #1 submitted
March 2004	NCRPP Proposal submitted
	EA #1 submitted
May 11, 2004	EFP DA-448 issued (Georges Bank component denied)
June 2004	NCRPP award notification and budget revision negotiations
July 2004	EFP DA-448 revised to remove hook limit
September 2004	NCRPP contract issued
November 2004	EFP application #2 submitted (Georges Bank component re-submitted)
	EA #2 submitted
December 2004	Field work (WGOM, Cashes)

2005

January 2005	Field work (WGOM, Cashes)
March 2005	NCRPP semi-annual progress report #1 submitted
January-April 2005	EFP #2 and EA #2 negotiations
May 2005	EFP DA-448 extended
	EFP DA-735 issued for CAII and EUSCA (HAPC denied)
	Field work (WGOM, Cashes, Platts)
June 2005	Field work (CAII, EUSCA, WGOM)
July 12, 2005	NMFS Temporary Rule #1 limits all vessels to 1 trip/month into EUSCA
July 2005	Field work (limited CAII+EUSCA)
August 1, 2005	Exemption granted from NMFS Temporary Rule #1
August 2005	Field Work (EUSCA, CAII, Cashes)
	Interim Final report submitted at request of NEFMC
August 26, 2005	NMFS Temporary Rule #2 closes EUSCA to all vessels
September 2005	Field work (Cashes)
	Review of Interim Final report declined
October 14, 2005	Exemption granted from NMFS Temporary Rule #2
November 15, 2005	Final catch reporting submitted for EFP DA-448
December 2005	Semi-annual report #2 submitted
October 2005-January 2006	Field work (CAII, EUSCA)

2006

February 6, 2006	Final catch reporting submitted for EFP DA-735
March 2006	No cost extension requested
	Semi-annual report #1 revised
	Semi-annual report #2 approved
April 3, 2006	No cost extension approved through 9/30/2006
April 2006	Subcontract executed with University of Maine for independent analysis
June- September 2006	Independent analysis performed, scientific report submitted to CCCHFA
October-November 2006	Contractual completion report prepared and submitted, including scientific analysis by University of Maine

2. Project Management:
The following individuals and organizations performed the work described in this report

a. CCCHFA Staff
Research Director **Tom Rudolph** acted as Project Leader, with overall administrative and operational oversight of the project, including field scheduling, contract and subcontract management, EFP procurement and management, participant and stakeholder communication, at-sea observation, and all reporting. He was also responsible for direct supervision of the lead scientific data collector.

Executive Director **Paul Parker** acted as Project Manager. He is Tom Rudolph's immediate supervisor, as well as the authorized representative for CCCHFA on this contract. In addition to general supervision of the project, he had a substantial role in preparation of permit applications and follow-up negotiations, financial management of the project budget, strategic planning, industry and other subcontract relations, and management of Finance Director Nat Mason.

Finance Director **Nat Mason** assisted in management of the project budget and handled the payroll and accounting workloads. The Project Leader and Finance Director employed a division of labor with multiple layers of error checking built in to ensure accurate, prompt payment to vessels, and close accounting of all project finances including fish revenue. The Finance Director also managed the commercial line of credit secured by CCCHFA and used to ensure payment of contractors in a timely fashion. This instrument is required because vessel owners expect a payment schedule similar to their typical commercial fishing settlement (5 business days). The reimbursement basis of Federal contracts makes this impossible for CCCHFA without the line of credit.

Program Coordinator **Melissa Sanderson** also participated in the project, mainly through assistance with data management, analysis and quality control. She was also lead author of interim final report attached here as Appendix C. Program Coordinator **Lara Slifka**, a former NMFS observer, performed scientific data collection at sea.

b. Maine DMR Staff
Director of the Bureau of Resource Management **Linda Mercer** and Resource Management Coordinator **Cindy Smith** assisted with project design, EFP negotiations, and assessment of management context. Maine DMR also acted as a liaison to Dr. Chen for data procurement and analysis review. **David Libby** assisted in the design of queries to extract data from the NMFS SeaSamp database.

c. Independent Contractors
Scientific data collectors for the program were supplied by **REMSA Inc.** from December 2004 through March 2005. When REMSA terminated its New England operations in April 2005, CCCHFA was forced to adapt. With approval from REMSA and NMFS, the two main data collectors used up until that point were independently contracted to continue work on the project, ensuring that consistency would be maintained. These were **Anne Magoon and Charles Pitts,** who between them observed 29 of the 33 trips taken during the project. In addition to her at-sea data collection duties, Anne Magoon served as lead data collector for the entire project. Additional responsibilities included all data entry keypunching for the CCCHFA and NMFS SeaSamp databases, data collector scheduling, deck protocol enforcement and management, and acting as a liaison to DMS branch at the NEFSC for SeaSamp issues. Two trips were observed by NMFS observers provided by the observer contractor **AIS Inc**.

Regional industry coordinators **Mike Russo, Mike Leary (FV Lori B), and Tom Kelly (AJ Marine Inc.**), were contracted by CCCHFA to assist in sailing and meeting coordination, bait delivery and management, meeting coordination, permit procurement, and overall strategic planning and project management. These consultants proved invaluable, especially in adjusting to the ongoing budget complications imposed by the fish revenue shortfall and the EFP delays and difficulties.

Dr. Yong Chen, Associate Professor for Fisheries Population Dynamics at the University Of Maine School Of Marine Science, was contracted to perform an independent analysis of the project data, and summarize his findings in a scientific report. This report is attached as Appendix A.

d. Fishing Vessels:
The vessels listed in Table 2 were utilized as sampling platforms in this study:

Fishing Vessel	Captain	Homeport
FV Never Enough	Bruce Kaminski	Chatham, Massachusetts
FV Lori B	Mike Leary	Portsmouth, New Hampshire
FV Black Beauty	Willie Viola	Portland, Maine
FV Fiona A	Brian Pearce	Portland, Maine
FV Cabaret IV	Peter Libro	Gloucester, Massachusetts
FV Last Chance	Henry McCarthy	Scituate, Massachusetts
FV Seahound	Peter Taylor	Chatham, Massachusetts

Table 2 - Project participants (fishing vessels)

F. Findings

1. Accomplishments and Findings

a. Contractual:

- Data were collected on 33 fishing trips to three year-round closed areas (WGOM, CLCA, and GB CAII), one rolling closure (GOM RC III, or Platts), and also in open areas of the EUSCA. Altogether, high quality observations were performed on 232 longline sets comprising 332,630 hooks.
- Fine scale data on the GOM and GB haddock stocks were collected in collaboration with the NEFSC, and are available to NEFSC scientists through the SeaSamp database.
- NEFSC haddock fecundity research was supported through in-kind purchase of equipment and supplies. While ovary sampling was not performed on project trips because the project EFP's did not allow access during peak spawning, CCCHFA was able to maintain communication with NEFSC scientists and provide opportunistic access to closed areas through other projects. In this manner, ovary collection needs were met.
- Two separate EFP's were secured and successfully managed, and their associated catch limits were successfully monitored and enforced for all study sites. For EFP DA-735, which allowed access to CAII and the EUSCA, this was accomplished in spite of a severe reduction of its cod bycatch cap in October 2005, from 20,000 pounds to 2,000 pounds. Catch reports were successfully submitted to NOAA Fisheries as required.
- Herring and Norbait™ 700E were successfully used to minimize cod bycatch, and were compared to each other and to other traditional baits (squid) on a limited basis, as permit and budget considerations allowed.
- 100% of trips were covered by certified scientific data collectors
- Strong relationships were developed between fishermen from different ports, gear sectors, vessel-size classes and backgrounds.
- Program goals and objectives were successfully communicated to fishermen outside the program, especially through the efforts of the regional industry coordinators. A high level of awareness was developed in New England about the potential opportunities to harvest haddock with minimal cod and yellowtail flounder bycatch using hook and line gear.
- Fishermen were actively involved in all aspects of the research, from program design through execution to analysis and reporting. Periodic meetings were held between CCCHFA staff, ME DMR personnel, and participating industry members.
- Semi-annual progress reports were submitted to NCRPP as required

b. Financial

The project budget was structured such that the projected $175,210 from fish sales was actually required to balance the budget. While revenues fell short of this, the $126,548 realized represented a significant contribution towards the cost of the project. Vessels were paid area-specific fixed daily rates for their participation. All contract funds, including the fish sales revenue, were successfully managed.

c. Scientific

Please reference **Appendix A** for Dr. Chen's scientific analysis and results, entitled **"An analysis of impacts of a fabricated bait on catch rates of haddock and Atlantic cod in a longline fishery."**

2. Problems Encountered

The main problem encountered in this project was the low number of comparative sets (side by side) with different baits. In retrospect this would have provided an important indicator of the relative abundance of target vs. bycatch species, especially for the presence/absence of cod. This problem has been addressed by Dr. Chen through the use of landings data, and also through careful analysis of the limited comparative sets available. Furthermore, it must be stressed again that this report is but one component of a growing body of work that indicates demersal longline can be used to target haddock and minimize cod bycatch.

Two factors which combined to limit the investigator's ability to conduct side by side trials were EFP issues and budget concerns:

a. Exempted Fishing Permits:

Problems with the timing and parameters of EFP coverage for this project have been well documented in semi-annual progress reports, and briefly touched on in this previously in this report. In fact, EFP acquisition and management proved a challenge for many of the other projects funded under this BAA. Again, this situation has been well documented. Most of the difficulties revolved around the legitimate concerns of the managers at SFD about increased potential impacts on SOC's due to these projects, especially within the year round closed areas. In fact, the SFD classified the projects funded through this BAA under a new category, SAP Demonstration Projects, and recognized differences between them and other research projects. Essentially, EFP's for these projects would be harder to obtain, and were almost certain to be constrained by conditions not anticipated by the investigators or the NCRPP contract managers responsible for the BAA.

A brief summary of the difficulties encountered in securing and administering EFP's on this project is presented below. It includes specific reasons for the limited number of comparative sets, as well as general problems:

- Two separate permits were required, each with a full NEPA review, EA, negotiation cycle, and monitoring and reporting requirements. Only one permit was originally envisioned, but the critical GB component of the study was not approved under the first permit.
- The review and negotiation process for these permits was lengthy and time-consuming, and a significant drain on resources.
- EFP DA-448, as originally issued on May 11, 2004, had four main problems which affected the project:
    - It was somewhat late- critical fishing time was lost between May 2004 and September 2004 because the permit and/or NCRPP contract were not actually in place
    - It did not exempt vessels from hook limits, an essential need for the experimental haddock fishery
    - It had fairly strict caps on cod bycatch which made the investigators reluctant to set baits like squid which had shown higher catch rates for cod in past work. There was a risk that this could shut the experiment down prematurely.
    - The GB component was denied

- EFP DA-735, as issued in May 2005, had the following problems which affected the project
  - Critical target grounds identified by industry partners were excluded from the EFP because they were in the Habitat Area of Particular Concern (HAPC) in GB CAII. Fortunately these grounds were successfully replaced by additional areas within the EUSCA just to the west of GB CAII.
  - This permit included even stricter controls on cod bycatch, with a cap of only 20,000 pounds for the entire GB component of the study. Even worse, the permit did not exempt participating vessels from the requirement that cod comprise no more than 5% of the catch onboard by weight. Under this regulation, trips with poor haddock catch could easily become a violation. In fact there was a catch-22. Since the EFP required full-retention of legal-sized cod, vessels could not discard down to the 5% cod threshold prior to terminating their trip if this regulation became a concern.
  - The EA which supported this EFP application presumed the use of 100% fabricated baits, leading to the assumption by investigators that they were not actually allowed to set anything else.
- Serious management complications in the EUSCA during the summer of 2005 had severe and deleterious effects on the project. High catch rates of cod by trawlers in the commercial fishery were the cause of two successive Temporary Rules which limited access to the area. In July, all vessels were restricted to one trip per month. In August the area closed completely. Adjusting to these changes required considerable staff time. Each Temporary Rule had to be analyzed, discussed by all participants, and responded to. While CCCHFA was in all instances able to salvage some access to the area for project sampling, weeks or months were lost in all cases, as the project participants waited for decisions from NOAA Fisheries. In both instances, we were unable to return to areas in which excellent haddock catches had been realized with little bycatch. In one case, a valiant effort to sail prior to the full closure of the area came up about an hour short. Vessel owners were essentially forced to abandon the project because of continued uncertainty about access to the area. In the end, prime good-weather fishing was lost, and there was an extremely strict, revised cod cap of 2,000 pounds.

b. Budget Constraints:

The financial design of the project budget is relevant and should also be mentioned. CCCHFA is dedicated to the concept of landing and selling legal and marketable bycatch during cooperative research projects, with the proceeds directed toward the project budget or other research initiatives. Vessels are paid a project specific, fixed daily rate. This project received a $300,000 federal award towards a total budget of $475,000; estimated fish revenues of $175,000 were essentially counted upon in order to balance the project budget.

By necessity, this affected the scheduling of fishing, since the investigators and collaborating fishermen were required to produce this revenue to balance the budget. While this priority meshed somewhat well with the objective of demonstrating economically and biologically viable special access fisheries for haddock (high haddock catch, low cod bycatch), it did not mesh well with bait comparisons or random stratification of area, time or depth.

Ill advised setting of baits more likely to catch cod might have resulted in catching the cod caps in their entirety without maximizing revenue or data from haddock catches. The investigators were forced to plan the fishing strategy to conserve the cod experimental caps.

Likewise, from the perspective of balancing the budget, setting gear in times and places with low productivity would have wasted vessel time funding without financial return to the project. Sampling times and areas scheduled in the statement of work that were unproductive were eliminated in favor of trips that could produce revenue.

It is also worth noting that the original project proposal was for full funding, with the return of fish revenues to the funding entity for re-competition. Subsequent negotiations led to the revised approach which built the fish revenue projection into the budget as a match, as if it already existed. This approach essentially attempted to produce the desired array of work for less money, but only with increased financial risk to the investigators. Since this risk is obviously unacceptable, the end result was a deviation from the ideal sampling approach, as well as less overall trips. Total revenues came up approximately $50,000 short for a variety of reasons (regulatory complications, weather, and poor haddock fishing due to lack of fish or abundance of spiny dogfish) and therefore overall sampling was scaled back.

In practice this experience has provided valuable confirmation that an alternative approach is needed. Cooperative research projects must be fully funded by the award. There should be careful accounting of any project fish revenues and these revenues should be returned to the program budget or funding entity, but they cannot and should not be counted on in advance. While obstacles to this approach may exist, such as the inability of Federal agencies to receive funds by any means other than their return to the General Treasury, the alternative is also unattractive. While this project was fairly well-suited to an approach that maximizes revenue, other scientific investigations forced to do so might be irreparably damaged. Either way, the discarding at sea of valuable fish should be avoided.

In summary, the fishing design component of the research was essentially required to demonstrate biologically sustainable (low overall bycatch, especially cod) and economically viable (profitable catch) opportunities to harvest haddock using hook and line, especially through the employment of fabricated baits. The investigators and collaborating fishermen endeavored to collect catch and bycatch data from as many areas and times contained in the statement of work as possible, within the permit constraints and budget realities of the project.

3. Additional Work Needed

a. SAP Modifications
This project demonstrates that demersal longlines, baited with herring or fabricated baits, can be used to harvest haddock with minimal bycatch, especially SOC's like cod and yellowtail flounder. It is important to follow through on these demonstrations and incorporate this tool into management. At a minimum, the data clearly demonstrate that demersal longline with unlimited hooks should be incorporated as an additional gear in two existing SAP's: the EUSCA Haddock SAP and the B-DAS Program. Because they differ in performance and because of the potential for gear conflict, separate quotas for hook gear and mobile gear within these SAP's should likely be considered.

b. Additional SAP Opportunities
These data also clearly demonstrate the potential of a longline fishery in the WGOM closed area in the winter months. As always, when contemplating management measures, it is important to consider results in the context of all available information. In this case, the successful, clean haddock fishing found from early December-late January has since been duplicated the following year through another project (EFP DA-5736).

c. Comprehensive Comparative Analysis
These results take their place in a large body of work which now includes well over a million experimental hooks. In addition, there are a large number of longline sets, of all bait types, from the commercial fishery which are available for examination through the observer database. These data show that demersal longlines with fabricated baits have relatively low cod bycatch across a wide variety of times and areas. Furthermore, it seems that the performance of this gear translates well from experimental use to commercial fishery use. In other words, it performs consistently over time and between users.

The continued inability of U.S. fishermen to capitalize on the GB haddock stock in the EUSCA due to cod and yellowtail bycatch is a growing concern. Some of this failure can be attributed to the poor performance of various haddock separator trawls. Now that several years of commercial data are available in addition to the various experimental datasets, there is a need for a comprehensive, comparative analysis of all the gears proposed and utilized for targeting haddock under SAP conditions. These gears (traditional otter trawl, haddock separator trawl, and longline) should be compared relative to each other. The commercial performance of each gear should also be compared to its experimental performance.

d. CAII HAPC

This area was identified as likely to hold large aggregations of haddock by the fishermen who conducted this work, but access was not permitted due to concerns about benthic impacts and juvenile cod bycatch. Furthermore, it was not considered necessary to survey the area for potential inclusion in an SAP because the designation was deemed not compatible with an SAP.

However, the ongoing need to increase utilization of the U.S. share of the transboundary haddock stock may warrant a reconsideration of this policy. Highly profitable and clean haddock catches were realized on the edges of this HAPC, and grounds with similar depth and bottom-type are found inside. Since the EFP was considered, the designation of this area has changed to include status as a Level III EFH closure. Fixed gear is a compatible use within this designation.

A demonstration survey of this area will provide important information to managers as they consider approaches to maximize haddock harvest in future fishing years.

G. Evaluation

1. Evaluation of Attainment of Project Goals and Objectives

Despite several significant setbacks, a series of logistical challenges, and a revenue shortfall, this project was successful.

- The primary objective was attained.
    - Specifically, the investigators, "collected data that demonstrates the viability of a fishery for haddock using hook and line in Georges Bank Closed Area I, Georges Bank Closed Area II, Cashes Ledge Closed Area, the Western Gulf of Maine Closure, and the Platts Rolling Closure that minimizes the bycatch of cod."
- Specific programmatic objectives were also attained.
    - CCCHFA accomplishments in the administration of the contract, as outlined in Section F.1 of this report, constitute satisfaction of the objectives outlined in Section D.2 as compiled from the original contract proposals.
    - Collaboration was fostered between scientists, managers, and fishermen from a variety of backgrounds and ports.
    - A high quality, fine scale dataset was generated and made available to NMFS
    - Support was provided to haddock fecundity research conducted by the NEFSC
    - EFP's were successfully administered
    - 100% coverage by scientific data collectors was achieved
    - Fish revenues were leveraged to support the project

2. Dissemination of Project Results
The project has been prominently featured on the CCCHFA website (http://www.ccchfa.org/pages/2/37/) and the page will be updated to include a summary and also a downloadable version of this report. The project has also been featured in the CCCHFA newsletter and annual reports

The project received coverage in National Fishermen twice (Market Reports, September 2005, Gear Review, January 2006), and was also the subject of a Portland Press Herald editorial ~~on~~ (10/12/2005).

With completion of the analysis and report, CCCHFA will seek placement in fishing and regional press for summary features on the project.

Dr. Chen believes the work has publication potential, and as such the investigators will be working together to revise his report for journal submission.

In addition, CCCHFA will present project results to other fishing organizations, and at an appropriate research venue pending a technical review.

CCCHFA will represent the results in front of the NEFMC Research Steering Committee (RSC) once NCRPP approval is secured and the report is forwarded for their review.

Glossary of Acronyms

A-DAS	A Days at sea
AIS	AIS Observers Inc. (NMFS Observer Provider)
Am 13	Amendments 13
BAA	Broad Agency Announcement
B-DAS	B Days at sea
CA I	Georges Bank Closed Area I
CA II	Georges Bank Closed Area II
CCCHFA	Cape Cod Commercial Hook Fishermen's Association
CLCA	Cashes Ledge Closed Area
CPUE	Catch per Unit Effort
DAS	Days-at-sea
DMS	NEFSC Data Management Systems Branch
EA	Environmental Assessment
EFH	Essential Fish Habitat
EFP	Exempted Fishing Permit
EUSCA	Eastern U.S. Canada Resource Sharing Area
FMP	Fishery Management Plan
FV	Fishing Vessel
FVTR	Fishing Vessel Trip Report
FY	Fishing Year
GB	Georges Bank
GOM	Gulf of Maine
HAPC	Habitat Area of Particular Concern
ME DMR	Maine Department of Marine Resources
mt	Metric Ton
NCRPP	Northeast Cooperative Research Partners Program
NEFMC	New England Fishery Management Council
NEFSC	Northeast Fisheries Science Center
NEPA	National Environmental Policy Act
NERO	Northeast Regional Office
NMFS	National Marine Fisheries Service

NOAA Fisheries	National Marine Fisheries Service
NOP	Northeast Observer Program
Platts	Gulf of Maine Rolling Closure III (Platts)
RC III	Gulf of Maine Rolling Closure III (Platts)
RSC	Research Steering Committee
SAP	Special Access Program
SDC	Scientific Data Collector
Sector	Georges Bank Hook Sector Inc.
SFD	Sustainable Fisheries Division
SOC	Stock of Concern
TAC	Total Allowable Catch
UOM	University of Maine
WGOM	Western Gulf of Maine Closed Area
YTF	Yellowtail Flounder

Appendix A: "An analysis of impacts of a fabricated bait on catch rates of haddock and Atlantic cod in a longline fishery" (Independent Analysis prepared by Yong Chen)

Appendix B: "CCCHFA Closed Area Haddock Projects Sampling Manual"

Appendix C: "Selective Targeting of Haddock Using Fabricated Bait: An industry motivated special access demonstration project" (Interim Final Report prepared in September 2005)

Appendix D: "Summary of CCCHFA Conservation Engineering Research: Targeting Haddock with Minimal Cod Bycatch using Demersal Longline"

Appendix A

An analysis of impacts of a fabricated bait on catch rates of haddock and Atlantic cod in a longline fishery

A report submitted to

Cape Cod Commercial Hook Fishermen's Association (CCCHFA)

By

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Executive summary

Demersal longline is usually considered to be an environment-friendly fishing gear because it does not damage fishing grounds and tends to be selective of species and sizes. Bait used in longline fisheries is one of the most important factors influencing its selectivity. In this study, using the data collected from 232 longline hauls conducted on 33 fishing trips in four areas (Cashes Ledge 448, Eastern US/Canada Area 735, Platts Bank 448, and WGOM 448) from December 2004 to January 2006, we evaluated the impacts of a fabricated bait (Norbait 700E™) on the catch rate of haddock (*Melanogrammus aeglefinus*) and Atlantic cod (*Gadus morhua*). More specifically, we tested the following null hypotheses (I) landed catch rate of haddock is not significantly higher than (1) the landed catch rate of cod, (2) discarded catch rate of cod, and (3) discarded catch rate of haddock in the longline fishery with Norbait; (II) there is no significant difference in catch rates of cod and haddock using Norbait and "traditional" squid baits; and (III) there is no significant difference in catch rates of cod and haddock using Norbait and "traditional" herring baits. Haddock and cod catches were found to be significantly related to the number of hooks, but not to soak time. Catch rate for landed haddock, measured as weight or number per 1000 hooks, differed significantly among fishing areas, vessels, and months, but not between day and night. For landed cod, however, the catch rate differed significantly among vessels and months, but did not differ significantly among fishing areas. The landed catch rate of haddock was significantly higher than the catch rates of both landed and discarded cod and discarded haddock, and this result was consistent for fishing areas, fishing months, and fishing trips. This suggests that the Norbait is effective in catching marketable haddock, while keeping the catch of haddock of undesirable sizes and cod bycatch at a low level. For a fishing trip in which both Norbait and squid were used as baits, catch rate of cod was much higher than haddock catch rate when bait was squid, but landed catch rate of haddock was much higher than cod catch rate when the bait was Norbait. No such differences were found in catch rates of haddock and cod for a fishing trip in which Norbait and herring were used. Yellowtail flounder (*Pleuronectes ferrugineus*) was only reported in two hauls, both in the Eastern US/Canada area 735: one on June 16, 2000 with a catch rate of 1.33 lbs/1000 hooks and the other on July 14, 2005 with a catch rate of 0.83 lbs/1000 hooks. This suggests an extremely low catch rate for yellowtail compared with haddock when Norbait was used. Evaluation of catch data in the trawl fishery in the Eastern US/Canada Area suggests that cod and yellowtail were not absent in the experiment area and time. Thus the low catch rate of cod and yellowtail in the Norbait-based longline fishery was likely the results of selectivity of Norbait, rather than the absence of cod and yellowtail in the fishing area. The high catch rate of haddock was likely to result from the selectivity of Norbait for efficient catch of marketable haddock, rather than from relative difference in abundance of cod and haddock in the fishing grounds. This study did not support the first two hypotheses, but tend to support the third hypothesis. However, a formal statistical test of the hypotheses II and III was not possible because of lack of replications for herring and squid baits. This study supports the conclusion that Norbait can significantly reduce cod bycatch while maintaining high catch rates of marketable sizes of haddock in longline fisheries.

Introduction

The incidental catch of Atlantic cod (*Gadus morhua*) in fisheries directed on other groundfish species is a major source of mortality that has raised considerable concern in the process of developing a cod recovery program. Major factors that are likely to influence the level of cod bycatch in the northeast USA include: 1) overlapping of the spatial and temporal distributions of cod and other targeted groundfish species; and 2) selectivity of fishing gear with respect to the targeted species and cod.

Different approaches can be taken for controlling and reducing bycatch in fisheries. These can be divided in two major groups. First, are the management measures, which are designed to keep fishermen from going out to sea and taking bycatch or to encourage them to reduce the bycatch by decisions they make themselves. These management measures may consist of incentives for reducing bycatch, like more quota of the target species or bycatch quotas that can also be transferable. They may also consist of restrictions on allowable types of fishing gear or mode of deployment of the gear. Managers can also reduce effort by shortening the fishing season, implementing area closures or taking boats out of the fishery. These approaches are somewhat difficult and controversial because of large uncertainty in our understanding of fish population dynamics on which the management measures are based.

The second category, much less controversial, is technological advances in the form of bycatch reduction devices. This is a very promising alternative although it takes a lot of initial research to develop and test solutions. If successful, this approach allows us to catch targeted species or size classes of fish efficiently with a low catch of unwanted species or size classes of fish.

Longlines, like other hook and line gears, are among the most selective fishing gears. Both hook size and type of bait used play a role in the ability of longline to selectively catch different species and different sizes of fish. This is not to say that longline is totally 'clean'. Within a given hook size, longlines are not very selective in the type of predatory fish that they catch. However, the bait used in the fishery can play an important role in selective catch of targeted species while maintaining a low catch rate of unwanted species. For example, cod and haddock (*Melanogrammus aeglefinus*) show a different behavior toward baited hooks (Lokkeborg et al. 1989). Haddock tend to nibble at the bait, but cod tend to completely ingest the bait with one bite (Johannessen et al. 1993). Studies suggest that using herring as baits can reduce cod catch when compared with squid baits in longline fisheries (Lokkeborg and Bjordal 1992, Jacobsen and Joensen 2004.

Fabricated baits have been used successfully in some cases and this is an area of promising research. The blackcod fishery in Alaska uses fabricated bait that does not catch as many dogfish as normal bait (Erickson and Berkeley 2000). A preliminary Canadian study of Norbait on cod and haddock catch yielded some promising results for reducing cod bycatch while maintaining high catch rate for haddock (Walsh et al. 2006).

In this study, using the data collected from 232 hauls conducted on 33 fishing trips in four different areas (Cashes Ledge 448, Eastern US/Canada Area 735, Platts Bank 448, and WGOM 448) from December 2004 to January 2006, we tested the impacts of an fabricated bait (Norbait 700E) on the catch rate of haddock and Atlantic cod. More specifically, we tested the following null hypotheses

(I) Landed catch rate of haddock is not significantly higher than (1) the landed catch rate of cod, (2) discarded catch rate of cod, and (3) discarded catch rate of haddock in the longline fishery with Norbait baits;
(II) There is no significant difference in catch rates of cod and haddock using Norbait and "traditional" squid baits; and
(III) There is no significant difference in catch rates of cod and haddock using Norbait and "traditional" herring baits

Clearly, a rejection of these null hypotheses would lead us to conclude that longline fisheries with Norbait as baits could catch haddock of marketable sizes efficiently while maintaining a low bycatch of cod, and of undersized haddock.

Materials and methods

The data used in this study were collected from 232 benthic longline hauls conducted in 33 fishing trips in four different areas:

Cashes Ledge Closed Area under EFP DA-448 (CLCA)
Eastern US/Canada Area under EFP DA-735 (EUSCA)
Platts Bank under EFP DA-448 (Gulf of Maine Rolling Closure III)
Western Gulf of Maine Closed Area under EFP DA-448 (WGOM)

Trips took place from December 2004 to January 2006. Norbait was used in all the 33 trips, herring was used in one trip (EUSCA), and squid was also used in one trip (WGOM). Detailed description on sampling procedure and area can be found in Applebee et al. (2004) and Sanderson et al. (2006).

For each haul, the following information was recorded: type of bait, weight and number of each species caught, if the catch was kept or discarded, fishing area, number of hauls, time when longline setting ended, time when longline began to be hauled, and number of hooks set. For each trip, the following information was collected: the time and date when each trip started and ended, vessel ID, and NMFS SeaSamp ID. All the data were entered into an in-house Microsoft ACCESS database maintained by the Cape Cod Commercial Hook Fishermen's Association (CCCHFA), as well as the NMFS SeaSamp database. From the information collected, we calculated the soak time as the time lapsed between when longline setting ends and when the haul starts. Based on the haul time, we also estimated if fishing occurred during daytime (between 7 am – 8 pm) or night.

To evaluate the quality of the data recorded in the CCCHFA in-house database, we compared the data with the relevant data recorded in the NMFS SeaSamp database. The two sets of data were compiled based on the SeaSamp ID. The weights of fish in each haul recorded in the two data sets were plotted against each other for landed and discarded cod and haddock for the identification of any systematical difference between the two data sets. For each catch category, we calculated mean and median relative differences index (RDI) as

$$Mean\ RDI = \frac{\sum_i \frac{(x_i - y_i)}{y_i} 100\%}{N} \quad (1)$$

$$Median\ RDI = Median\left[\frac{x_i - y_i}{y_i} 100\%\right] \quad (2)$$

where i indicates ith haul, N is the total number of haul, x_i is the catch (weight) of fish recorded in the SeaSamp database, and y_i is the catch (weight) of fish recorded in the CCCHFA in-house database. Clearly, the larger the RDI, the larger the difference in data between the two databases. A negative value of RDI suggests that records in the CCCHFA database are higher than the records in the SeaSamp database, and vice versa.

This study suggests no systematical differences between the CCCHFA and SeaSamp data sets for landed and discarded haddock data and discarded cod data, but CCCHFA database tends to have consistently lower estimates of landed cod. Such a difference in landed cod data between the two databases is, however, unlikely to influence the results of this study. We used the CCCHFA database for this study.

We started the data analysis with a regression analysis to evaluate if a significant proportion of variations in landed catch and discarded catch for haddock and cod could be explained by the number of hooks and hook soak time. We then took the variable that was identified as significant in the regression analysis as the measure of fishing effort, and used the variable to divide the catch (in weight) to compute catch rate (i.e., CPUE) for landed and discarded cod and haddock, separately. An analysis of variance (ANOVA) was conducted to test if there was significant difference in catch rate among landed haddock, discarded haddock, landed cod, and discarded cod in each experimental area.

This was followed by an ANOVA for evaluating if catch rates for landed and discarded cod and haddock differed significantly among fishing areas, fishing time (day or night), fishing month, and vessels used. The fishing time was used to evaluate if day/night might influence the catch rate. Vessels used were included because it might relate to fishing trips and reflect different fishing strategies (selection of location, time to set and haul, etc.) by different skippers. Because of lack of degree of freedom, no interaction term between these variables was considered in ANOVA.

A one-tail student t test was conducted for evaluating if catch rates of landed haddock differed significantly higher than the catch rates of discarded haddock and landed and discarded cod. The results from the statistical tests were then used to decide if we accepted or rejected the first null hypothesis developed in the beginning of this project. The test of the second and third hypotheses, however, required comparison of cod and haddock catch rates for both the Norbait and "traditional" baits.

Norbait was used in all 33 fishing trips recorded in the CCCHFA database except for the two aforementioned trips for which both the Norbait and one type of traditional bait (herring or squid) were used. The haul with the traditional bait could be used as a "control" group. A comparison of catch rates of cod and haddock between hauls of Norbait and herring or squid in the same fishing trip can provide us with the evidence for testing the second and third null hypotheses

The two fishing trips that used both Norbait and traditional baits are fishing trip 48 in the Western Gulf of Maine (area 448) and fishing trip 61 in the Eastern US/Canada (area 735). There were four hauls in fishing trip 48, of which three hauls were Norbait and one haul was squid. There were 12 hauls in fishing trip 61 in which 11 hauls were Norbait and one haul was herring. For both trips, the number of hauls with herring or squid as baits is only one, which cannot provide statistically significant results for testing null hypotheses II and III.

Results and discussion

There were no systematical differences in landed and discarded haddock data between the SeaSamp database and CCCHFA database (Fig. 1). The difference between the two data sets, quantified with RDI in equations 1 and 2, was small (Table 1). No systematical differences were found between the two databases for discarded cod (Fig. 2) and the RDI value was small (Table 1). However, the landed cod in the CCCHFA database was systematically lower than the landed cod recorded in the SeaSamp database (Fig. 2). On average, the SeaSamp landed cod values were 14.9% higher than the CCCHFA landed cod value (Table 1). Given the large difference in landed catch of haddock and cod, it is virtually impossible that the choice of using CCCHFA or SeaSamp data can change the results of this study in comparing catch rates of cod and haddock. This difference is likely due to gut weight- either the application of a Product Recovery Ratio to landed cod in one database but not the other, or the use of actual round weight instead of dressed weight (Rudolph, personal communication, 2006). Thus, the CCCHFA data were used for further data analysis.

The number of hooks used in the longline fishery tended to be significant for explaining the variation in landed haddock (specie ID = 1). The soak time was, however, not a significant factor in explaining landed haddock (Table 2). This was also the case for sub-legal haddock (Species_ID=2; Table 3). For haddock discarded because of damages as a result of bites from predator species (species ID = 10), both number of hooks and soak time were significant (Table 4). For haddock discarded due to undefined reasons (species ID = 11), only the number of hooks was significant (Table 5).

The number of hooks was shown to be significant, but soak time was not, in the regression analysis of landed cod against the number of hooks and soak time (Table 6).

Although the model was significant (P=0.029), the r2 was only 0.04, indicating that the number of hooks, although significant, was not a good predictor for landed cod (Table 6). This was also the case for sub-legal sized cod (Species ID = 13) that were discarded at sea (Table 7). For cod discarded because of damages from predator bites, neither number of hooks nor soak time was significant (Table 8). This was also the case for cod discarded due to unspecified reasons (Table 9).

For each category (kept and discarded due to various reasons), the number of hooks tended to predict haddock catch better than Atlantic cod catch, suggesting that the number of hooks was more important and relevant for haddock catch. Because the number of hooks is likely to correlate with effective fishing effort if fish are attracted to baits, the lower importance of hook numbers for cod catch may imply lack of interest in Norbait by cod.

Based on these regression results, we used the number of hooks as the measure of fishing effort. Thus, catch rate was calculated as the ratio of catch over the corresponding number of hooks used to yield the catch.

The ANOVA suggests that there were significant differences among the catch rates of landed haddock, discarded haddock, landed cod and discarded cod in each experimental area (Table 10a –10d). Significant differences in catch rates were found among experimental areas for landed haddock (Table 11), discarded sub-legal haddock (Table 12), discarded sub-legal cod (Table 13), but not for discarded damaged haddock and cod (Table 14, Table 15), landed cod (Table 16), and cod and haddock discarded due to unspecified reasons (Tables 17 and 18). Significant differences were also found among vessels used in the experiment in catch rates of landed and sub-legal haddock (Tables 11 and 12) and landed and sub-legal cod (Tables 16 and 13), but not for other discarded haddock and cod. Significant differences were also found among fishing months in catch rates of landed and sub-legal haddock and landed cod, but not in other categories of haddock and cod. Fishing time (day or night) appeared to have no significant impacts on catch rates of haddock and cod (Tables 11-18). Given the ANVOA results, we computed key statistics (mean, median, standard error, 2.5th and 97.5th percentiles) for catch rates of different categories of haddock and cod by fishing area, month and vessels (Table 19). In most cases, there were no overlaps between landed haddock and discarded haddock and cod in the 95% confidence intervals defined by the 2.5th and 97.5th percentiles. This suggests that landed haddock tended to have significantly higher catch rates than all cod catch categories and discarded haddock (Table 19).

To make more specific comparison, we calculated the percentage of each category of catch for haddock and cod with respect to the sum of haddock and cod catches and with respect to the total catch combining all species. If we only considered haddock and cod caught in the experiment, landed haddock dominated the catch for each month in each area. This was particularly clear in the Eastern US/Canada Area 735 (Fig. 3). The only two exceptions were in September and December 2005 in Cashes Ledge 448 for which landed cod was higher than landed haddock (Figure 3). The same results could be obtained when we included the catch of all species (Figure 4). The percentages were calculated based on weights for Figures 3 and 4. When we measured the catch with the number of fish caught, landed haddock again dominated the catch and was much higher than cod and other species (Figures 5 and 6). Clearly, for a given area and month, the majority of catch was landed haddock (Figures 3 -6).

If we analyzed catch rate (i.e., CPUE) data by fishing trip, similar results could be reached (Fig. 7). Landed haddock formed the majority of catch in both weight and number for all fishing trips except for fishing trip 40 which occurred in Cashes Ledge 448 on Dec. 29, 2004 (Figures 7-10). This fishing trip was the earliest we have in the CCCHFA database. It is not clear why the result of his fishing trip differs from those of other fishing trips.

The frequency of hauls in which landed and discarded haddock and cod occurred is summarized in Table 20 for each experimental area and in Table 21 for all areas combined. The number of hauls in which landed haddock was recorded was higher than that for landed cod, discarded haddock and discarded cod. This suggests that the higher catch of landed haddock was not just from a small proportion of hauls; instead, it suggests selectivity for haddock across all the hauls in the experiment. In other words, the high catch rate of landed haddock was not the result of some large catch of haddock from a few hauls. This shows the persistency of the results on various spatial and temporal scales across all the experimental areas and throughout the duration of the project.

The mean and standard error of catch rates of landed and discarded haddock and cod are summarized in Table 22. Overall for weight, the catch rate of landed haddock was over 20 times of the catch rates of all discarded haddock, 14 times of the catch rate of landed cod, and 50 times of the catch rate of discarded cod. For number, the catch rate of landed haddock was almost 14 times of the catch rate of discarded haddock, 36 times of the catch rate of landed cod, and 48 times of the catch rate of discarded cod. The Student t test showed that the catch rate of landed haddock, in both weight and number, was significantly higher than the catch rates of discarded haddock, landed cod, and discarded cod ($p < 0.00001$).

The catch rates of landed and discarded haddock and cod differed greatly between hauls in fishing trip 48, in which squid was used in one haul and Norbait was used in the other three hauls (Table 23). For the haul based on squid, the catch rate of landed cod was 305 lbs/1000 hooks, over 15 times higher than the catch rate of 20 lbs/1000 hooks for landed haddock. The catch rate in number was 70.8 cod/1000 hooks for landed cod, also much higher than 7.5 haddock/1000 hooks for landed haddock. Even sub-legal cod had a much higher catch rate than landed haddock (Table 24). The comparison results were totally different for the three hauls based on Norbait made in the same trip (Table 24). The average catch rate of landed haddock was over 4 times higher than the catch rate of landed cod. The results were consistent with the findings in other studies that the cod tend to be more attracted to squid in longline fisheries (Lokkeborg 1990, Lokkeborg and Bjordal 1992, Walsh et al. 2006). The comparison of results between squid- and Norbait-based hauls within this fishing trip also demonstrated that the Norbait tended to be selective of haddock, and suggested that the low catch rates of landed and discarded cod associated with Norbait were likely to result from the selectivity of Norbait for haddock, rather than from the absence of cod in the fishing ground.

The catch rates of landed and discarded haddock and cod were similar between hauls in fishing trip 61, in which herring was used in one haul and Norbait was used in the other 12 hauls (Table 25). For the haul based on herring, landed haddock has a much higher catch rates compared with cod (Table 26). The difference in catch rates of haddock and cod was small between the herring- and Norbait-based hauls (Table 25), suggesting similar selectivity of Norbait and herring. Previous studies suggested high catch rates for haddock and low catch rates for cod when herring was used as bait in the longline fishery (Lokkeborg and Bjordal 1992, Jacobsen and Joensen 2004). This is consistent with the result derived from data collected in fishing trip 61 in this study.

Yellowtail flounder was only recorded in two hauls, both on fishing trip to the Eastern US/Canada area 735: one on June 16, 2000 with a catch rate of 1.33 lbs/1000 hooks and the other on July 14, 2005 with a catch rate of 0.83 lbs/1000 hooks. No catch of yellowtail was reported in the other 31 trips. This suggests extremely low catch rate for yellowtail flounder compared with haddock when Norbait was used.

To further test if the low catch rate of cod resulted from the absence of cod in the fishing area rather than the use of Norbait, we calculated the total landing of cod, haddock, and yellowtail in the Eastern US/Canada area in fishing year 2005 (Table 27). The catch of cod and yellowtail including both landed and discarded was about 41.3% and 661% of haddock catch, respectively. This suggested that both cod and yellowtail were present in the fishing area and that the low catch rate of cod and yellowtail in the Norbait-based longline fishery was likely the results of selectivity of Norbait, rather than the absence of cod and yellowtail in the fishing area.

Conclusion

This study did not support the first two hypotheses, but tend to support the third hypothesis. However, a statistical test of hypotheses II and III was not possible because of lack of replications for herring and squid baits. The results derived in this study supports the conclusion that the catch rate of landed haddock was significantly higher than the catch rate of discarded haddock, landed cod, and discarded cod in the longline fishery with the Norbait baits.

Although unable to conduct a formal statistical test for hypotheses II and III because there is not enough fishing trips in which both "traditional" and Norbait were used, all evidence and data we have collected and analyzed tend to strongly support that the catch rates of landed haddock in the Norbait-based longline fishery tend to be much higher than those in the squid-based longline fishery, but similar to those in herring-based longline fishery.

We conclude that the high catch rate of haddock is likely to result from the selectivity of Norbait for efficient catch of marketable haddock, rather than from relative difference in abundance of cod and haddock in the fishing grounds and that Norbait can significantly reduce cod bycatch while maintaining a high catch rate for marketable sizes of haddock in longline fisheries.

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Table 1. Mean and median relative difference index (RDI), described in Equations (1) and (2), for comparing differences in landed and discarded catch of haddock and cod recorded in the NMFS SeaSamp Database and CCCHFA database.

Species	Species_ID	Mean RDI	Median RDI
Landed haddock	01	4.96%	0%
Sub-legal haddock	02	-0.05%	0%
Discarded haddock	10	-0.40%	0%
Landed cod	12	-14.87%	-14.49%
Sub-legal cod	13	-0.84%	0%
Discarded cod	14	there are only two records in SeaSamp.	

Table 2. A regression analysis of landed catch of haddock (in lbs) versus the number of hooks and soak time in the experiment.

```
catch_ID=1

The REG Procedure  Model: MODEL1  Dependent Variable: wt
                           Analysis of Variance
                                  Sum of            Mean
Source                  DF       Squares          Square    F Value    Pr > F
Model                    2       9808411         4904206      34.76    <.0001
Error                  213      30053346          141096
Corrected Total        215      39861757

Root MSE             375.62684    R-Square     0.2461
Dependent Mean       425.22222    Adj R-Sq     0.2390
Coeff Var             88.33660

                        Parameter Estimates
                       Parameter        Standard
Variable      DF        Estimate           Error    t Value    Pr > |t|

Intercept      1        61.24261        51.66430       1.19      0.2372
hook           1         0.25102         0.03043       8.25      <.0001
Hr_fished      1        -1.07151         0.67391      -1.59      0.1133
```

Table 3. A regression analysis of discarded catch of sub-legal haddock (in lbs) versus the number of hooks and soak time in the experiment.

catch_ID=2

The REG Procedure   Model: MODEL1   Dependent Variable: wt

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	17079	8539.48886	14.55	<.0001
Error	193	113246	586.76524		
Corrected Total	195	130325			

Root MSE	24.22324	R-Square	0.1310
Dependent Mean	24.22959	Adj R-Sq	0.1220
Coeff Var	99.97377		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	8.44066	3.47418	2.43	0.0160
hook	1	0.01071	0.00201	5.33	<.0001
Hr_fished	1	-0.04537	0.04347	-1.04	0.2979

Table 4. A regression analysis of discarded catch of haddock (due to damages caused by predators, in lbs) versus the number of hooks and soak time in the experiment.

catch_ID=10

The REG Procedure   Model: MODEL1   Dependent Variable: wt

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	8322.90262	4161.45131	24.80	<.0001
Error	93	15604	167.78958		
Corrected Total	95	23927			

Root MSE	12.95336	R-Square	0.3478
Dependent Mean	18.16667	Adj R-Sq	0.3338
Coeff Var	71.30291		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	11.10376	3.45769	3.21	0.0018
hook	1	0.01040	0.00168	6.20	<.0001
Hr_fished	1	-2.61429	0.60858	-4.30	<.0001

Table 5. A regression analysis of discarded catch of haddock (due to unspecified reasons, in lbs) versus the number of hooks and soak time in the experiment.

catch_ID=11 The REG Procedure Model: MODEL1 Dependent Variable: wt

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	27866	13933	11.21	<.0001
Error	70	87041	1243.44095		
Corrected Total	72	114907			

Root MSE	35.26246	R-Square	0.2425
Dependent Mean	29.64384	Adj R-Sq	0.2209
Coeff Var	118.95376		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	-7.69904	9.05589	-0.85	0.3981
hook	1	0.01686	0.00473	3.57	0.0007
Hr_fished	1	3.21024	1.71670	1.87	0.0657

Table 6. A regression analysis of landed catch of Atlantic cod (in lbs) versus the number of hooks and soak time in the experiment.

catch_ID=12 The REG Procedure Model: MODEL1 Dependent Variable: wt

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	7204.39551	3602.19775	3.63	0.0286
Error	175	173746	992.83665		
Corrected Total	177	180951			

Root MSE	31.50931	R-Square	0.0398
Dependent Mean	30.70787	Adj R-Sq	0.0288
Coeff Var	102.60990		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	20.15263	4.79570	4.20	<.0001
hook	1	0.00712	0.00274	2.60	0.0101
Hr_fished	1	-0.04606	0.05657	-0.81	0.4166

Table 7. A regression analysis of discarded catch of sub-legal cod (in lbs) versus the number of hooks and soak time in the experiment.

catch_ID=13 The REG Procedure Model: MODEL1 Dependent Variable: wt

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	1300.17209	650.08604	6.42	0.0024
Error	101	10220	101.18860		
Corrected Total	103	11520			

Root MSE	10.05925	R-Square	0.1129
Dependent Mean	8.91346	Adj R-Sq	0.0953
Coeff Var	112.85464		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	2.93196	1.97382	1.49	0.1405
hook	1	0.00414	0.00117	3.56	0.0006
Hr_fished	1	-0.01235	0.01813	-0.68	0.4973

Table 8. A regression analysis of discarded catch of cod (due to damages caused by predators, in lbs) versus the number of hooks and soak time in the experiment.

catch_ID=14 The REG Procedure Model: MODEL1 Dependent Variable: wt

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	84.35803	42.17902	1.34	0.2857
Error	19	598.41469	31.49551		
Corrected Total	21	682.77273			

Root MSE	5.61209	R-Square	0.1236
Dependent Mean	6.31818	Adj R-Sq	0.0313
Coeff Var	88.82438		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	1.81045	3.18766	0.57	0.5767
hook	1	0.00135	0.00179	0.76	0.4588
Hr_fished	1	0.47628	0.43958	1.08	0.2921

Table 9. A regression analysis of discarded catch of cod (due to unspecified reasons, in lbs) versus the number of hooks and soak time in the experiment.

catch_ID=15 The REG Procedure Model: MODEL1 Dependent Variable: wt

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	55.78465	27.89233	1.58	0.2720
Error	7	123.81535	17.68791		
Corrected Total	9	179.60000			

Root MSE	4.20570	R-Square	0.3106
Dependent Mean	8.80000	Adj R-Sq	0.1136
Coeff Var	47.79204		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	2.72657	3.89914	0.70	0.5069
hook	1	0.00272	0.00286	0.95	0.3730
Hr_fished	1	0.22794	0.49376	0.46	0.6583

Table 10a. An analysis of variance (ANOVA) for evaluating if the catch rate differs significantly among landed and discarded catch of haddock and cod for Cashes Ledge 448 (location 1).

```
location=1     The GLM Procedure
          Class Level Information
Class         Levels     Values
catch_ID         8       1 2 10 11 12 13 14 15

Number of observations    132
Dependent Variable: wt_hook
                                        Sum of
Source                     DF          Squares      Mean Square      F Value     Pr > F

Model                       7       92427.8446       13203.9778         7.78     <.0001
Error                     124      210359.3486        1696.4464
Corrected Total           131      302787.1932

R-Square      Coeff Var      Root MSE     wt_hook Mean
0.305257       136.1397      41.18794         30.25417

Source                     DF      Type III SS      Mean Square      F Value     Pr > F
catch_ID                    7      92427.84456      13203.97779         7.78     <.0001
```

Table 10b. An analysis of variance (ANOVA) for evaluating if the catch rate differs significantly among landed and discarded catch of haddock and cod for Eastern US/Canada Area 735 (location 2).

```
location=2     The GLM Procedure
          Class Level Information
Class         Levels     Values
catch_ID         8       1 2 10 11 12 13 14 15
Number of observations    485
Dependent Variable: wt_hook

                                        Sum of
Source                     DF          Squares      Mean Square      F Value     Pr > F
Model                       7      10254884.05       1464983.44        58.88     <.0001
Error                     477      11867460.65         24879.37
Corrected Total           484      22122344.70

R-Square      Coeff Var      Root MSE     wt_hook Mean
0.463553       153.9379      157.7320         102.4647

Source                     DF      Type III SS      Mean Square      F Value     Pr > F
catch_ID                    7      10254884.05       1464983.44        58.88     <.0001
```

Table 10c. An analysis of variance (ANOVA) for evaluating if the catch rate differs significantly among landed and discarded catch of haddock and cod for Platts Bank 448 (location 3).

```
location=3
The GLM Procedure
          Class Level Information
Class          Levels    Values
catch_ID            7    1 2 10 11 12 13 14
Number of observations    29
Dependent Variable: wt_hook
                                       Sum of
Source                       DF       Squares      Mean Square    F Value    Pr > F
Model                         6   30105.13237       5017.52206       8.92    <.0001
Error                        22   12374.79445        562.49066
Corrected Total              28   42479.92681

R-Square     Coeff Var      Root MSE     wt_hook Mean
0.708691      104.5337      23.71689         22.68828

Source                       DF   Type III SS      Mean Square    F Value    Pr > F
catch_ID                      6   30105.13237       5017.52206       8.92    <.0001
```

Table 10d. An analysis of variance (ANOVA) for evaluating if the catch rate differs significantly among landed and discarded catch of haddock and cod for WGOM 448 (location 4).

```
location=4     The GLM Procedure
          Class Level Information
Class          Levels    Values
catch_ID            7    1 2 10 11 12 13 14
Number of observations    249
Dependent Variable: wt_hook
                                       Sum of
Source                       DF       Squares      Mean Square    F Value    Pr > F
Model                         6   13507317.44       2251219.57      37.10    <.0001
Error                       242   14685738.06         60684.87
Corrected Total             248   28193055.50

R-Square     Coeff Var      Root MSE     wt_hook Mean
0.479101      169.2499      246.3430         145.5499

Source                       DF   Type III SS      Mean Square    F Value    Pr > F
catch_ID                      6   13507317.44       2251219.57      37.10    <.0001
```

Table 11. An analysis of variance (ANOVA) for evaluating if the catch rate of landed haddock differs significantly among experiment areas, months, vessels, and fishing time (day or night).

catch_ID=1 The GLM Procedure

Class Level Information

Class	Levels	Values
location	4	1 2 3 4
Vessel_ID	7	51 55 58 101 102 103 104
month	9	1 2 5 6 7 8 9 11 12
fishing_time	2	1 2

Number of observations 216

Dependent Variable: wt_hook

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	18	25378587.61	1409921.53	41.94	<.0001
Error	197	6622809.45	33618.32		
Corrected Total	215	32001397.06			

R-Square	Coeff Var	Root MSE	wt_hook Mean
0.793046	50.38952	183.3530	363.8713

Source	DF	Type III SS	Mean Square	F Value	Pr > F
location	3	613097.45	204365.82	6.08	0.0006
Vessel_ID	6	14700614.53	2450102.42	72.88	<.0001
month	8	1650761.41	206345.18	6.14	<.0001
fishing_time	1	3972.67	3972.67	0.12	0.7314

Table 12. An analysis of variance (ANOVA) for evaluating if the catch rate of discarded sub-legal haddock differs significantly among experiment areas, months, vessels, and fishing time (day or night).

catch_ID=2 The GLM Procedure

Class Level Information

Class	Levels	Values
location	4	1 2 3 4
Vessel_ID	7	51 55 58 101 102 103 104
month	9	1 2 5 6 7 8 9 11 12
fishing_time	2	1 2

Number of observations 196 Dependent Variable: wt_hook

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	18	19730.21912	1096.12328	6.77	<.0001
Error	177	28646.91996	161.84701		
Corrected Total	195	48377.13908			

R-Square	Coeff Var	Root MSE	wt_hook Mean
0.407842	69.27143	12.72191	18.36531

Source	DF	Type III SS	Mean Square	F Value	Pr > F
location	3	1641.326203	547.108734	3.38	0.0195
Vessel_ID	6	7914.766452	1319.127742	8.15	<.0001
month	8	6485.802735	810.725342	5.01	<.0001
fishing_time	1	167.020428	167.020428	1.03	0.3111

Table 13. An analysis of variance (ANOVA) for evaluating if the catch rate of discarded sub-legal cod differs significantly among experiment areas, months, vessels, and fishing time (day or night).

catch_ID=13 The GLM Procedure

Class Level Information

Class	Levels	Values
location	4	1 2 3 4
Vessel_ID	7	51 55 58 101 102 103 104
month	9	1 2 5 6 7 8 9 11 12
fishing_time	2	1 2

Number of observations 104

Dependent Variable: wt_hook

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	18	5684.995500	315.833083	6.48	<.0001
Error	85	4140.051561	48.706489		
Corrected Total	103	9825.047062			

R-Square	Coeff Var	Root MSE	wt_hook Mean
0.578623	87.14118	6.979003	8.008846

Source	DF	Type III SS	Mean Square	F Value	Pr > F
location	3	516.182755	172.060918	3.53	0.0182
Vessel_ID	6	2212.907097	368.817850	7.57	<.0001
month	8	795.713057	99.464132	2.04	0.0508
fishing_time	1	0.423711	0.423711	0.01	0.9259

Table 14. An analysis of variance (ANOVA) for evaluating if the catch rate of discarded haddock (damaged by predators) differs significantly among experiment areas, months, vessels, and fishing time (day or night).

catch_ID=10 The GLM Procedure

Class Level Information

Class	Levels	Values
location	4	1 2 3 4
Vessel_ID	6	51 58 101 102 103 104
month	9	1 2 5 6 7 8 9 11 12
fishing_time	2	1 2

Number of observations 96

Dependent Variable: wt_hook

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	16	3049.514304	190.594644	3.60	<.0001
Error	79	4184.212546	52.964716		
Corrected Total	95	7233.726850			

R-Square	Coeff Var	Root MSE	wt_hook Mean
0.421569	61.72107	7.277686	11.79125

Source	DF	Type III SS	Mean Square	F Value	Pr > F
location	3	109.394815	36.464938	0.69	0.5617
Vessel_ID	4	1394.281375	348.570344	6.58	0.0001
month	7	912.843681	130.406240	2.46	0.0245
fishing_time	1	0.364795	0.364795	0.01	0.9341

Table 15. An analysis of variance (ANOVA) for evaluating if the catch rate of discarded cod (damaged by predators) differs significantly among experiment areas, months, vessels, and fishing time (day or night).

catch_ID=14 The GLM Procedure

Class Level Information

Class	Levels	Values
location	4	1 2 3 4
Vessel_ID	5	51 101 102 103 104
month	7	1 2 5 6 7 8 9
fishing_time	2	1 2

Number of observations 22

Dependent Variable: wt_hook

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	265.1933568	24.1084870	0.99	0.5082
Error	10	242.7052250	24.2705225		
Corrected Total	21	507.8985818			

R-Square	Coeff Var	Root MSE	wt_hook Mean
0.522138	114.8615	4.926512	4.289091

Source	DF	Type III SS	Mean Square	F Value	Pr > F
location	1	2.1316000	2.1316000	0.09	0.7730
Vessel_ID	2	3.9108667	1.9554333	0.08	0.9232
month	3	114.8187583	38.2729194	1.58	0.2558
fishing_time	1	5.9202667	5.9202667	0.24	0.6321

Table 16. An analysis of variance (ANOVA) for evaluating if the catch rate of landed cod differs significantly among experiment areas, months, vessels, and fishing time (day or night).

catch_ID=12 The GLM Procedure

Class Level Information

Class	Levels	Values
location	4	1 2 3 4
Vessel_ID	6	51 58 101 102 103 104
month	9	1 2 5 6 7 8 9 11 12
fishing_time	2	1 2

Number of observations 178

Dependent Variable: wt_hook

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	17	83951.1964	4938.3057	5.85	<.0001
Error	160	135070.5704	844.1911		
Corrected Total	177	219021.7668			

R-Square	Coeff Var	Root MSE	wt_hook Mean
0.383301	109.7114	29.05497	26.48309

Source	DF	Type III SS	Mean Square	F Value	Pr > F
location	3	3533.11086	1177.70362	1.40	0.2463
Vessel_ID	5	38845.11870	7769.02374	9.20	<.0001
month	8	14721.68611	1840.21076	2.18	0.0316
fishing_time	1	17.95656	17.95656	0.02	0.8842

Table 17. An analysis of variance (ANOVA) for evaluating if the catch rate of discarded haddock (due to unspecified reasons) differs significantly among experiment areas, months, vessels, and fishing time (day or night).

catch_ID=11 The GLM Procedure

Class Level Information

Class	Levels	Values
location	4	1 2 3 4
Vessel_ID	7	51 55 58 101 102 103 104
month	8	1 2 5 6 7 8 9 12
fishing_time	2	1 2

Number of observations 73 Dependent Variable: wt_hook

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	17	5487.59846	322.79991	0.65	0.8376
Error	55	27400.23676	498.18612		
Corrected Total	72	32887.83522			

R-Square	Coeff Var	Root MSE	wt_hook Mean
0.166858	104.0816	22.32008	21.44479

Source	DF	Type III SS	Mean Square	F Value	Pr > F
location	3	644.530636	214.843545	0.43	0.7314
Vessel_ID	6	704.514793	117.419132	0.24	0.9630
month	7	2365.039177	337.862740	0.68	0.6897
fishing_time	1	104.435081	104.435081	0.21	0.6489

Table 18. An analysis of variance (ANOVA) for evaluating if the catch rate of discarded cod (due to unspecified reasons) differs significantly among experiment areas, months, vessels, and fishing time (day or night).

catch_ID=15 The GLM Procedure

Class Level Information

Class	Levels	Values
location	2	1 2
Vessel_ID	3	102 103 104
month	3	1 8 12
fishing_time	2	1 2

Number of observations 10 Dependent Variable: wt_hook

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	15.44601000	3.86150250	0.47	0.7607
Error	5	41.48368000	8.29673600		
Corrected Total	9	56.92969000			

R-Square	Coeff Var	Root MSE	wt_hook Mean
0.271317	53.03638	2.880406	5.431000

Source	DF	Type III SS	Mean Square	F Value	Pr > F
location	0	0.00000000	.	.	.
Vessel_ID	0	0.00000000	.	.	.
month	1	3.52666667	3.52666667	0.43	0.5432
fishing_time	1	2.35445000	2.35445000	0.28	0.6170

Table 19. Summary statistics of catch rates for landed and discarded haddock and cod for different months, vessels, and experimental areas (i.e, locations). For location, 1 = Cashes Ledge 448; 2= Eastern US/Canada Area 735; 3= Platts Bank 448; and 4=WGOM 448 . For catch_ID, 1=landed catch of haddock; 2=discarded catch of sub-legal haddock; 10=discarded catch of haddock due to damages from predators; 11=discarded catch haddock for unspecified reasons; 12=landed catch of Atlantic cod; 13=discarded catch of sub-legal cod; 14=discarded catch of cod due to damages of predators; and discarded catch of cod for unspecified reasons. Vessel_ID indicates different vessels used in the experiment. N = the number of hauls. m_CPUE = mean catch rate. stdmean=standard error. med_CPUE = median value of catch rates. CPUE_2.5 = 2.5th percentile of catch rate. CPUE_97.5=97.5th percentile of catch rate. Dot "." means "not available".

Obs	location	catch_ID	month	Vessel_ ID	n	m_CPUE	stdmean	med_CPUE	CPUE_2.5	CPUE_97.5
1	1	1	1	102	5	85.86	20.380	102.86	10.00	126.43
2	1	1	5	102	4	179.65	68.360	129.31	78.46	381.54
3	1	1	8	103	8	78.09	18.209	88.75	1.67	136.67
4	1	1	9	103	7	48.97	8.819	45.00	15.83	89.17
5	1	1	12	102	4	12.01	7.095	8.01	0.00	32.03
6	1	2	1	102	5	19.18	7.095	11.43	2.86	40.00
7	1	2	5	102	4	29.66	9.985	22.66	14.36	58.97
8	1	2	8	103	6	25.65	5.789	25.42	8.89	48.33
9	1	2	9	103	6	4.91	1.201	5.14	1.67	9.17
10	1	2	12	102	4	3.34	1.529	2.34	0.87	7.79
11	1	10	1	102	3	4.69	2.131	4.29	1.22	8.57
12	1	10	5	102	1	15.38	.	15.38	15.38	15.38
13	1	10	8	103	2	2.92	0.415	2.92	2.50	3.33
14	1	10	9	103	2	2.92	0.415	2.92	2.50	3.33
15	1	10	12	102	1	6.49	.	6.49	6.49	6.49
16	1	11	1	102	3	37.14	17.303	48.21	3.21	60.00
17	1	11	5	102	4	28.09	19.645	12.31	2.05	85.71
18	1	11	8	103	1	8.33	.	8.33	8.33	8.33
19	1	11	9	103	1	4.17	.	4.17	4.17	4.17
20	1	11	12	102	3	21.21	5.727	23.38	10.39	29.87
21	1	12	1	102	5	11.24	2.173	12.14	4.29	15.71
22	1	12	5	102	4	15.90	7.416	14.36	0.00	34.87
23	1	12	8	103	7	31.82	11.316	24.44	2.50	85.83

Table 19 (continued)

Obs	location	catch_ID	month	Vessel_ ID	n	m_CPUE	stdmean	med_CPUE	CPUE_2.5	CPUE_97.5
24	1	12	9	103	7	72.66	22.423	35.83	25.83	184.17
25	1	12	12	102	4	14.98	8.527	8.01	3.64	40.26
26	1	13	1	102	5	7.25	1.554	7.14	2.86	11.43
27	1	13	5	102	3	5.98	1.630	6.15	3.08	8.72
28	1	13	8	103	4	3.75	1.464	3.75	0.83	6.67
29	1	13	9	103	3	2.59	1.214	1.67	1.11	5.00
30	1	13	12	102	4	4.39	2.579	1.95	1.56	12.12
31	1	14	1	102	2	3.83	0.255	3.83	3.57	4.08
32	1	14	8	103	4	3.33	0.589	2.92	2.50	5.00
33	1	14	9	103	2	12.50	10.830	12.50	1.67	23.33
34	1	15	1	102	2	6.63	0.510	6.63	6.12	7.14
35	1	15	12	102	2	3.25	1.085	3.25	2.16	4.33
36	2	1	1	103	20	30.42	4.882	21.62	2.00	72.67
37	2	1	6	51	11	1021.12	56.369	1056.00	561.33	1277.33
38	2	1	6	103	17	271.38	35.442	275.56	21.90	555.00
39	2	1	6	104	13	279.40	59.371	263.64	73.64	812.14
40	2	1	7	51	11	568.85	63.679	580.00	201.33	844.00
41	2	1	7	58	11	317.20	21.647	337.50	196.67	442.50
42	2	1	7	103	14	552.99	43.535	570.48	226.00	791.43
43	2	1	8	103	2	48.00	28.670	48.00	19.33	76.67
44	2	1	8	104	12	348.08	51.801	322.90	23.81	572.11
45	2	1	11	103	13	136.33	27.580	143.33	21.33	297.78
46	2	1	12	103	4	141.18	14.581	137.50	114.17	175.56
47	2	2	1	103	16	5.75	0.740	6.10	0.67	11.11
48	2	2	6	51	11	25.00	3.778	24.00	6.00	48.00
49	2	2	6	103	16	20.08	1.835	19.67	6.67	31.67
50	2	2	6	104	11	16.28	2.790	15.29	5.00	32.86
51	2	2	7	51	11	25.18	3.163	28.00	8.00	40.00
52	2	2	7	58	11	33.94	5.229	35.00	12.50	64.17
53	2	2	7	103	14	20.51	2.839	18.10	5.33	46.25
54	2	2	8	103	2	7.89	3.445	7.89	4.44	11.33
55	2	2	8	104	9	4.29	1.231	2.72	1.02	11.99
56	2	2	11	103	13	13.98	3.995	11.33	1.33	53.33

Table 19 (continued)

Obs	location	catch_ID	month	Vessel_ ID	n	m_CPUE	stdmean	med_CPUE	CPUE_2.5	CPUE_97.5
57	2	2	12	103	5	4.55	1.272	4.44	1.11	8.89
58	2	10	6	103	16	15.13	2.498	14.17	1.43	44.67
59	2	10	6	104	9	10.96	2.608	9.09	2.73	23.57
60	2	10	7	51	10	15.67	2.194	14.50	8.00	26.00
61	2	10	7	58	6	5.00	2.500	2.50	2.50	17.50
62	2	10	7	103	12	21.78	1.746	22.93	11.43	30.00
63	2	10	11	103	3	3.14	0.831	2.67	2.00	4.76
64	2	11	1	103	10	26.48	7.849	26.67	2.00	83.33
65	2	11	6	51	2	7.33	2.000	7.33	5.33	9.33
66	2	11	6	103	5	16.02	6.704	10.56	1.43	37.14
67	2	11	6	104	2	9.10	4.545	9.10	4.55	13.64
68	2	11	7	51	2	3.50	0.500	3.50	3.00	4.00
69	2	11	7	58	1	2.50	.	2.50	2.50	2.50
70	2	11	7	103	1	9.39	.	9.39	9.39	9.39
71	2	11	8	104	2	6.05	3.025	6.05	3.02	9.07
72	2	12	1	103	23	21.42	2.191	22.67	5.33	41.33
73	2	12	6	51	8	18.58	3.538	17.67	8.00	32.00
74	2	12	6	103	10	10.75	3.202	6.52	1.90	35.71
75	2	12	6	104	13	42.21	8.892	35.29	8.18	95.00
76	2	12	7	51	8	17.29	4.672	12.50	4.00	44.00
77	2	12	7	58	8	10.63	2.690	8.34	2.50	22.50
78	2	12	7	103	12	6.41	1.388	5.96	0.00	13.67
79	2	12	8	103	1	25.33	.	25.33	25.33	25.33
80	2	12	8	104	9	17.44	3.184	16.47	6.80	31.97
81	2	12	11	103	8	14.44	2.888	12.67	5.56	29.05
82	2	12	12	103	4	36.53	12.201	26.95	20.00	72.22
83	2	13	1	103	13	5.01	1.236	3.33	1.33	16.67
84	2	13	6	103	1	1.33	.	1.33	1.33	1.33
85	2	13	6	104	8	4.02	0.763	3.20	2.73	9.09
86	2	13	7	51	4	1.67	0.578	2.00	0.00	2.67
87	2	13	7	58	7	2.86	0.510	3.33	0.83	5.00
88	2	13	7	103	3	0.87	0.231	0.67	0.61	1.33

Table 19 (continued)

Obs	location	catch_ID	month	Vessel_ ID	n	m_CPUE	stdmean	med_CPUE	CPUE_2.5	CPUE_97.5
89	2	13	8	103	1	6.00	.	6.00	6.00	6.00
90	2	13	11	103	2	4.45	2.225	4.45	2.22	6.67
91	2	14	6	103	2	2.19	0.190	2.19	2.00	2.38
92	2	14	6	104	3	3.72	0.993	2.73	2.73	5.71
93	2	14	7	51	2	1.00	1.000	1.00	0.00	2.00
94	2	14	7	103	1	3.33	.	3.33	3.33	3.33
95	2	15	1	103	5	5.78	1.431	6.00	0.67	8.89
96	2	15	8	104	1	5.67	.	5.67	5.67	5.67
97	2	37	6	51	1	2.67	.	2.67	2.67	2.67
98	2	75	7	58	1	0.83	.	0.83	0.83	0.83
99	3	1	5	102	6	85.14	18.668	78.16	37.95	161.92
100	3	2	5	102	6	14.86	7.809	6.25	1.11	50.00
101	3	10	5	102	3	5.69	2.295	5.77	1.67	9.62
102	3	11	5	102	1	4.17	.	4.17	4.17	4.17
103	3	12	5	102	6	2.35	1.126	1.27	0.00	6.54
104	3	13	5	102	5	3.16	1.020	2.05	0.92	6.15
105	3	14	5	102	2	3.47	0.385	3.47	3.08	3.85
106	4	1	1	101	23	1146.55	53.278	1112.95	762.30	1772.50
107	4	1	1	102	10	261.04	38.132	280.25	100.65	480.48
108	4	1	2	102	4	290.18	104.336	305.54	47.35	502.29
109	4	1	5	55	3	55.17	15.590	43.81	35.71	86.00
110	4	1	5	102	6	127.93	31.318	94.20	67.43	275.00
111	4	1	6	103	4	48.24	12.119	46.67	24.29	75.33
112	4	1	12	102	4	117.37	40.519	124.68	15.58	204.55
113	4	2	1	101	21	34.93	4.356	36.11	5.71	67.50
114	4	2	1	102	9	10.70	1.796	11.43	1.62	17.62
115	4	2	2	102	4	32.01	13.014	28.11	6.12	65.71
116	4	2	5	55	1	2.37	.	2.37	2.37	2.37
117	4	2	5	102	6	7.38	1.976	7.09	1.05	15.38
118	4	2	6	103	2	1.62	0.285	1.62	1.33	1.90
119	4	2	12	102	3	9.31	2.067	11.04	5.19	11.69

Table 19 (continued)

Obs	location	catch_ID	month	Vessel_ ID	n	m_CPUE	stdmean	med_CPUE	CPUE_2.5	CPUE_97.5
120	4	10	1	101	11	13.89	2.678	11.27	7.50	38.96
121	4	10	1	102	10	7.55	1.246	6.97	1.95	13.71
122	4	10	2	102	4	7.38	2.510	8.25	1.22	11.79
123	4	10	5	102	1	2.38	.	2.38	2.38	2.38
124	4	10	6	103	1	5.00	.	5.00	5.00	5.00
125	4	10	12	102	1	3.90	.	3.90	3.90	3.90
126	4	11	1	101	13	24.85	4.243	20.00	4.99	57.38
127	4	11	1	102	7	30.55	13.239	10.00	6.86	93.51
128	4	11	2	102	1	4.29	.	4.29	4.29	4.29
129	4	11	5	55	3	24.21	13.966	16.01	5.18	51.43
130	4	11	5	102	1	2.63	.	2.63	2.63	2.63
131	4	11	6	103	6	25.73	7.885	17.15	8.00	56.25
132	4	11	12	102	4	20.46	7.179	19.48	3.90	38.96
133	4	12	1	101	18	77.45	15.973	48.75	16.19	209.37
134	4	12	1	102	8	12.17	2.684	13.10	1.30	20.54
135	4	12	2	102	3	7.21	3.141	7.50	1.63	12.50
136	4	12	5	102	6	34.51	5.320	33.28	21.58	58.08
137	4	12	6	103	3	1.78	0.446	1.43	1.25	2.67
138	4	12	12	102	3	7.14	1.632	8.44	3.90	9.09
139	4	13	1	101	17	22.69	3.338	18.43	5.09	50.00
140	4	13	1	102	7	3.14	0.880	2.86	0.48	7.62
141	4	13	2	102	4	6.33	1.026	6.84	3.43	8.21
142	4	13	5	55	2	5.30	3.000	5.30	2.30	8.30
143	4	13	5	102	6	20.67	1.739	22.01	15.00	24.76
144	4	13	6	103	2	2.13	0.795	2.13	1.33	2.92
145	4	13	12	102	3	2.60	0.751	2.60	1.30	3.90
146	4	14	1	101	1	12.99	.	12.99	12.99	12.99
147	4	14	2	102	1	3.57	.	3.57	3.57	3.57
148	4	14	5	102	2	2.01	0.855	2.01	1.15	2.86

Table 20. Frequency (and percentage) of hauls in which different categories of haddock and cod occurred for different experimental areas.

Catch	Cashes Ledge 448	Eastern US/Canada Area 735	Platts Bank 448	WGOM 448
Landed haddock	28 (96.6%)	116 (82.3%)	6 (100%)	54 (100%)
Sub-legal haddock	25 (86.2%)	109 (77.3%)	6 (100%)	46 (85.2%)
Dropoff haddock	9 (31.0%)	56 (39.7%)	3 (50%)	28 (51.9%)
Discarded haddock	12 (41.4%)	14 (9.9%)	1 (16.7%)	35 (64.8%)
Landed cod	27 (93.1%)	90 (63.8%)	6 (100%)	41 (75.9%)
Sub-legal cod	19 (65.5%)	32 (22.7%)	5 (83.3%)	41 (75.9%)
Dropoff cod	8 (27.6%)	8 (5.7%)	2 (33.3%)	4 (7.4%)
Discarded cod	4 (13.8%)	4 (2.8%)	0 (0%)	0 (0%)
Total numer of hauls	29	141	6	54

Table 21. The frequency (and percentage) of hauls in which different categories of haddock and cod occurred for all the experimental areas combined.

Catch	Frequency	Percentage
Landed haddock	204	88.7%
Sub-legal haddock	186	80.9%
Dropoff haddock	96	41.7%
Discarded haddock	62	27.0%
Landed cod	164	71.3%
Sub-legal cod	97	42.2%
Drop-off cod	22	9.6%
Discarded cod	8	3.5%
Total number of hauls	230	

Table 22. The average catch rate (lbs/1000 hooks and number of fish per 1000 hooks) for landed and discarded haddock and cod. The numbers in the parentheses are standard errors.

lbs (standard error) per 1000 hooks	Cashes Ledge 448	Eastern US/Canada Area 735	Platts Bank 448	WGOM 448	**Overall**
Landed haddock	77.3 (14.17)	345.2 (26.94)	85.1 (18.67)	587.7 (71.23)	363.9 (26.25)
Discarded haddock	16.5 (2.78)	16.4 (0.93)	11.0 (4.81)	19.8 (1.82)	17.3 (0.84)
Landed cod	33.7 (7.91)	19.6 (1.75)	2.3 (1.13)	42.6 (8.61)	26.5 (2.64)
Discarded cod	5.2 (0.81)	3.7 (0.41)	3.2 (0.71)	13.3 (1.88)	7.2 (0.76)
Number (standard error) per 1000 hooks					
Landed haddock	32.4 (6.07)	120.8 (9.99)	34.6 (7.58)	198.0 (23.40)	126.6 (9.20)
discarded haddock	7.2 (1.16)	9.9 (0.71)	5.9 (2.80)	8.0 (0.80)	8.8 (0.48)
Landed cod	4.1 (0.62)	2.9 (0.30)	0.6 (0.30)	4.7 (0.65)	3.5 (0.26)
discarded cod	1.7 (0.24)	1.1 (0.09)	1.4 (0.30)	4.9 (0.65)	2.6 (0.28)

Table 23. The average catch rate in weight (lbs per 1000 hooks) of landed and discarded haddock and cod for Norbait and squid in fishing trip 48 in which Norbait was used in 3 hauls and squid was used in one haul. Numbers in the parentheses are average catch rate measured in number (number of fish per 1000 hooks)

	Norbait 3 hauls	Squid 1 Haul
Landed haddock	83.3(31.1)	20(7.5)
Discarded haddock	5.2(2.96)	0(0)
Landed cod	29.4(6.82)	305(70.8)
Discarded cod	20.6(8.3)	88.4(35)

Table 24. Catch rate in lbs per 1000 hooks (numbers in parentheses are catch rate in number per 1000 hooks) and percentage of catch for different categories of haddock and cod for the haul when squid was used on fishing trip 48.

	Catch rate	Percentage of catch (%)
Landed haddock	20 (7.5)	4.7 (6.5)
Sub-legal haddock	0 (0)	0 (0)
Dropoff haddock	0 (0)	0 (0)
Discarded haddock	0 (0)	0 (0)
Landed cod	305 (70.8)	72.2 (61.6)
Sub-legal cod	76.7 (32.5)	18.1 (28.3)
Dropoff cod	11.7 (2.5)	2.8 (2.2)
Discarded cod	0 (0)	0 (0)

Table 25. The average catch rate (lbs per 1000 hooks) of landed and discarded haddock and cod for Norbait and squid in fishing trip 61 in which Norbait was used in 12 hauls and herring was used in one haul.

	Norbait 12 hauls	Herring 1 Haul
Landed haddock	317.2(112.9)	370(131.7)
Discarded haddock	41.4(15)	2.2(3.4)
Landed cod	10.6(0.68)	0.8
Discarded cod	2.9(0.32)	0.8

Table 26. Catch rate in lbs (numbers in brackets are catch rate in number) and percentage of catch for different categories of haddock and cod for the haul when herring was used on fishing trip 61.

	Catch rate	Percentage of catch (%)
Landed haddock	370 (131.7)	53.6 (55.2)
Sub-legal haddock	1.7 (1.7)	0.2 (0.7)
Dropoff haddock	5 (1.7)	0.7 (0.7)
Discarded haddock	0 (0)	0 (0)
Landed cod	5 (0.8)	0.7 (0.3)
Sub-legal cod	1.1 (0.8)	0.5 (0.3)
Dropoff cod	0 (0)	0 (0)
Discarded cod	0 (0)	0 (0)

Table 27. Total catch (lbs) of cod, haddock, and yellowtail in fishing year 2005 in the Eastern US/Canada area 735.

Species	Landed	discarded	Total
Cod	157243	274055	431298
Haddock	939954	104743	1044697
Yellowtail	6434261	466807	6901068

Figure 1. The comparison of landed and discarded haddock recorded in the NMFS SeaSamp database and CCCHFA database.

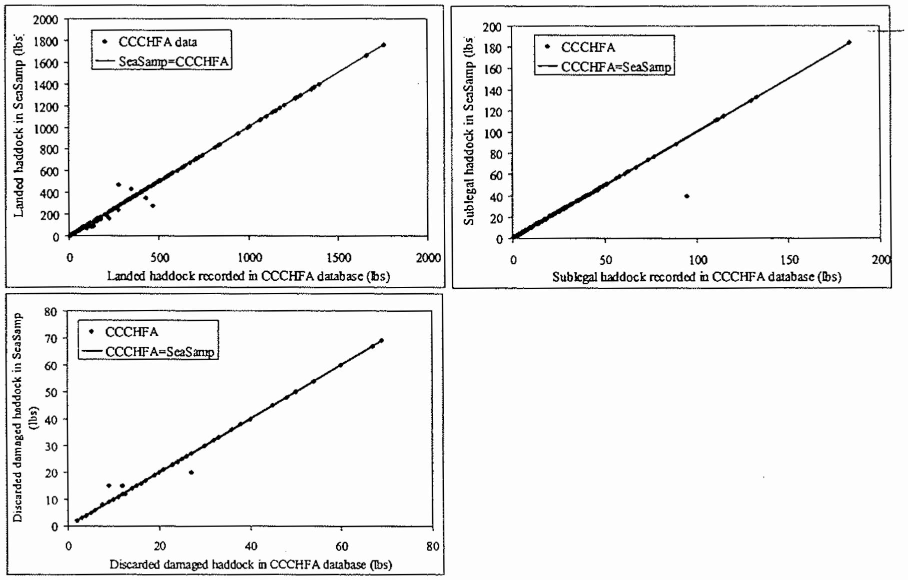


Figure 2. The comparison of landed and discarded Atlantic cod recorded in the NMFS SeaSamp database and CCCHFA database.

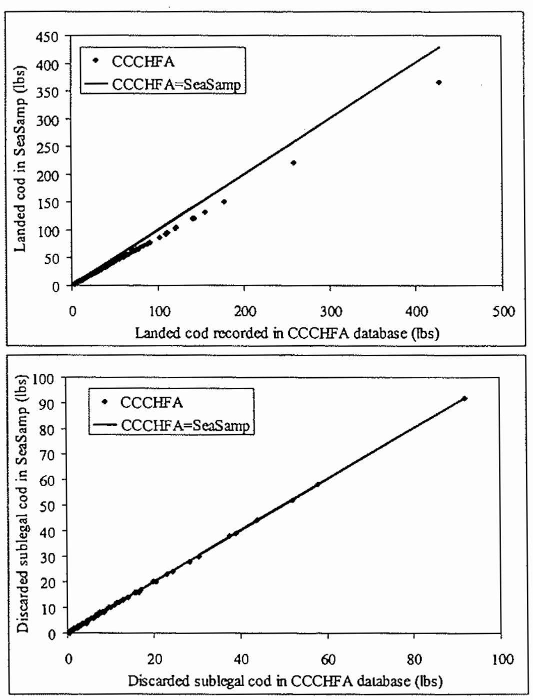


Figure 3. The percentage of catch rate (measured in lbs per 1000 hooks) of landed and discarded haddock and cod in different months and different areas when only haddock and cod were considered. The top left panel is for Cashes Ledge Area 448, top right panel is for Eastern US/Canada Area 735, bottom left panel is for Platts Bank Area 448, and Bottom right panel is for Western Gulf of Maine Area 448.

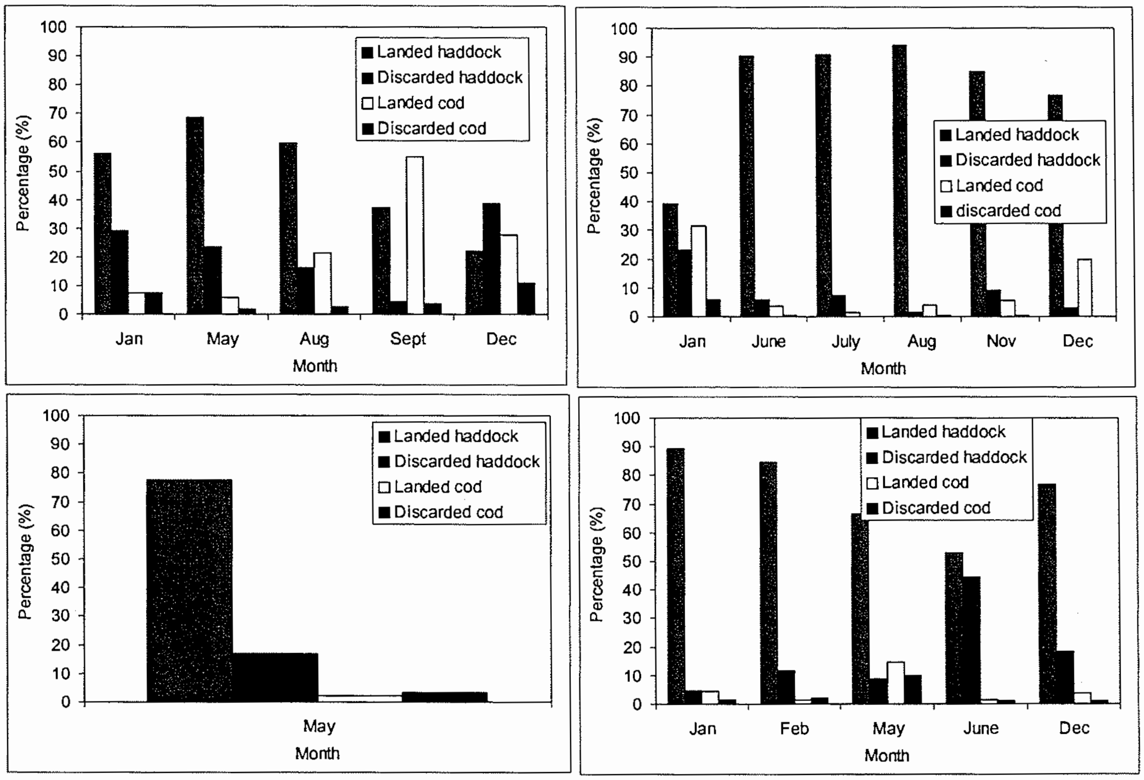


Figure 4. The percentage of catch rate (measured in lbs per 1000 hooks) of landed and discarded haddock and cod in different months and different areas when all species were considered. The top left panel is for Cashes Ledge Area 448, top right panel is for Eastern US/Canada Area 735, bottom left panel is for Platts Bank Area 448, and Bottom right panel is for Western Gulf of Maine Area 448.

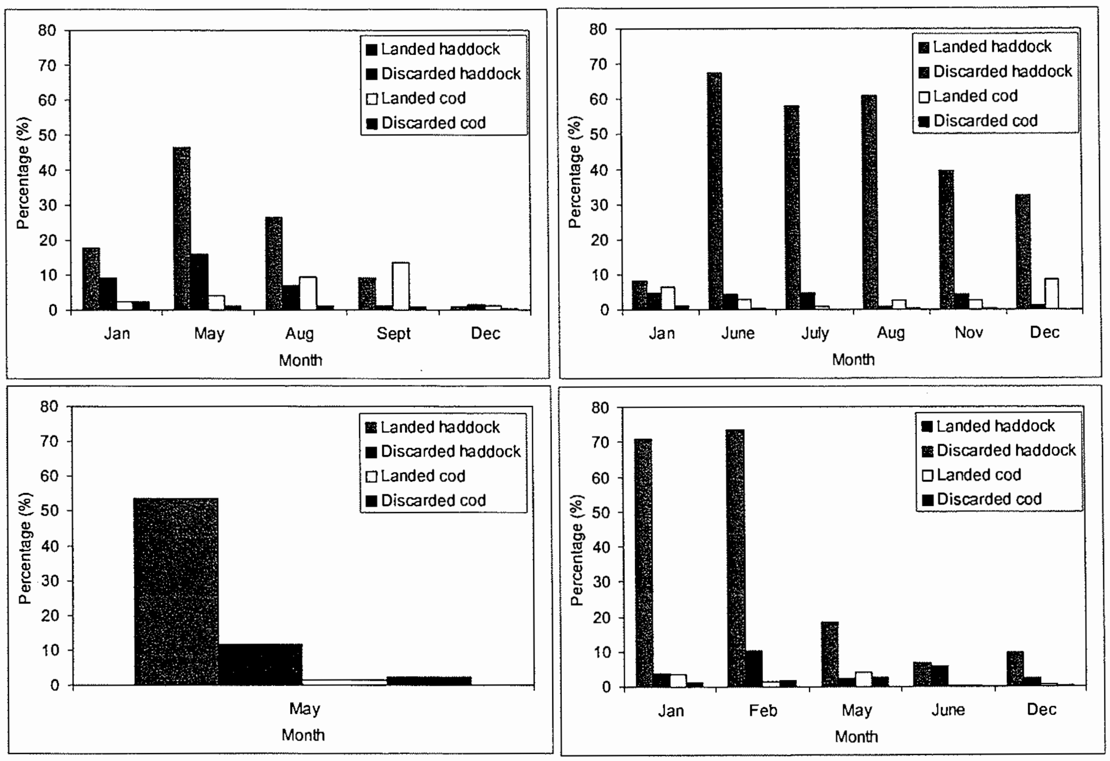


Figure 5. The percentage of catch rate (measured in number per 1000 hooks) of landed and discarded haddock and cod in different months and different areas when only haddock and cod were considered. The top left panel is for Cashes Ledge Area 448, top right panel is for Eastern US/Canada Area 735, bottom left panel is for Platts Bank Area 448, and Bottom right panel is for Western Gulf of Maine Area 448.

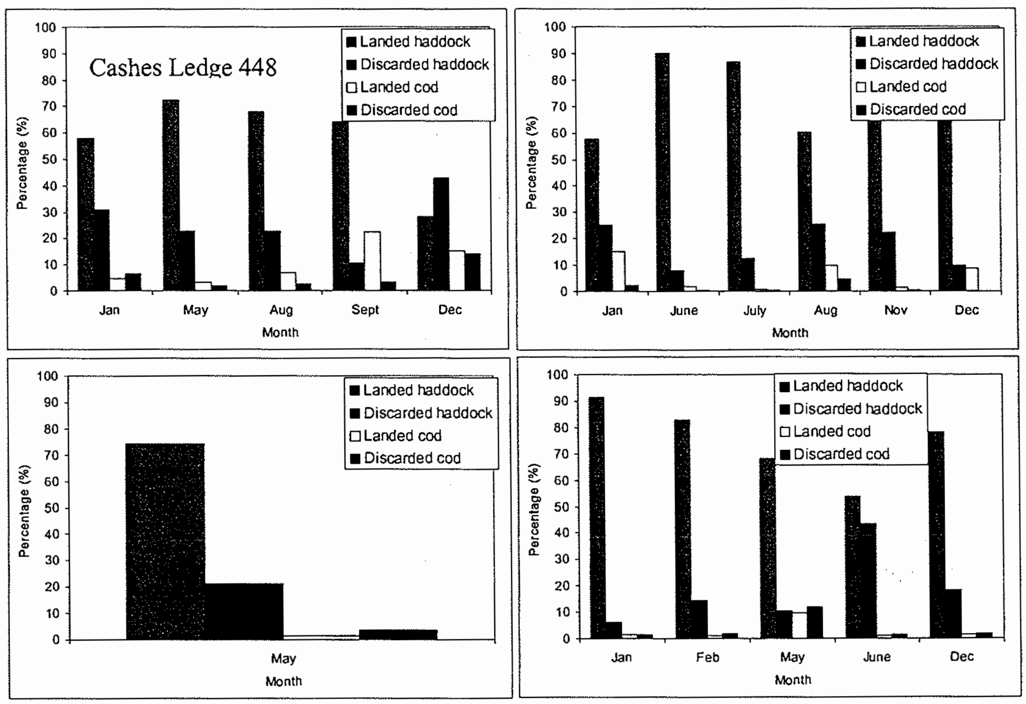


Figure 6. The percentage of catch rate (measured in number per 1000 hooks) of landed and discarded haddock and cod in different months and different areas when all species were considered. The top left panel is for Cashes Ledge Area 448, top right panel is for Eastern US/Canada Area 735, bottom left panel is for Platts Bank Area 448, and Bottom right panel is for Western Gulf of Maine Area 448.

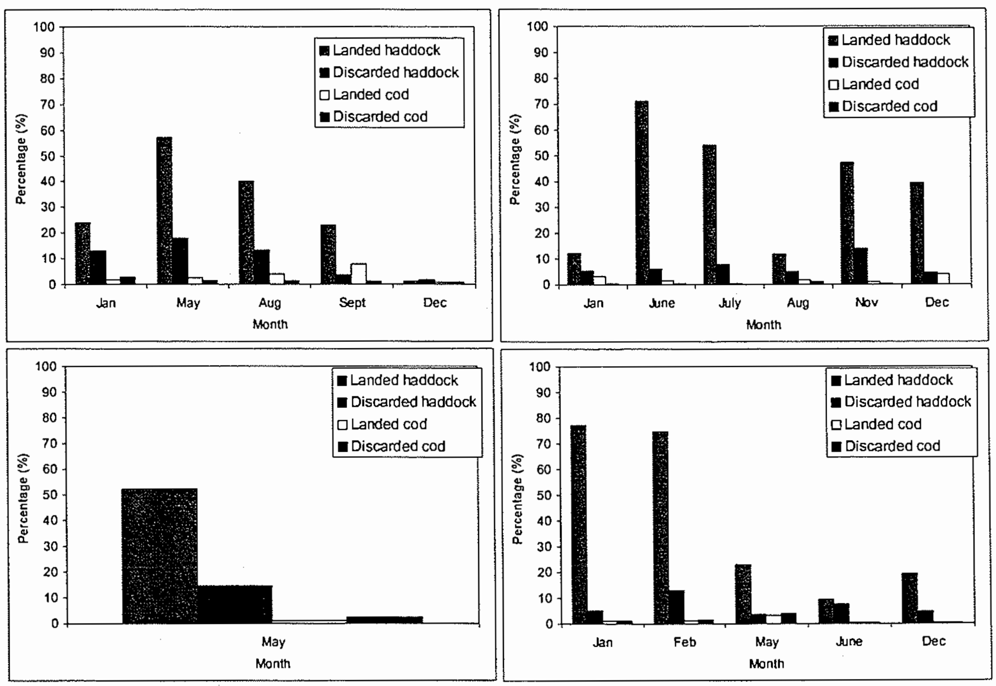


Figure 7. The percentage of catch rate (measured in lbs per 1000 hooks) of landed and discarded haddock and cod for different vessels and different areas when only haddock and cod were considered. The top left panel is for Cashes Ledge Area 448, top right panel is for Eastern US/Canada Area 735, bottom left panel is for Platts Bank Area 448, and Bottom right panel is for Western Gulf of Maine Area 448.

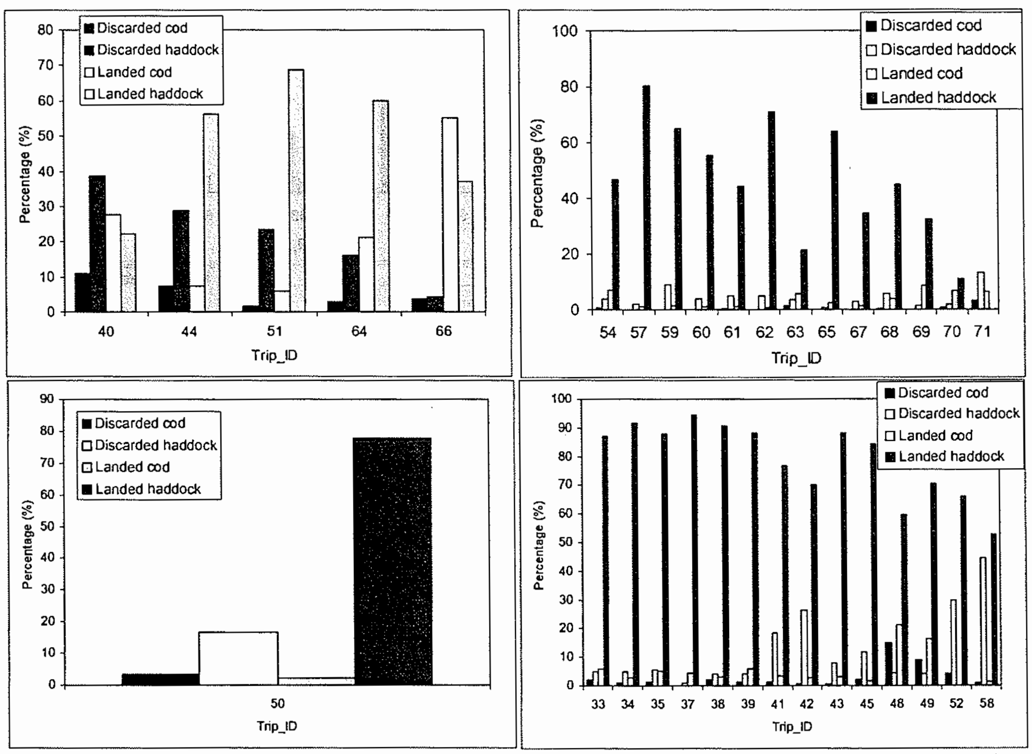


Figure 8. The percentage of catch rate (measured in lbs per 1000 hooks) of landed and discarded haddock and cod for different vessels and different areas when all species were considered. The top left panel is for Cashes Ledge Area 448, top right panel is for Eastern US/Canada Area 735, bottom left panel is for Platts Bank Area 448, and Bottom right panel is for Western Gulf of Maine Area 448.

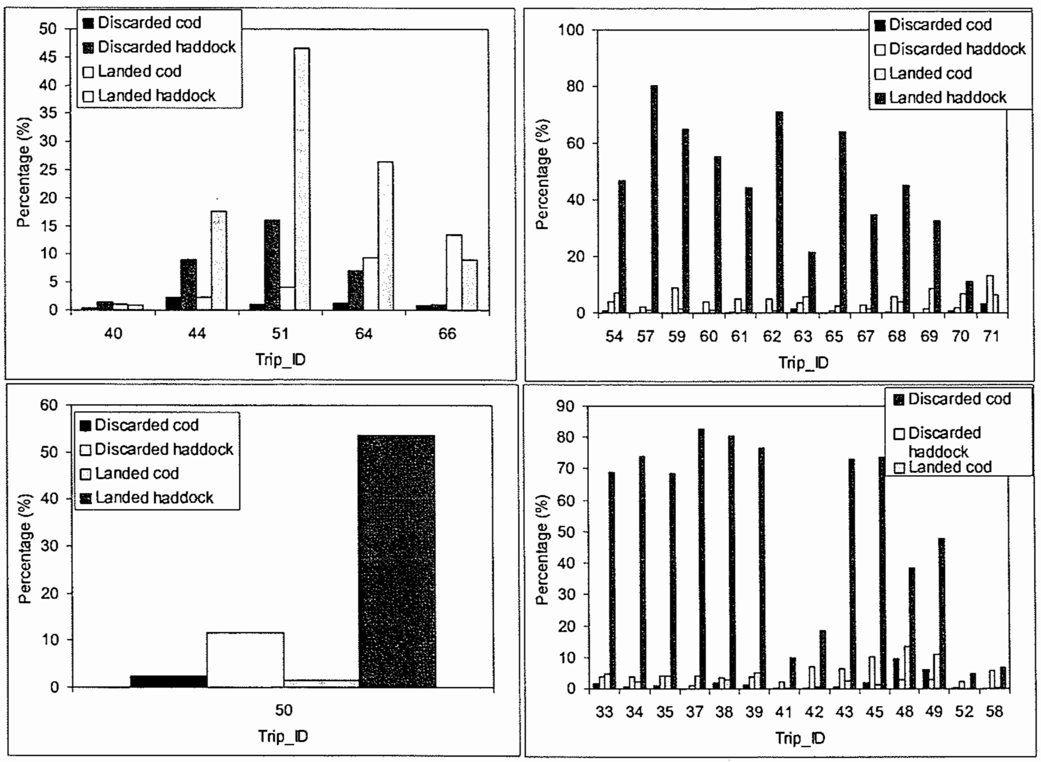


Figure 9. The percentage of catch rate (measured in number per 1000 hooks) of landed and discarded haddock and cod for different vessels and different areas when only haddock and cod were considered. The top left panel is for Cashes Ledge Area 448, top right panel is for Eastern US/Canada Area 735, bottom left panel is for Platts Bank Area 448, and Bottom right panel is for Western Gulf of Maine Area 448.

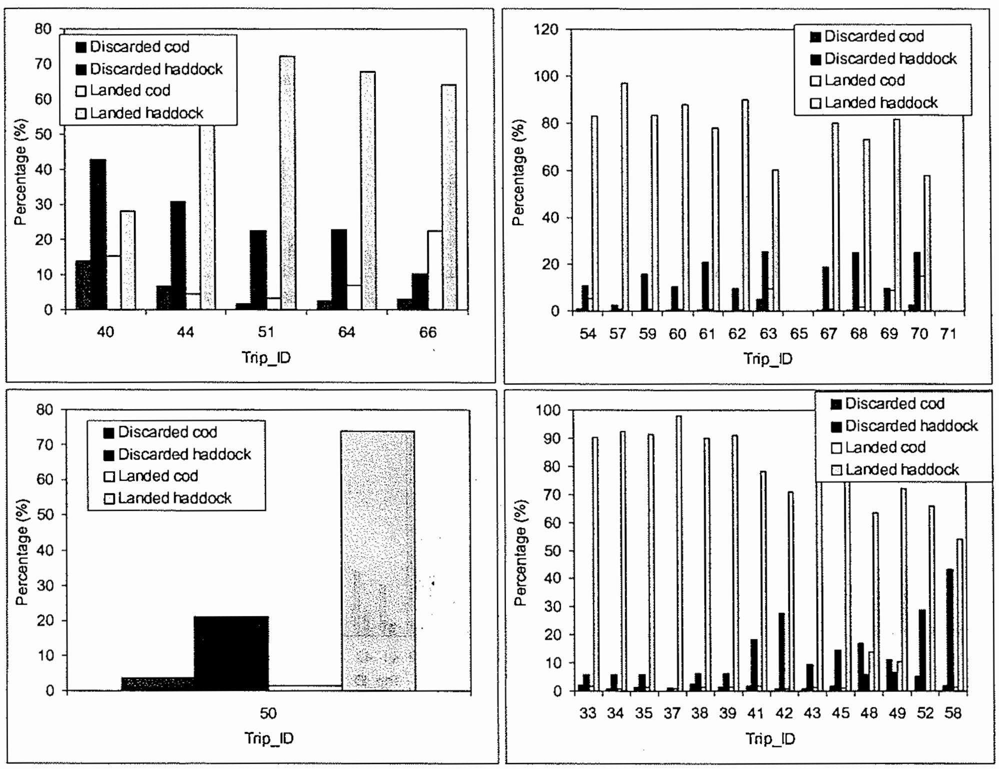
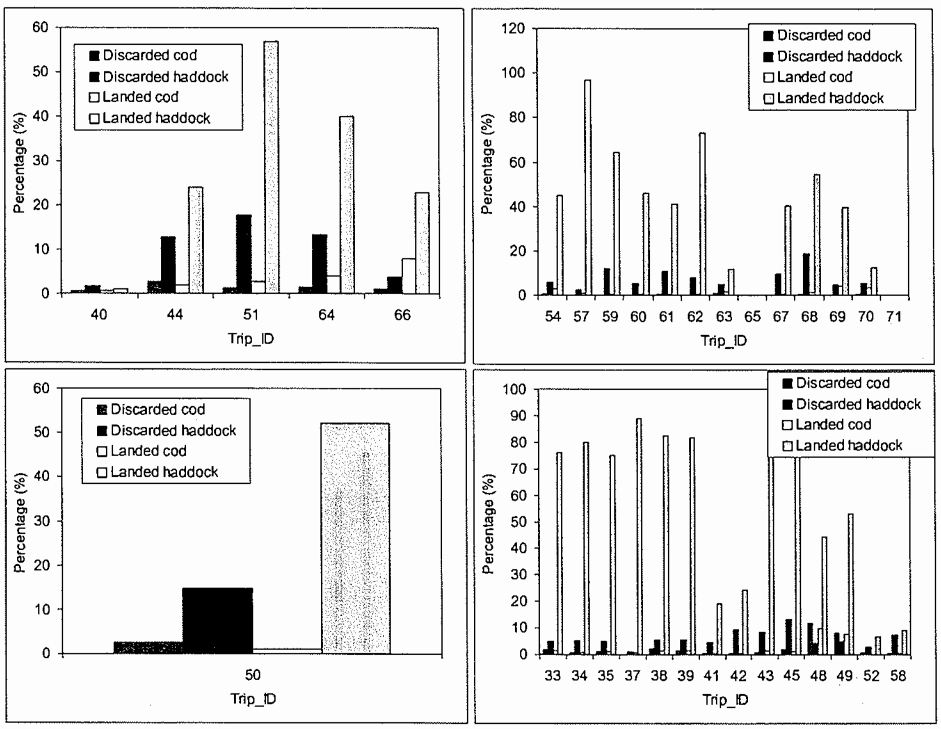


Figure 10. The percentage of catch rate (measured in number per 1000 hooks) of landed and discarded haddock and cod for different vessels and different areas when all species were considered. The top left panel is for Cashes Ledge Area 448, top right panel is for Eastern US/Canada Area 735, bottom left panel is for Platts Bank Area 448, and Bottom right panel is for Western Gulf of Maine Area 448.



Appendix B:

CCCHFA Closed Area Haddock Projects

Closed Area I
Closed Area II
Cashes Ledge
Platts Bank
Western Gulf of Maine

Sampling Manual

2004

REMSA, Inc.
Tami Applebee
Jesse Agee
Lynn Collier

TABLE OF CONTENTS

Closed Area Haddock Project Overview

The vessels participating in the Cape Cod Commercial Hook Fishermen's Association (CCCHFA) Haddock Closed Area Projects are executing Exempted Fishing Permits (EFP's) and have been allowed into defined portions of the designated closed areas to target haddock with demersal (bottom) longline gear. These permits (which every vessel should have a copy of while fishing) have been granted providing all unexempt regulations are followed. These areas are normally closed to all bottom gear. The study participation period is from May 2004 to February 2005.

"The purpose of this study is to determine the best spatial and temporal location for a directed haddock hook-gear fishery in Closed Area (name), while having minimal impact to cod (EFP DA-338)." A contingency of the EFP is that independent biologists are on-board for every trip verifying fishing effort and catch. As with all hypotheses, data must be collected objectively, without foregone conclusions.

Sampling Protocol

1-BEFORE YOUR TRIP

Please eat well, get plenty of sleep and drink a lot of fluids the day before your trip - you may go16+ hours without eating, drinking or sleeping. And keep in mind that if you decide to over-socialize the night before you go out to sea, you will most likely encounter the worst kind of seasickness!

Bring your own lunch, water, watch, rain gear, boots and gloves. Make sure you dress appropriately. Wear warm clothes that you don't plan on ever wearing in public again. If you don't have your own rain gear, the coordinators may be able to arrange some for you. If you are purchasing boots or raingear, please feel free to ask your coordinator, fellow data collectors, or crew for advice. All sampling gear will be provided.

LOCATING YOUR VESSEL:

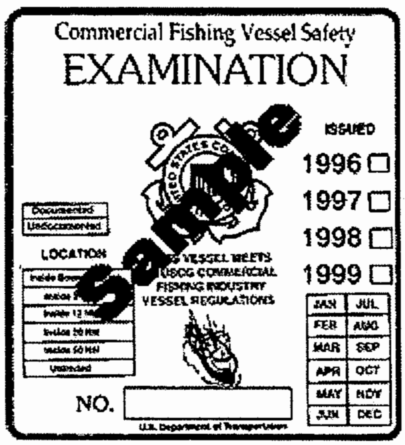
When the coordinator (or captain) calls you to schedule a fishing trip, they will tell you where you should be and what time you should be there. Fishing trips can start as early as midnight, so for those of you who live more than a half hour away from Chatham (or another area) it may be convenient to arrange to come the evening before and stay the night. The coordinator can help you with sleeping arrangements.

Directions will be provided to the dock and you will be given a description of the boat. Maps are located in the appendix. You should arrive at the dock at least 15 minutes early. You need to leave yourself enough time to brief and pick up your sampling gear before you go to the dock. **Please fill out and sign your gear list before leaving the building**. You are responsible for the return of **ALL** gear (well-maintained) in reasonable condition (and definitely clean).

AT THE DOCK:

Please introduce yourself to the captain and crew when you arrive.

All vessels participating in the program are required to have a current USCG fishing vessel safety examination sticker. The first thing you should do when you locate your boat before you put your gear on board is ensure the vessel has a current USCG safety decal (shown below).



Record the Decal # and Date Issued on the back of the CAPTAIN INTERVIEW form under VESSEL INFORMATION.

Also ask for a safety briefing by the captain or crew. Ensure the appropriate equipment is onboard. Check the life raft, the EPIRB and the survival suits. The life raft should be able to accommodate the number of people going on the trip (usually four). Check the expiration date on the life raft and make sure that the hydrostatic release has been properly attached (see the diagram in the appendix). Check the expiration date on the EPIRB and make sure that it is turned "on" (or activated in the appropriate manner). The EPIRB should be attached to the boat in such a way that it can float free (not inside the house). Check to make sure that every person on board has their own survival suit. When you bring your gear on board make sure that you either store your survival suit yourself or know exactly where it is and have easy access to it.

Indicate whether or not you were provided with a safety briefing on the back of the CAPTAIN INTERVIEW form under VESSEL INFORMATION.

Do not get on the boat if any of these three requirements are not met: proper life raft, proper EPIRB, sufficient number of survival suits. All of the captains have been informed that samplers will not accompany them if these safety requirements are not met.

Be aware that as an independent contractor, you have the right to refuse embarkation on any vessel involved in the Closed Area Haddock Project deemed unsafe by your own judgment (weather conditions included). In this event, please contact your coordinator as soon as possible and inform them of the situation.

If you should arrive at the dock and cannot find the vessel, locate a phone and call the captain (a contact list for captains is included in the appendices). Sometimes plans change, most often due to weather. If the vessel decided not to fish and did not contact you before you left for the dock or if everyone is at the dock and the captain decides not to fish, REMSA has made arrangements for a stipend to be paid. If you are unable to reach the captain, try to contact your coordinator. This may occur in the middle of the night and it is more than likely that your coordinator will either be fishing or getting ready to fish but please make the effort. If the vessel does not appear within one hour of the scheduled sailing time, you may consider the trip cancelled.

2-DURING YOUR TRIP:

STEAMING:

When the boat leaves the dock record the time (24-hour) on the Captain Survey sheet. Please use military time or at least specify AM/PM. After the boat leaves the dock it will steam for several hours. **If any time is lost from the steam (i.e. to pick up fuel, etc.) please note the amount of time lost and the reason.**

Usually these boats only fish with two people: the captain and the deck person. For this project, a third person has been added to help you collect haddock and cod lengths. **This is a good time to have a dialogue with your 'third crew'** (see HAULING GEAR for more information) to ensure that they are familiar with the way lengths and weights are to be collected. Most third crew have been trained by your coordinator, but in the event of constrained resources someone may be filling in. Also, protocol may change under certain circumstances (i.e. bait study, dedicated trips, etc) and third crew may not be aware of said changes. Trained third crew have been told that protocol could change at any time and they are to follow your instructions regarding data collection.

Also have a discussion with your captain and crew regarding vessel operations during fishing i.e. flow of fish, who works where etc. Ask the captain how he usually relays information to the data collector (does he call out LORAN positions and depth, or does he prefer to write them down for you?). Most prefer to write the information down for you to copy later but you should make your best effort to verify the information yourself. The captain can fill out the CAPTAIN INTERVIEW during the steam to the fishing grounds, but most prefer to do this on the steam back to port when it is most often during daylight hours. This is also true for the 'six month questions'. These need to be filled out twice per year. Please check with your coordinator to see if your vessel's six month questions need to be completed.

Some boats have bunks with bedding where you can sleep during the steam. But don't count on it. Wear warm comfortable clothes and consider bringing a blanket and sleeping mat that you can get dirty in case you end up sleeping on the floor of the house or on a tote. **If leaving from the port of Chatham it is safe practice to wait until after passing the bar to go to sleep.**

If you sleep during the steam be sure to ask the captain before you lie down to wake you in plenty of time before he sets the gear. **Captains have been instructed to give you at least 15 minute's notice.** You may also ask to be woken if marine mammals or other species of interest are sighted.

You will hear and feel the boat slow down when you reach the fishing grounds. When the boat slows down you should get up and get organized because gear will be set shortly.

SETTING GEAR:

You will need to get your foul weather gear on, have a deck sheet on your clip board, a sharpened pencil and your thumb counter. **Record Vessel Name, Date, Your Name, Set # and Bait Type on the deck sheet.** If you are on a vessel participating in the bait study (any bait being set in addition to/other than herring), please ask the captain which direction the tide/current is running and what angle he is setting his gear at. **Fill this information in under Notes on the deck sheet.**

You will know that they are getting ready to set because the deck crew will have a high flier (looks like a giant dart), buoys and some tubs of gear ready to go over the rail. A tub of gear is referred to as a bundle. A "string" consists of a number of bundles tied together.

When the captain gives the signal the crew will throw the high flier, buoy and buoy line over board.

It takes awhile for the buoy line to pay out. **Write down the Start Time, depth and Coordinates on the deck sheet**. If the coordinates are in Lat/Lon please cross out LORAN on your deck sheet (Appendix F). The depth can be found on the sounder (usually near other equipment by the helm). If you don't know where to get some of this information ask the captain.

When the buoy line is paid out the anchor and the gear will go over. Be ready to start tallying hooks with your thumb counter. Choose a position on deck to stand or sit where you will not be in the way of the crew and you can still see the hooks going overboard. This can be challenging because the decks are so small but do your best. If you are on a vessel using an autobaiter or otherwise setting gear mechanically, you will need to do a hook count of three bundles twice per day. This can be done before gear is set, or after it is hauled. Gear will likely be 'racked' and ready to go. Use your thumb counter.

Be aware of your counter when you are tallying and glance down at it occasionally to make sure that it is working correctly - sometimes they get stuck or the mechanism wears out. If this happens, stop tallying and start with a different thumb counter on the next bundle (do not use the defunct thumb counter again--return it to your coordinator and notify them that it needs repair).

SPECIAL NOTE ON SEABIRDS: Birds often feed on the line as it is being set. One would sometimes think they like the bait better than the fish!

If you see any seabirds get hooked and taken down with the gear, please include this in your notes on the deck sheet. Try to identify the bird. Write down key characteristics. Keep a close eye on this particular bundle during the haul to see if the bird comes back up on the line.

Also make notes of species of interest, uncommon species or unusual behavior.

Sometimes bundles have tangles in the line (these are also called snarls or hickeys). When this happens a big clump of line will go over all at once and you can't tell how many hooks were deployed. Try to estimate. If the tangle is too big and you can't estimate the number of hooks that went over in it, stop tallying and make a note. Start a new tally on the next bundle.

Note the bundle # and the number of hooks/bundle (usually ~300) on the deck sheet. If there are more than three bundles, just use the blank space on your page or the notes section to record hook count sure to write down on the deck sheet that there was a tangle.
As you are tallying, pay attention to how many weights are used in the set if any at all. These may be called 'sash weights'. Weights may be placed in the middle of a bundle, between bundles or not used at all (other than the anchors).

Record any other problems during the setting of gear in your notes.

After the last hook goes over, this is a good time to ask the captain what the vessel speed was during the set. **When the second high flyer goes over, write down the vessel speed (when setting), depth, End Time, and Coordinates on the deck sheet. Also note the # High Fliers, Buoys, # Weights, Total # Bundles and Total # Hooks on the deck sheet** (if you missed a bundle due to a snarl or a defunct counter, you may use an average hook count for the total).

JIG VESSELS:
There is a chance that you may be assigned to a vessel using rod and reels. These vessels catch fewer fish, work at a slower pace, and usually have one crew member. The information you collect is the same, but the manner is significantly different.

Setting and hauling are not the distinct entities they are with a longline/tub-trawl vessel. A haul is the time a vessel spends drifting. There will be a location for when the vessel first dropped lines and then a second location for when the vessel moves (goes into gear). In between keep track of 1) how many lines are being used 2) how many hooks on each line 3) how many hooks lost and 4) how many times lines were retrieved.

On these vessels the data collectors do the lengthing in addition to tallying and weighing. You can use a blank waterproof paper and put several hauls on one sheet. Complete the Captain Survey as completely as possible. The cost information applies but appropriate gear information includes type of line, test weight, and brand/size of hooks. This is a new aspect to the program and to the fishery so please describe the gear used, problems encountered and ask questions.

The captain will most likely set all of his strings one after another on one slack tide, without taking any time in between. As soon as one set ends get ready for the next one. After the last string has been set the captain will likely steam over to the first set and haul it.

HAULING GEAR:

After the last string is set, ask the captain if he intends to haul the gear in the same order that he set it. **Sometimes gear will be hauled in a different order than it was set** - this is fine, but it needs to be recorded that way on the deck sheet. It is perfectly acceptable to have a deck sheet with information on it for Set # 1 and Haul #3 as long as the two numbers refer to the same string of gear on the same sheet! One way to keep track of strings without having to ask the captain is to write down the identifying information on the buoy when the string is set. Also, the coordinates should be very close if not identical between the set and the haul.

Gather the equipment together for the person who will be collecting the lengths (third crew) before the haul. They will need the wooden fish cradle, a length strip, a means of attaching the length strip to the cradle (thumb tacks or screws), scales (10 and 100lb), a "third crew sheet" on a clipboard and a sharpened pencil. Please ensure that the strips are labeled correctly. It also helps to place marks indicating legal sizes for haddock and cod.

a) Start of Haul

NOTE: If there are stability issues with a vessel during a trip, you have the right to ask the captain to stop hauling and 'buoy off' while the fish gets put away. Approach this situation carefully. Some will take offense. If you have any questions regarding stability, please contact me any time. I consider a boat to be unstable if the deck is underwater (water continually coming up through scuppers), has a list, or if a large percentage of the fish is on one side or the other. If there are ANY safety issues during a trip, you are to note it on your deck sheet with a good description of the scenario. I will be keeping records on any vessel issues that arise.

When the high flier and buoy are picked up and brought on board record the Haul #, Start Time, and coordinates on the deck sheet. Don't forget to note the weather, sea surface temperature, wind speed/direction and wave height at some point during or shortly after the haul.

b) Tally

Your main job during the haul is to tally 100% of all species and their disposition (kept or discarded) at the rail and fill out the deck sheet. Make sure you are in position to start tallying fish as soon as the anchor comes up (a good place is the starboard stern of the boat--this should give you a good view of the incoming gear as well as keep you out of the crew's way). You cannot be distracted at any time during the haul. You need to be able to account for every single organism that comes up on the line and all drop-offs.

drop-off: An organism that is hooked on the gear and breaks the surface of the water but does not make it on to the boat because it falls off the hook and escapes. You will notice as you look down the line into the water that organisms drop off and swim or float away that do not make it to the surface: these are not recorded as drop-offs because they did not break the surface of the water and could not be positively identified. Tally the haddock using the thumb counter. Do not include juvenile haddock or drop-off haddock in your thumb counter tally-there is space on the deck sheet to make tick marks for juvenile haddock and drop-off haddock.

The most common species seen are already listed on the deck sheet. Make sure you are especially familiar with their identification. Blank spaces are available for tally of additional species. Please enumerate 100% of all catch, including other organisms such as invertebrates, as well as any debris (describe as accurately as possible i.e. rubber boot, soda can). Some by-catch is marketable, such as white hake, monkfish and cusk. Be aware that most captains (but not all) will retain these fish. It is important to distinguish tallies between kept and discarded species.

Warning: fishermen speak their own fish jargon. The name that they know a fish by may not be the name that the rest of the world knows it by. Take what they say about fish ID with courtesy, gratitude and a grain of salt. There are no such things as "good hake" or "bad hake."

Sometimes sharks or marine mammals feed on the catch (Section **e**). Tally any fish 'parts' as they come up and describe (ie. heads) as a new category. If the species is haddock, please keep and weigh parts if this occurs during the 'last haul'. If it is not haddock, please keep and weigh parts during all hauls. **Make a note on your deck sheet and be sure to fill out the 'Special Situations' Form.**

If you cannot positively identify a fish, make as many notes as possible regarding its characteristics. If you have the fish 'in-hand', even better: use your ID Guide for assistance. Gather as much information as you can. Record the fork length and weight, describe it on the deck sheet (or blank sheet) and provide a sketch. Pay attention to the shape of the tail, the length and width of the caudal peduncle, the number of gill rakers on each arch, the color, the size of the jaw in relation to the orbit of the eye, the number of dorsal fins, the type of pelvic fins, general shape (round, flat, diamond etc.) and anything at all that looks distinctive about the fish - even a lack of distinctive features is worth writing down. There is a diagram of basic fish anatomy in the species ID booklet if you need a refresher. **Take photos to accompany your notes and be sure and fill out the photo log.**

You need to keep close track of all cod that come aboard. Cod data is one of the limiting factors for this project and you should make it a high priority. If too much cod fish are caught the project ends. So it is very important to account for and accurately measure and weigh each cod fish that comes on board. You will measure and weigh all adult cod between hauls. You may obtain assistance from the third crew with weighing other species.

careful release method: refers to the way that the captain/roller-man removes the hook from the mouth of the fish. There is a way to either straighten the hook or position the gaff on the hook and twist and shake so that the hook comes out without tearing the flesh of the fish. This method should be used on all juvenile haddock and cod and all barndoor skates. If the captain is not using this method, please tactfully bring it to his attention. If he continues to neglect this protocol, just make a note on your deck sheet.

Dogfish will be carefully released at the rail and do not need to be weighed. Skates are usually carefully released at the rail and do not need to be weighed. Sometimes, however skates are kept. You are to sort kept skates to species and weigh them along with the rest of the bycatch.

Skates are difficult to identify to species when not brought on board, but make your best attempt. **The exception is barndoor skates. This is a prohibited species.** Make every attempt to identify these skates accurately and tally them separately from the other skate species (space is provided). The easiest way to identify the barndoor skate is by its distinctly pointed nose, the round black markings on its body and its grey back side. Next to your tally for barndoor skates, please write down an estimate of their size (S, M, L). Keep in mind that a fully grown barndoor skate can be up to 5 ft in diameter.

During the haul bycatch can be stored next to the roller station, or the captain can throw the bycatch into the chucker and the crew can put them into totes next to your tally station. The benefit of having the bycatch by your tally station is that you don't have to climb over the chucker at the end of the haul to weigh bycatch and it's out of the captain's way. However, there probably will not be anywhere to hang a scale by your tally station. The preferred method will depend on the layout of the vessel. If you have problems with establishing an area to sample on a vessel please inform your coordinator so they can visit the vessel and assist with setting up a "sample station".

Subsampling: In the event that a large number individuals of one species is coming up, you may use average weights instead of weighing all individuals. Collect the first 50 individuals and tell the captain to release those individuals after fifty. Continue to tally each individual even though you are not collecting each one. You will record the weight of the fifty fish between hauls. This allows an average weight to be calculated and applied to the total number of fish.

For every species you must have separate tallies for kept or discarded fish. **Make sure you indicate this on the deck sheet by circling K or D.**

IF THE PRIMARY SPECIES CAUGHT IS NOT THE TARGET SPECIES (HADDOCK) YOU WILL NEED TO SAMPLE THIS SPECIES AS IF IT WERE HADDOCK (if dogfish or yellowtail flounder, they will also need to be sexed).

c) Fish Measurement

The first 100 haddock that come aboard are to be measured by the third crew. This is to be done during the haul, while you are tallying.

All juvenile cod and haddock are to be measured and weighed, then released immediately. This task will be completed by the third crew as you will be tallying. It is important that these fish be taken care of as soon as they come up on the line and handled as gently and as little as possible.

All adult cod that come aboard are to be measured and weighed by you between hauls.

All bycatch (except skates and dogfish) will be weighed by you and the third crew between hauls.

During the LAST HAUL ON EACH SLACK TIDE, ALL BYCATCH INCLUDING SKATES AND DOGFISH IS TO BE KEPT (information on sublegals can be taken as per other hauls). ALL BYCATCH IS WEIGHED AND EVERY INDIVIDUAL IS LENGTHED. THESE FISH MUST BE weighed ROUND. THIS INCLUDES ADULT COD--YOU WILL STILL NEED INDIVIDUAL COD WEIGHTS. Please transfer information to the NMFS form provided. There is NO SUBSAMPLING ALLOWED ON THIS HAUL. BARNDOOR SKATES ARE NOT BROUGHT ON BOARD.

IF THE PRIMARY SPECIES CAUGHT IS NOT THE TARGET SPECIES (HADDOCK) YOU WILL NEED TO SAMPLE THIS SPECIES AS IF IT WERE HADDOCK (if dogfish or yellowtail flounder, they will also need to be sexed).

A note on asking the crew to weigh fish for you: there is motivation for the fishermen to bring in small amounts of cod; therefore it puts a lot of pressure on them to weigh codfish for you. Don't assume that they would under represent a weight but be aware that this temptation exists and that it is always best to do the weighing yourself in between hauls if you can manage it.

FOR MORE INFORMATION, SEE FISH MEASUREMENT IN **APPENDIX B**

d) Birds

If a bird comes up on the line, describe it as fully as you can, noting any distinct markings and characteristics. Make a sketch if necessary. Use your bird ID guide to assist you. Note any band numbers. Take a photo with a size reference included, even if you are turning in a specimen. NOTE: Please do not include crewmembers or distinguishing vessel characteristics in any photos. All photos are to be turned in to your coordinator.

Dead birds are to be retained whole. Make sure you have your bird permit on board. Fill out the provided specimen tag as completely as possible. Place the specimen and tag in the bag provided and keep cold or frozen. Notify your coordinator as soon as possible.

Fill out the photo log and Incidental Take log on the Special Situations form, with applicable information.

e) Marine Mammals

Please make a note of any marine mammal sightings or interactions that may occur. Include as much information as possible. Describe sighting cues, animal characteristics, behavior, markings, number of individuals, etc.

If there is an incidental take of a marine mammal, do NOT retain any specimens. Unfortunately, we have yet to obtain permits that allow us to retain specimens. Take measurements if possible (this is not advised for LIVE incidental take), note any tag numbers or distinct markings and try to take photos with a size reference. NOTE: Again, please do not include crewmembers or distinguishing vessel characteristics in any photos. All photos are to be turned in to your coordinator.

Note all relevant information under Marine Mammal Sighting, Photo Log, and/or Incidental Take Log on the Special Situations form.

REFER TO **APPENDIX C** FOR A MORE INFORMATION ON MARINE MAMMALS

f) Gear Problems

Please record any problems with hauling the gear in the notes section of your deck sheet. One typical problem is parting of the line during the haul. If this happens, the captain will look disgruntled, say nothing, immediately steam to the other end of the string and start hauling again. Record this on the deck sheet and try to estimate the amount of gear that may have been lost (if any).

g) End of Haul

When the last hook comes up, **record the total number of haddock from the thumb counter (and any other species tallied via thumb counter) onto the deck sheet**. Tell the captain what the total number of haddock is. **When the high fliers and buoys come on board, record the End Time and Coordinates on the deck sheet.**

This is the time to measure and weigh cod and weigh other bycatch. It will most often be a short steam to the next string. Check with the third crew to ensure data accuracy and help them prepare for the next haul if necessary.

h) Weighing Bycatch

All of the kept cod will be measured and weighed by you. Please write down individual cod weights in the space provided on your deck sheet. When transferring lengths to your deck sheet, please use a separate line for sublegal (discarded) and legal (kept) cod and indicate as such.

Bycatch needs to be separated to species if possible (sculpins can be grouped), counted and weighed. All weights are in **pounds**. Make sure you subtract the weight of the basket each time! **Write down the number of fish weighed and their weight in pounds on the deck sheet.** Writing down the number of fish weighed in addition to the tally is important. This is done to ensure data quality by introducing redundancy into the dataset and makes error checking much easier. Sometimes not all fish tallied get weighed and this lets us know if that is the case. It also indicates a species that was subsampled. **Try to work with kept species first as the crew will be anxious to take care of these fish as soon as possible!**

Try to obtain round weights if at all possible. **Indicate on the deck sheet whether the weight you have obtained is from dressed or round fish by circling Dr or Rd.** If there was shark or marine mammal predation you will need to weigh 'parts' as they are and describe as fully as possible.

During the LAST HAUL ON EACH SLACK TIDE, ALL BYCATCH INCLUDING SKATES AND DOGFISH IS TO BE KEPT (information on sublegals can be taken as per other hauls). ALL BYCATCH IS WEIGHED AND EVERY INDIVIDUAL IS LENGTHED. THESE FISH MUST BE weighed ROUND. THIS INCLUDES ADULT COD--YOU WILL STILL NEED INDIVIDUAL COD WEIGHTS. Please transfer information to the NMFS form provided. There is NO SUBSAMPLING ALLOWED ON THIS HAUL. BARNDOOR SKATES ARE NOT BROUGHT ON BOARD.

IF THE PRIMARY SPECIES CAUGHT IS NOT THE TARGET SPECIES (HADDOCK) YOU WILL NEED TO SAMPLE THIS SPECIES AS IF IT WERE HADDOCK (if dogfish or yellowtail flounder, they will also need to be sexed).

STEAMING BACK:

After you are finished sampling your last haul, please try to clean your gear while the crew is cleaning the deck. If this is not possible, there is a cleaning station available at the Chatham Fish Pier shanty (24-7) for your use. A freshwater hose and floor drain make cleaning your gear (and raingear) very efficient and leave no excuse for the return of dirty sampling gear. Much effort has been put forth to obtain quality products for your use, so please make your best effort to maintain those items in top condition.

The steam back is a good opportunity for you to transfer the length data from the length strips and third crew sheets to the deck sheets. Please keep sublegal fish (discarded) and legal fish (kept) on separate lines. If the weather is bad, you are being thrown around a lot, you don't feel good, there is no clean clear surface to do the transferring, or if there are any other reasons you cannot transfer the length data don't worry about it - you can do it when you get to shore.

The steam back (or the steam out) is also a good opportunity to fill out the **Captain Survey**. One Captain Survey needs to be filled out for every trip. The captains may not know the answers to all of the questions. This is fine. Fill it out as completely as you can (or let them fill it out). If you are getting on a boat that has yet to be observed this year we will ask you to fill out a **6 Month Questions Sheet** with the captain (or let them fill it out). Make the information as complete as possible but remember it is completely voluntary. Some of the 'other costs' which have been encountered and may be inquired after are: baiter fees, dockage/moorage fees, and hull/vessel maintenance. These amounts may be placed in the comments section.

When you arrive at the dock, record the time (24-hour) on the Captain Survey sheet.

3-AFTER YOUR TRIP:

OFFLOAD:

You need to monitor the offload when you get to the dock. What this means is that you stand nearby and watch the flow of fish from the boat to the buyers. Introduce yourself. Try to be friendly. The dock workers should be used to being monitored. **Please note the port where fish are sold under Port Landed on the back of the Captain Survey.**

What you are watching is how the fish are weighed. The fish come off the boat and are put into totes before being weighed and carried off. Each tote weighs about eight pounds when empty, they pay the boat for 100 pounds per tote and yet they often fill the totes until they weigh between 111 and 113 pounds. The buyers justify this by saying that they lose that amount through water loss and shrinkage. Be aware of this. See that they really are keeping the total weight of the tote to below 113 pounds consistently. If they are not doing this make a note of it.

Tally all totes of fish that are removed from the vessel by market category (i.e. haddock, scrod, steak cod, market cod, etc.). Note weights if possible and whether or not the scales were tared first or if the individual weights still include a tote weight. Make a note if all fish are not removed from the vessel and estimate how much. There could be motivation for the fishermen to retain fish in their holds for sale at a later time. This is fine-we just need to know about it.

At the end there will be a partial tote of full sized haddock, totes of scrod haddock (haddock under 3.5lbs.), and totes of salable by-catch. Write these numbers down. At the very end of the offload, a fish ticket with total weigh-outs will be issued: you are to obtain a copy from your captain or the buyer if possible. If not, please ask the captain to provide your coordinator with a copy as soon as possible. In this case, **record any information you can immediately obtain from the ticket on the back of the Captain Survey.**

Occasionally, there is more than one buyer and hence there will be more than one fish ticket that you need to track down. Also, be aware that the captain and crew often take fish home for themselves and others, commonly called "home packs". These fish need to be weighed by you before they leave the boat and added to the total weigh-out from the fish ticket.

RETURN OF FORMS AND GEAR:

Please drop off your clean gear, survival suit, deck sheets and length strips at the CCCHFA (or other designated location) before you go home.

Please check over your deck sheets for readability and completeness of information before you turn them in. **Blood, rips, crumpled is ok-but illegibility is not.** You should add up your tally marks for each species and circle the total number inside the box for that species. This is a good time to check and make sure all information has been recorded and/or transferred correctly.

The day after your first few trips your coordinator will be in touch with you on the phone or via email to see how things went, answer questions, ask any questions about your data, and thank you profusely for all of your hard work!

If you have suggestions on ways that things can be improved please talk to your coordinator. Data quality is of the utmost importance. Working as a group will help this program evolve into a high-caliber operation!

Summary of Some Things to Remember

- Write your name and the date on ALL FORMS. Write the page number on all forms. Start with the captain interview, 6 month questions, deck sheets, third crew sheets, and special situations. Do not forget to include a copy of the fish ticket and any extra sheets (i.e. blank rite in the rain) that you may have used.

- Write down the times the **boat leaves the dock and returns to the dock** in 24-hour time on the back of the Captain Survey.

- Record all weights in **pounds and fish lengths in centimeters.**

- A Deck Sheet is filled out for every string. Data are kept separate by string number and **should always be associated with locations and set/haul times**. Collect four sets of coordinates for each string: one at the beginning of the set, one at the end of the set, one at the beginning of the haul and one at the end of the haul.

- Be familiar with the gear set-up and measurements such as number of hooks per bundle, length between hooks, length of gangions, buoys used, weights attached to the line, and type of hooks. Parted or lost gear should be noted on the deck sheet. For lost gear an estimate is required as to the number of hooks lost.

- All animals/plants/debris are tallied for each string. Counts for the same species brought on board, those that dropped off the line and could not be retrieved, and the juveniles that are thrown overboard **are all kept separate**.

- Animals are identified to species when possible, especially **barndoor skates.**

- The **first 100 haddock** of each string are measured for length.

- All **juvenile haddock and cod** are measured and weighed.

- **Adult cod** are measured and weighed. Dressed weights are acceptable for adults, but please note if the weight is round or dressed. If dressed in any other manner than gutting, i.e. head removed, please note this as well.

- On the last haul on every slack tide, ALL BYCATCH is to be brought on board, sorted to species, weighed and lengthed. Use the NMFS length frequency log provided.

- Birds caught on the line should be carefully documented. **Return whole specimens of dead seabirds only.**

- Carefully document any marine mammal interactions or incidental take. **Do not retain specimens of marine mammals.**

- The offload should be monitored to verify all fish are passing over the scale and all weights are being accurately recorded. If possible, record the weights and add them up independently. **Obtain a copy of any fish tickets.**

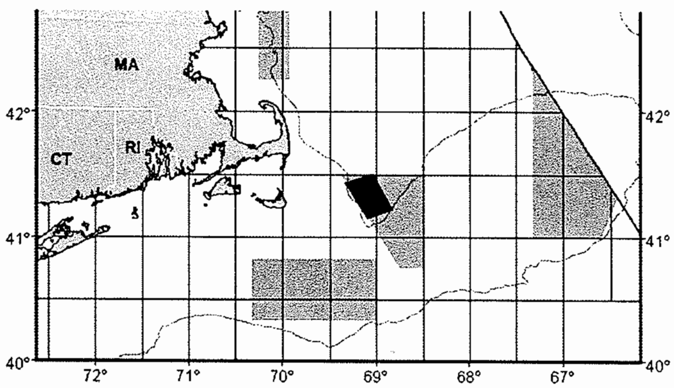
- Before you go home (leave Chatham) you should leave behind with the coordinator: all of your clean sampling gear (don't forget to sign the form for gear return), your survival suit, one deck sheet for every set, any third crew sheets, one Captain Survey, one Six Month Question (if applicable), Special Situations Form(if applicable), and fish ticket(s). **Please hand in all original forms, even if re-copying was necessary.**

- Forms you need to hand in (if applicable):

  - Captain Interview
  - Six Month Questions
  - Deck Sheets
  - NMFS Length Frequency Log
  - Third Crew Sheets
  - Special Situations
  - Any notes you have made i.e. if keeping a log/notebook with extra information
  - Any blank sheets with raw data

APPENDIX A-Study Area Locations

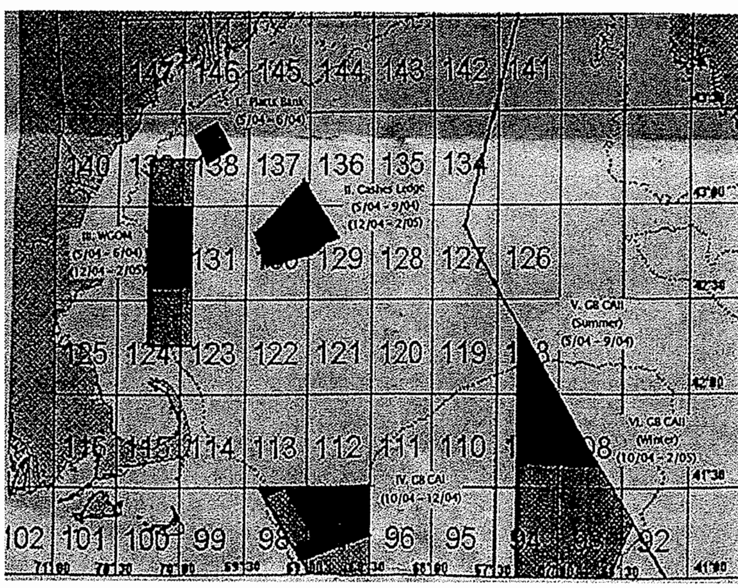
Closed Area 1 Haddock Project Study Area



COORDINATES:

Point	Loran-C (CORNER)
CI1	13700 X 43820 (NW)
CI2	13700 X 43680 (SW)
CI3	13625 X 43680 (SE)
CI4	13625 X 43820 (NE)
CI1	13700 X 43820 (NW)

Gulf of Maine Closed Area Haddock Project Study Areas



Area	Closure Type	Duration	Location
Platts	Rolling	5/04 – 6/04 2 months	43.15 X 69.52 43.18 X 69.40 43.13 X 69.17 42.58 X 69.40
Cashes	Year-Round	12/04 – 2/05 5/04 – 9/04 8 months	Entire Cashes Closed Area
WGOM	Year-Round	5/04 – 6/04 12/04 – 2/05 5 months	WGOM: North of 42.35 South of 43.00
GB CAII	Year-Round	5/04 – 9/04 5 months	CAII : North of 42.00
GB CAII	Year-Round	10/04 – 2/05 5 months	CAII : North of 41.40

APPENDIX B-Fish Measurement

Notes for Third Crew:

RECORD ALL LENGTHS IN CENTIMETRES AND ALL WEIGHTS IN POUNDS

Getting Ready

-Note the haul number and write “haddock” on the upper half and “cod” on the lower half.
-Offset the length strip by 20cm or so (30, 40 or whatever works best for you) and label as such.
-You may find it helpful to use the ‘**third crew sheet**’ to assist you with task #2.
-REMEMBER: The fork length is the measurement from the lips of the fish to the notch in the tail fin.

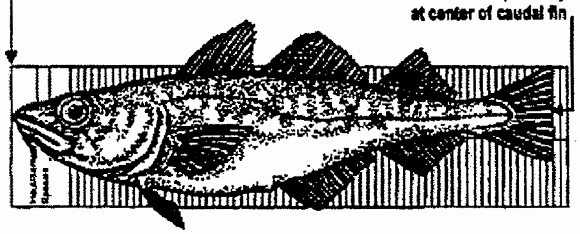


Figure 9-9 Measuring Fish

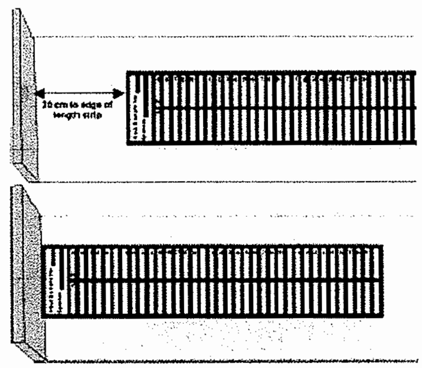


Figure 9-10 Measuring Strip Placement

(NPGOP Sampling Manual, 2004)

Task #1: Measure the first 100 haddock that come aboard for each haul

-Place each fish with its nose against the raised end of the board.
-Place a pencil mark in the box where the fork of the tail falls. Make the marks clear and easy to read. Some people may find it easier to tally them in groups of five

Task #2: Measure and weigh all SUBLEGAL haddock and cod

-Any haddock under **49cm (19 inches)** or cod under **56 cm (22 inches)** must **IMMEDIATELY** be measured and weighed (use 10 lb scale) individually and then returned to the water.
-You must record juvenile lengths on the length strip as well as on the third crew sheet
-**DO NOT** weigh juveniles by the gills. Please use the Ziploc bag provided.

Task #3: Assist the data collector between hauls

-They may ask for help sorting and weighing fish. The more you can help, the faster the day will go and the sooner everyone goes home!

Observer taking length frequencies on spiny dogfish.

(NFOP Sampling Manual, Revised 12/01/03)

LEGAL FISH SIZES (Total Length):
Cod: 22 inches (55.9 cm)
Haddock: 19 inches (48.3 cm)
Pollock: 19 inches (48.3 cm)
Witch Flounder (Gray Sole): 14 inches (35.6 cm)
Yellowtail Flounder: 13 inches (33.0 cm)
American Plaice (Dab): 14 inches (35.6 cm)
Atlantic Halibut: 36 inches (91.4 cm)
Winter Flounder (Blackback): 12 inches (30.5 cm)
Redfish: 9 inches (22.9 cm)

****Part of a third crew sheet is shown below. Your writing is represented by a font like this: "I like to measure fish"

THIRD CREW SHEET

HAUL #	Name
1	Jimmy Smith

SUBLEGAL COD "SHORTS"

LENGTH (CM)	ROUND WEIGHT (LBS)
25	3.2

SUBLEGAL HADDOCK "SHORTS"

LENGTH (CM)	ROUND WEIGHT (LBS)
20	1.7
21	
25	2.1

NOTES:
I forgot to weigh the second juvenile haddock. Oops!

Notes for the Data Collector:

You are to measure and weigh every ADULT cod that comes aboard. This must be done between hauls. Your captain will have to wait.

-Measure all adult cod as per Task #1 above (same as haddock although you may want to offset your strip by a larger number-Please note the change i.e. fill in lengths on strip or note "add 20cm for cod…").

- One way to solve the problem of a cod or haddock that is longer than the length strip is to line up another length strip and note the length on the original strip or on the third crew sheet.

- All adult cod must be weighed. Use the 10 lb (small) scale for this, and record weight to the nearest 1/10 of a pound. **If the cod weighs more than 10 lbs, use the 100 lb scale.**

-Make sure you indicate if the adult cod weights are DRESSED or ROUND

-Adults may be weighed as a group if there isn't time to weigh them individually. Weigh the basket or bucket you will be using and note the weight (i.e. Bucket=2.3 lbs) and whether or not you have already subtracted bucket weights. Note the weight by bracketing the corresponding lengths and noting: "20 fish @ 60lbs" or whatever is applicable.
At the end of the haul you should check to make sure you have **as many weights recorded for cod as you have tally marks.** If you are missing weights at the end of the haul look in the chucker -the missing codfish are probably sitting in there waiting to be gutted.

Make sure you understand how the lengther/third crew is recording their information during hauls. Sublegal lengths must appear on BOTH the length strip AND the third crew sheet. You will have to account for this information if there are any questions.

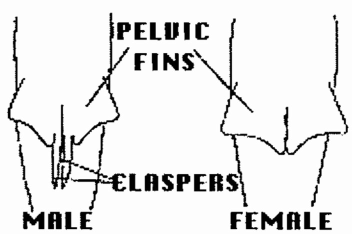
The number 100 is not hard and fast. Ideally we would measure 25% of the total amount of haddock. Because we don't know how much haddock will be caught until they are actually on-board we want to overestimate the number of lengths we will need. By deciding in advance to collect 100 haddock lengths per string we are assuming that on a string with four bundles there will be less than 100 haddock per bundle. There are usually far less than 100 haddock per bundle. Sometimes there will be less than 100 haddock on the entire string and so every single haddock will have a length measurement. This is fine. In that situation the level of activity on the deck is low and taking lengths from all the haddock is not difficult to do.

When there are a lot of fish coming on board however the level of activity on deck can be much higher. Generally what happens in that situation is that the person gutting the haddock as they come on board is not able to keep up with the rate at which they are coming on board so that haddock pile up on the deck of the boat. Some boats use boards to section off a portion of the deck next to the roller station to chuck the haddock into while they wait to be gutted (the "chucker"). After they are gutted, they are washed. This usually means that they are thrown into a tote full of water where they soak for a few minutes before the lengther grabs them, washes the blood off of them, takes a length measurement and puts them on ice.

What this situation can mean for the data is that the first **100 haddock that need to be lengthed can get mixed up with haddock coming on board after them.** One way to solve this problem is to say something to the person gutting the fish when you reach 100 on the thumb counter and have that person remove all of the haddock lying on the deck to a tote, or separate them in some other way so that the lengther knows exactly which fish they need to length. If the vessel has additional bin boards there is an easy fix. Sometimes however there is no tote available or nowhere to move all the length fish. If there is no way that you can see to solve the problem of mixing the haddock that need to be lengthed with the haddock coming on board after them carry on and make a note of the problem on the deck sheet.

During the LAST HAUL ON EACH SLACK TIDE, ALL BYCATCH INCLUDING SKATES AND DOGFISH IS TO BE KEPT (information on sublegals can be taken as per other hauls). ALL BYCATCH IS WEIGHED AND EVERY INDIVIDUAL IS LENGTHED. THESE FISH MUST BE weighed ROUND. THIS INCLUDES ADULT COD--YOU WILL STILL NEED INDIVIDUAL COD WEIGHTS. Please transfer information to the NMFS form provided. There is NO SUBSAMPLING ALLOWED ON THIS HAUL. BARNDOOR SKATES ARE NOT BROUGHT ON BOARD.

IF THE PRIMARY SPECIES CAUGHT IS NOT THE TARGET SPECIES (HADDOCK) YOU WILL NEED TO SAMPLE THIS SPECIES AS IF IT WERE HADDOCK (if dogfish or yellowtail flounder, they will also need to be sexed).
Please sex spiny dogfish and yellowtail flounder if you have time and do separate length frequencies for each sex. Do not cut either species, the illustrations below are for demonstration purposes only. Dogfish are easily sexed visually. Males have claspers and females do not. Yellowtail flounder can be sexed by a technique called 'candling'. Hold the fish up to the light and you should be able to see through it to determine the shape of the gonads. If you are unsure, leave the sex field blank and length 'sex undetermined' species separately.



(http://www.sharktagger.com/program.html)

Figure 1-Sex determination of sharks. Males have claspers; females do not.

(NPGOP Observer Manual 2004)

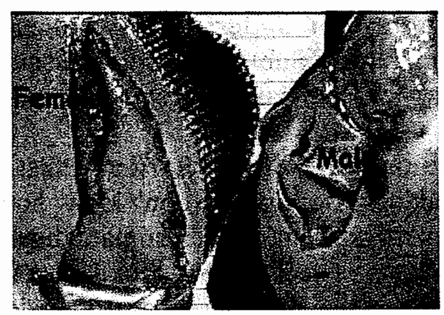


Figure 9-8 Female and Male Flatfish Gonads

Female flatfishes have elongate triangle ovaries that extend from behind the anal spine area almost to the tail when mature. When immature, the ovaries will be almost equilateral triangles with one angle shaped like a smoothly rounded tube extending only slightly back toward the tail (the triangle looks like a funnel in shape). The color will be pink (spent, immature) or orange (ready to spawn). Ovaries always have rounded edges on the triangular gonad.

Male flatfishes have a white, equilateral triangle shaped gonad on each side. The triangle will not have a tail extending back toward the caudal fin. Immature males have a small crescent moon shaped, tan colored gonad laying right at or behind the anal spine location. All male flatfishes have "edges" to the triangle. If you lift the gonad with the knife or scalpel and examine the sides of the triangle, you can distinguish the sharp edges (male) or rounded sides (female), even on an immature flatfish.

APPENDIX C-COMMON MARINE MAMMAL BEHAVIOR DESCRIPTIONS

Small Cetaceans	Large Cetaceans	Pinnipeds
Bow riding-- Animals swim beside the bow or in the bow wave of a moving vessel. **Leaping entirely out of the water**-- Animal jumps fully clear of the surface of the water (as opposed to merely breaking the surface of the water), not for forward locomotion but for other reasons (known only to them). **Porpoising**-- Animal raises its body to be nearly or fully out of the water while traveling forward at a fast rate of speed, usually in a fluid, arching motion. **Rooster-tailing**--Animal surfaces at high speed creating a spray of water in front and over the top of the animal which looks like a rooster's tail. Usually seen only in Dall's porpoise. **Slow rolling**-- Animal comes to the surface to breathe, with the blowhole and dorsal area usually showing, and then rolls back underwater.	**Blow visible from a distance**-- Blow can be seen from more than 500 meters away. Usually only seen in certain large cetaceans. **Breaching**-- Used for larger cetaceans (orca sized and larger). The whale accelerates forward underwater and then jumps free of the water, sometimes fully clearing the water's surface, and then lands on the surface of the water, creating a large splash. **Flipper slapping**-- Whale floats or swims at the surface, turns on its side and slaps one pectoral fin against the water, either once or several times in quick succession. **Group feeding**-- Seen primarily in humpback whales, when they coordinate feeding by lunging out of the water with their mouths open, engulfing fish and water. **Lob-tailing**-- Whale raises its tail flukes up out of the water and slaps them down against the surface with great force. This may occur once or be repeated many times. **Spy-hopping**-- Whale is vertical or upright in the water and raises its head up out of the water, usually with its eye showing. **Tail raised on dive**-- When diving, the whale's entire tail lifts completely above the water before going underwater.  **Side and stern wake riding**-- Whale is riding in the wake created midships along the side of the vessel, or the wake created by the stern.	**Jug handle**-- Seal or sea lion floats on its side with ~~one~~ front flipper and one rear flipper above the water, creating what looks like a handle. **Porpoising**-- Pinniped is swimming fast, jumping at least partially out of the water in fluid, arching motions. This swimming pattern resembles that of dolphins or porpoises seen at a distance. **Rafting**-- A group of pinnipeds resting at the surface together. **Spooked from haulout**-- Pinnipeds which had been resting on beach, rocks or ice, dove into the water due to your vessel's interaction with them. **Vocalizing**-- Pinniped making directed noises at you or at another pinniped.

Figure 12-8 Marine Mammal Behavioral Descriptions

(NPGOP Sampling Manual, 2004)

APPENDIX D-Forms

Data Collection Gear List

Item	Description/Serial No.	Quantity
Basket	orange	
Camera (use to photograph marine mammal/seabird interactions, unique specimens which cannot be collected, or photos that would benefit training)		
Cleanser and Scrubbie		
Clip Board		
Fish Cradle		
Fish ID Guide		
Length Strips (use no.2 pencil and erase with dish soap or comet)		
Paperwork (Waterproof Deck Sheets, Blank Waterproof Paper, Captain Survey, Marine Mammal Sighting, 6 month questions, Bird Permits)		
Scale (rinse with fresh water and oil after every trip)	100lb 10lb	
Survival Suit (store with zipper about 1" from bottom, wax zipper regularly, inspect for holes/tears, ensure there is a light and whistle)		
Thumb Counters (occasionally jam-watch carefully-can be fixed by popping off face plate and oiling gears)		
Thumb Tacks, Rubber Bands, Paper Clips, Pencils		
Tote	white	
Ziploc/Bird Collection Bag with Tags (for dead incidental take)		

Name:____

Date Out:____

Date Returned:_______________________________________

Damaged/Lost Gear:___________________________________

***Gear is to be cleaned thoroughly and rinsed with fresh water before being returned to the CCCHFA. There is a 'cleaning station' available at the Chatham Fish Pier if resources are limited.

***Data Collectors are responsible for replacing lost or damaged gear.

Vessel: **Captain:**

Hull # (Doc or State): **Home Port:**

Date: **Total # Sets This Trip:**

Crew Size (data collector not included): **Set Method (cues):**

TRIP INFORMATION

Ice used in tons _______________ Price per ton $ _____________

Fuel used in gallons ______________ Price per gallon $ _____________

Damage/Loss of gear, dollar estimate $ _____________

Cost of supplies used (i.e. hooks, gangions, knives, gloves, etc.) $ _____________

Cost of food $ _____________ Cost of Oil $ _____________

Cost of bait $ ______________ Pounds of bait used (each bait type) _____________

Cost of baiting $ ______________

Pounds of bait / bundle __________________ Number bundles on board________________

Distance between hooks ____________ ft Number of hooks per bundle _____________

Swivels on gear? Y N # swivels/gangion___ #Anchors/set and lbs each______________

Number of strands in mainline ____________ Diameter of mainline _______mm

Length of Mainline (nautical miles)_________ Test Strength of mainline ____________ lbs

Mainline Material/Color___________________ Gangion Material/Color______________

Diameter of gangions _______________ Test Strength of gangions _____________

Gangion Length __________________ Hooks:Size _______Brand_______Model______

NOTES:

VESSEL INFORMATION

USCG Decal # ______________________________ Date Issued __________________

Safety Briefing? Y N

STEAM TIMES

Time left the dock________________ Time returned to dock_____________

Time lost ____________________ Reason _____________________________

OFFLOAD: TOTE TALLY (by market category)

WEIGHTS

Port Landed _________________________________

Haddock weigh out from fish ticket #1 ______________________________

Haddock weigh out from fish ticket #2 (if any)_________________________

Weight/Species of any home packs________________________________

Total haddock weight____

Vessel	Date	Data Collector

SET #:	Start Time	LORAN Coordinates	LORAN Coordinates
	Beg Depth (Fath)	Vessel Speed (kts)	End Depth (Fath)
BAIT TYPE:	End Time	LORAN Coordinates	LORAN Coordinates

# High Fliers	Bundle # # Hooks	Total #Bundles	NOTES:
# Buoys	Bundle # # Hooks	Total # Hooks	
# Weights	Bundle # # Hooks		

Haddock Length Frequency (48.3cm legal)

0	1	2	3	4	5	6	7	8	9	**0**	1	2	3	4	5	6	7	8	9
0	1	2	3	4	5	6	7	8	9	**0**	1	2	3	4	5	6	7	8	9
0	1	2	3	4	5	6	7	8	9	**0**	1	2	3	4	5	6	7	8	9
0	1	2	3	4	5	6	7	8	9	**0**	1	2	3	4	5	6	7	8	9

Cod Length Frequency (55.9 cm legal)

0	1	2	3	4	5	6	7	8	9	**0**	1	2	3	4	5	6	7	8	9
0	1	2	3	4	5	6	7	8	9	**0**	1	2	3	4	5	6	7	8	9
0	1	2	3	4	5	6	7	8	9	**0**	1	2	3	4	5	6	7	8	9
0	1	2	3	4	5	6	7	8	9	**0**	1	2	3	4	5	6	7	8	9

HAUL#	Start Time	LORAN Coordinates	LORAN Coordinates
	End Time	LORAN Coordinates	LORAN Coordinates
Weather	SS Temp (F)	Wind Speed (kts)/Direction (deg)	Wave Height (ft)

Haddock Tally	Cod Tally	Kept Cod Weights
Adult K / D	**Adult** K / D	Rd/Dr
Dropoff	**Dropoff**	
Sublegal **Sublegal Dropoff:**	**Sublegal** **Sublegal Dropoff:**	

Tally Only

Skates (list species) K/D Barndoor: S M L			Dogfish K/D		
Tally	Number Weighed	Weight	Tally	Number Weighed	Weight
White Hake K/D		Rd/Dr	K/D		Rd/Dr
Cusk K/D		Rd/Dr	K/D		Rd/Dr
K/D		Rd/Dr	K/D		Rd/Dr
K/D		Rd/Dr	K/D		Rd/Dr

K/D=Kept/Discarded Rd/Dr=Round/Dressed SML-small, medium, large (barndoors only)

NOTES:

Special Situations

Date	Vessel Name	Trip #
Time	Latitude or LORAN	Longitude or LORAN

Marine Mammal Sighting

Weather Code (circle one)	Animal Behavior (circle one)
01 Clear	01 Near gear; physical contact
02 Partly Cloudy	02 Near gear; within 50 meters
03 Solid Clouds	03 Near gear; within 51-150 meters
04 Drizzle	04 Feeding on catch
05 Rain	05 Porpoising
06 Showers	06 Bow riding
07 Thunderstorms	07 Breaching
08 Rain & Fog	08 Swimming/traveling
09 Fog/Thick Haze	09 Milling/rolling at surface
10 Snow/Rain	10 Dead at surface
11 Blowing Snow	11 Startled by vessel
99 Other_______________	12 Attracted by vessel
	99 Other _______________

Where on vessel were you observing from?	Sighted off of:	Animal Condition:
Wheelhouse	Port	Alive
Deck	Starboard	Injured
Bow	Bow	Dead
	Stern	Decomposed

Species:	Number Sighted:
Level of Certainty 1 2 3 4 5	Photos Y N (See Reverse: Photo Log)

Sketch:

Sighting Cues (describe blow, color, physical characteristics, markings, injuries, etc.):

Photo Log

(marine mammal/seabird interactions, incidental take, unidentified species)

Date	Camera/ Roll #	Frame #	Haul #	Tag #	Species/Subject

Incidental Take (marine mammals, seabirds, sea turtles)

Tag #	Species	Haul #	Photos Y N Frame # INCLUDE SIZE REFERENCE AND TAG
Specimen Y N **DEAD SEABIRDS ONLY	Comments:		

APPENDIX E-Definitions

"the bar" A dangerous sand bar boats pass by when leaving Chatham Harbor.

bundle One tote or one tub of gear is called a bundle. The bundles are tied together to make up strings. Usually the bundles within the string are separated by weights.

buoy Large, plastic, floating ball with identifying writing on it.

buoy line Long segment of line attached to the buoy at one end and the anchor at the other.

caudal peduncle The area on the fish before the tail and after the dorsal and ventral fins

dressed weight The weight of the fish after it has been gutted.

drop-off An organism that is hooked on the gear and *breaks the surface of the water* but does not make it on to the boat because it falls off the hook and gets away. You will notice as you look down the line in to the water that organisms drop off and swim or float away that do not make it to the surface -these are not recorded as drop-offs because they did not break the surface of the water and could not be definitely identified.

EPIRB Emergency Position Indicating Radio Beacon

gaff A rod with a hook on the end of it to puncture fish with in order to move them from one place to another.

gangion A nylon line attaching the hooks directly to the groundline or using swivels.

gear A longline string composed of several sections, uniquely configured for a specific target species.

ground line Rope or cord comprising the bulk of the gear, hooks are attached at 5 to 6 foot intervals. Also referred to as the main line.

haul Example of use: "**Haul** #3 had 230 haddock on it." "We were **hauling** #3 when the line parted."

high flier A long pole with reflective material on the top that coupled with a buoy is placed at both ends of each string.

leader A relatively short section of mono or steel wire placed between a swivel and the hook. It reduces bite offs, makes hook replacement easier and helps to maintain gangion length. Leader lengths should not be included in any gangion measurements.

long line A term used to describe the type of gear or method of fishing. Example of use: "We went long lining for haddock yesterday." It can also be used to refer to a particular string or sometimes used interchangeably with ground line.

LORAN Long Range Aid to Navigation

port Left side of the boat as you are looking in the direction of travel (forward).

roller station Where the captain stands to gaff the fish and bring them on board during the haul.

round weight The weight of the whole fish before it has been cut or processed in any way.

set Examples of use: "We are going to **set** three bundles of gear." "Record the time at the beginning of the set."

starboard Right side of the boat as you are looking in the direction of travel (forward).

stern The back of the boat.

string Everything in between the two buoys. A boat may set three **strings** of gear on a trip - this means that you will be setting, hauling and collecting data three separate times on that trip. A string consists of smaller units called **bundles or tubs**. Example of use: "How many bundles are in that **string**?"

APPENDIX F-Navigation

LORAN (Long Range Aid to Navigation):

LORAN is basically a type of triangulation, or a way to fix an object's location based on its distance from two or more known points. In this case the object is a fishing vessel, and the known points are radio transmission towers located on land. These towers transmit a radio signal, and a receiver on the fishing vessel records the slight differences in the time required for these signals to reach the boat. The farther away from the transmitter the boat is the longer the signal will take to cover the distance. A computer within the receiver converts these "time differences" (TD's) to distances by multiplying by the speed of light, which is how fast a radio signal travels. The LORAN lines on a chart show the distances from a particular tower, expressed as the number of microseconds (1/1,000,000 of a second) it takes a signal to reach a receiver somewhere on that line relative to a signal from a master transmitter. TD's from two different secondary transmitters will pinpoint an object at the intersection of those two LORAN lines. There are many different groups of transmitters, which together form a LORAN chain. Most fishermen on Cape Cod use the Northeast US Chain, also know as the 9960 (Figure 1)

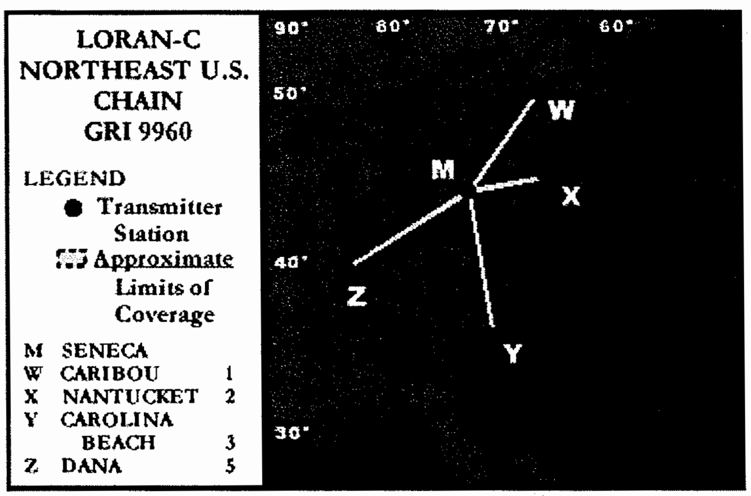


Figure 1- The 9960 LORAN Chain

Latitude/Longitude:

This system describes a location on the globe by expressing it as a pair of angles:

Latitude describes a point's elevation above or below the equatorial plane by measuring the angle formed between two lines, one which connects the center of the globe to a point on the equator, and one which connects the center of the globe to the point in question. Thus latitude will range between 90 degrees North and 90 degrees South. (Figure 2)

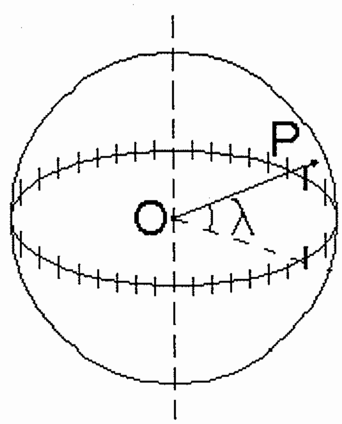


Figure 2- Latitude as an Angle

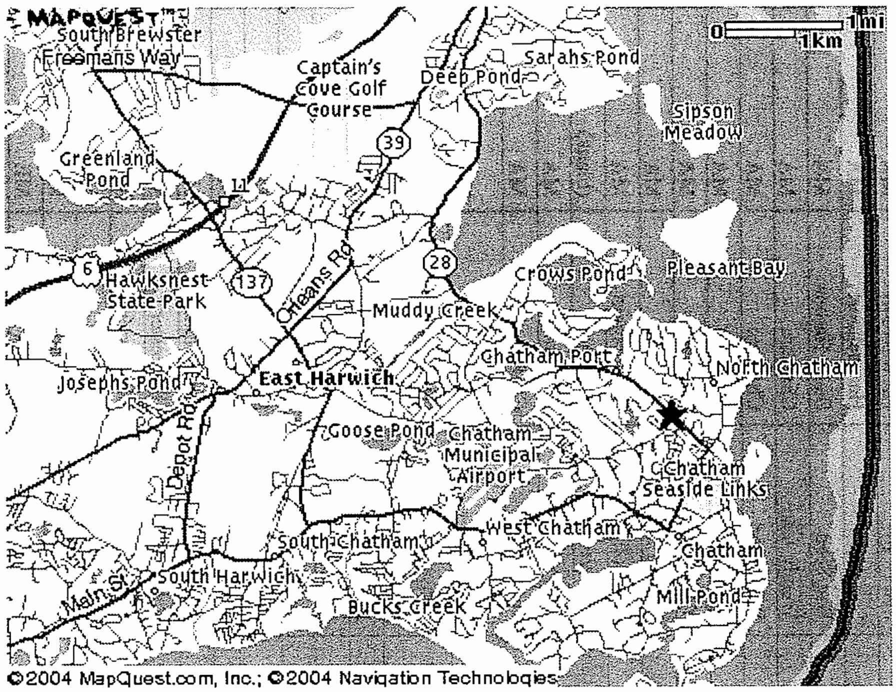
Longitude is a little different: Lines of longitude are called meridians. They extend from the North Pole to the South Pole like the edges of orange slices. To express them as angles, we find the point at which they cross the equator. The equator, like any circle, can be divided into 360 degrees of arc, so there are 180 meridians in each half of the Earth, or hemisphere. People decided long ago that the meridian which passed through Greenwich, England was to be assigned zero degrees, so that longitude angles range from zero to 180 degrees West (often expressed as -180) and 180 degrees East.

These angles can be made more precise through the use of smaller increments beyond degrees, like minutes and seconds (For example: 41°30' 24" North Latitude) or minutes and hundredths of minutes (For example 41°30.44' North Latitude).

APPENDIX G-Captain Phone List

Program	Last Name	First Name	Home Phone	Mobile Phone	Vessel Name	Home Port City	State
Haddock CAl	Braun	Ron	(508) 394-4463	(blank)	Peggy B II	Harwichport	MA
	Eldredge	Jamie	(508) 945-4135	(508) 364-7625	Yellowbird	Chatham	MA
		Kenneth	(508) 432-5730		Fiasco	Chatham	MA
	Hesse	Eric	(508) 362-8462	(508) 364-5015	Tenacious	Harwichport	MA
	Horne	Roger	(508) 945-1352	(blank)	William Gregory	Chatham	MA
	Kaminski	Bruce	(508) 945-5382	(blank)	Never Enough	Chatham	MA
	Leach	Mark	(508) 430-1344	(508) 292-7555	Sea Holly	Harwichport	MA
	Luce	Tom	(508) 420-4195	(508) 274-9402	Sea Win	Harwichport	MA
	Nadeau	Dave	(508) 240-5475	(508) 560-6212	Bad Seed	Stage Harbor	MA
	Pickard	Terry	(508) 945-3487	(blank)	Wendy Jean	Chatham	MA
	Russo	Mike	(508) 255-0895	(774)244-1018	Susan Lee	Chatham	MA
	Taylor	Peter	(508) 945-5095	(508) 237-0806	Sea Hound	Chatham	MA
Haddock CAII	Eldredge	Jamie	(508) 945-4135	(508) 364-7625	Yellowbird	Chatham	MA
	Kaminski	Bruce	(508) 945-5382	(blank)	Never Enough	Chatham	MA
	Leach	Mark	(508) 430-1344	(508) 292-7555	Sea Holly	Harwichport	MA
	Russo	Mike	(508) 255-0895	(774)244-1018	Gulf Venture	(blank)	(blank)
					Susan Lee	Chatham	MA
	Taylor	Peter	(508) 945-5095	(508) 237-0806	Sea Hound	Chatham	MA
Haddock GOM	Borden	John	(207)439-6227	(603)752-1649 or (207)337-1061	Mary Baker	Portsmouth	NH
	Fryberg	Dave	(blank)	(978) 857-9419	Merganser	Gloucester	MA
					Sarah Kate	Gloucester	MA
	Jackson	Dave	(603)868-3078	(781)696-9503	Jeopardy	Gloucester	MA
	Kelly	Tom	(207) 773-4219	(207) 6718984	Celtic Pride	Portland	ME
				(207) 671-8984	Willmar	Portland	ME
	Kuntz	Jack	(207) 775-0949	(207) 671-4943	Cheryl K	Portland	ME
					Jennifer K	Portland	ME
	Leary	Mike	(603) 772-6207	(603) 234-3399	Lori B	Portsmouth	NH
	Libro	Peter	(978)281-1274	(978)317-4912	Cabaret 4	Gloucester	MA
	Marciano	Dave	(978) 922-5987	(508) 654-1644	Lucky Strike	Gloucester	MA
	McCarthy	Buster	(781) 585-6090	(blank)	Last Chance	Scituate	MA
	Pearce	Brian	(207) 829-6622	(207) 350-0472	Danny Boy	Portland	ME
					Fiona A	Portland	ME
	Shannon	Dan	(508) 866-3691	(blank)	Sorry Charlie	Scituate	MA
	Thompson	Matt	(207) 596-1773	(207) 594-1778	Shearwater	Monhegan Island	ME

APPENDIX H-Area Maps



Figures 1 and 2-CCCHFA Office (210 Orleans Rd.)

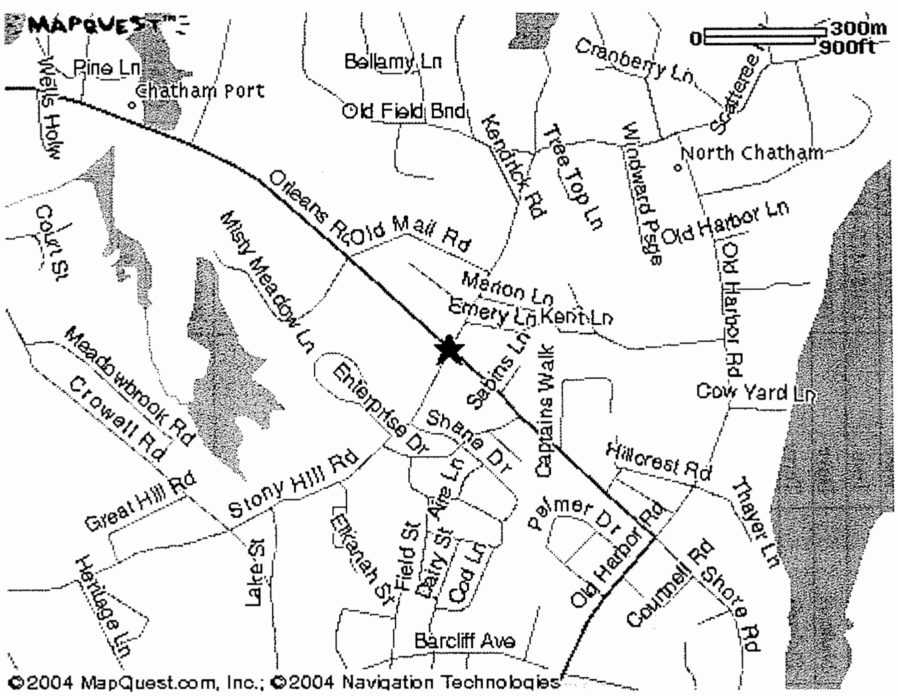


Figure 3-Harwich Port Docks-West of Chatham on 28.
(Wychmere is to the left and Saquatucket to the right of the star)

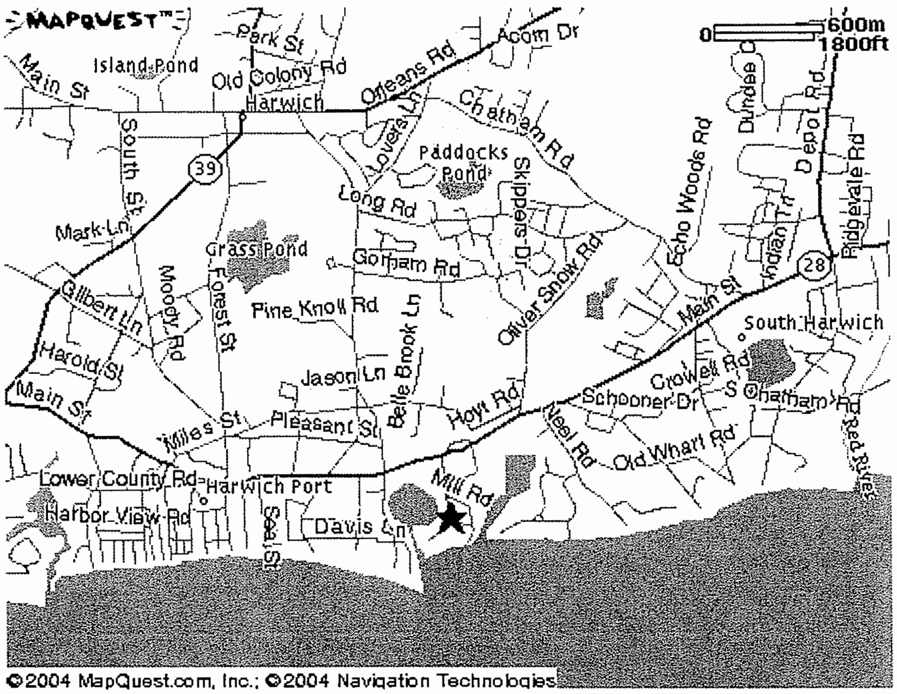
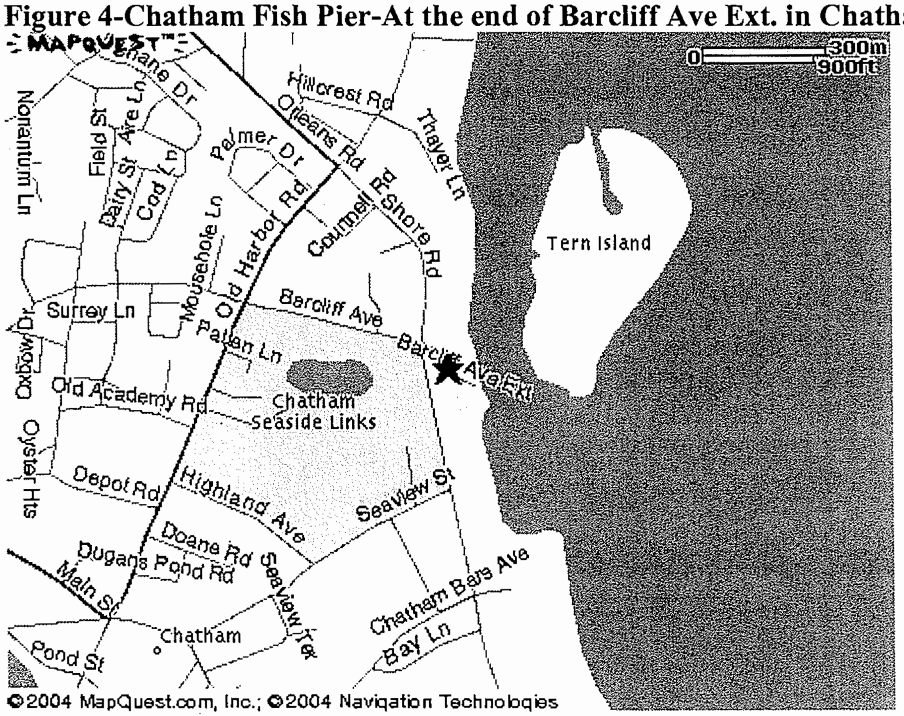


Figure 4-Chatham Fish Pier-At the end of Barcliff Ave Ext. in Chatham



****Other area maps can be found on Mapquest or ask your captain for directions**

Appendix C:

Selective Targeting of Haddock Using Fabricated Bait: An industry motivated special access demonstration project

Melissa Sanderson[1], Thomas Rudolph[1], Mike Russo[2] Mike Leary[3]

1: Cape Cod Commercial Hook Fishermen's Association, 210-E Orleans Road, North Chatham, MA 02650.
2: FV Susan Lee, 67 Nickerson Road, RR#3, Orleans, MA 02653
3 FV Lori B, 3 Orchard Drive, Hampton Falls NH 03844-2410

ABSTRACT

Atlantic haddock stocks have recovered, particularly in groundfish closed areas on Georges Bank. The ability to selectively target haddock and avoid stocks of concern, such as cod, would be invaluable in implementing a haddock fishery without endangering the cod's tenuous recovery. Over 380,000 benthic longline hooks were baited with fabricated bait during 71 trips in Gulf of Maine and Georges Bank closures to test the bait's selectiveness in catching haddock and cod. The data support the hypothesis that fabricated bait catches haddock with a low incidence of cod. The overall catch per unit effort (CPUE) of haddock is 56 times greater than the CPUE of cod. The difference between haddock and cod mean CPUEs is significant ($P < 0.05$). Such a difference is likely to result from the effectiveness of fabricated baits in targeting haddock, but not from the absence of cod in the experimental areas. The verification of fabricated bait's capacity of selectively targeting haddock has a range of implications for fisheries management and fishing businesses, from facilitating rebuilding of species to creating new fishing opportunities.

INTRODUCTION

Georges Bank haddock is a primary New England groundfish stock. Georges Bank haddock spawning biomass was only 11 thousand mt in 1993 with landings of roughly 4 thousand mt. Historically, when haddock spawning biomass is above 75 thousand mt, the average year class size is over 5-fold larger and the odds of above average recruitment are 30-fold greater than when spawning biomass is below 75 thousand mt. Thus, spawning biomass is important for recruitment success of this stock. At present, Georges Bank haddock spawning biomass was projected to be about 120 thousand mt in 2003 (Brodziak et al, 2002). This is the highest abundance of adult spawners since 1967 and a 10-fold increase since 1993. The stock is about halfway to rebuilding to its target spawning biomass of 250 thousand mt (NEFSC, 2004).

Year round closures enacted under the Northeast Multispecies Fishery Management Plan (FMP) of the New England Fishery Management Council in 1995 aimed at rebuilding overfished stocks of yellowtail, haddock and cod (Federal Register, 1995). The haddock resource is rebuilding rapidly and is considered one of the most impressive success stories in New England fisheries management. On the other hand, cod rebuilding has been problematic and slow. A directed haddock fishery could be warranted if cod bycatch can be maintained at very low levels.

Bait preference among species lets fishermen direct on a desired species. For instance, cod prefer clams or squid while haddock will scavenge on practically anything (Bjordal, 1996). The selective nature of baited benthic longline fishing gear (Bjordal, 1996) provides a potential method for targeting haddock. Research by Norwegian scientists (Lokkeborg, 1992) has shown three methods by which longliners can increase their haddock catches while greatly decreasing that of cod:

1. Replace squid with herring
2. Use smaller baits
3. Use a commercially available biodegradable fabricated bait

Previous research tested the first method, comparing the catch rates (lbs per hook) of cod and haddock when using both squid and herring as bait in Closed Area I on Georges Bank during October-December 2003. The cod catch rate using squid as bait was 0.13; using herring as bait reduced the catch rate by more than half to 0.06. The haddock catch rates were similar for the two bait types: 1.32 for herring and 1.66 for squid (Rudolph, 2004).

The fabricated bait suggested by the third method is manufactured by a process that restructures waste fish and fish offal from processing and mixes it with gelling agents, binders and other attractants. The formulaic mixture is subsequently extruded into a fiber mesh tube to form a continuous "sausage". The bait boasts a myriad of advantages for longline fishing vessels. Such advantages include no wastage, less preparation time, less bait, a higher baiting frequency, more bait delivered to the target, higher catches and less volume required for bait storage (Norbait, 2005).

OBJECTIVES

The objective of the experiment was to test the various fabricated baits' effectiveness at catching haddock and cod in fishing closures throughout New England, using benthic longline fishing gear. It was hypothesized that fabricated bait, when used in conjunction with benthic longline fishing gear, selectively targets haddock without catching cod. If the bait is actually selective, it should be effective regardless of spatial and temporal differences.

METHODS

The data presented here were collected through 324 benthic longline hauls exclusively using fabricated bait. A total of 380,720 hooks were set in areas of Closed Area I (CA1), Western Gulf of Maine Closure (WGOM), Rolling Closure III (Platts), Cashes Ledge Closure (Cashes), and Eastern U.S. Canada Resource Sharing Area (EUSCA). Figure 1 indicates general sampling areas; Table 1 indicates distribution of effort among the areas. The CA1 hauls were completed exclusively by small (36'-40') commercial hook and line dayboats during 49 trips. The EUSCA, Cashes and Inshore GOM hauls were completed by a diverse fleet of hook and line vessels, ranging from small dayboats to large (65') commercial auto-longliners.

All hauls were observed and processed by a trained, independent scientific data collector and met the guidelines set forth by the various Exempted Fishing Permits (EFP) necessary to perform the research. The actual round catch weights of each species (kept and discard) on a haul by haul basis were measured. When actual weight measurements of landed fish could not be obtained, estimated weights were determined by counting the number of individual fish and converting to dressed weight using the average landed weight per trip. Dressed weight was converted to round weight using the NMFS standard conversions for groundfish (1.17 cod, 1.14

haddock). Length measurements of all cod, all sublegal haddock, and 33% of legal haddock were also collected. On preliminary trips, a subset of adult haddock were weighed and measured to confirm that the length-weight relationships agreed with previous assessment data collected by NMFS (Brown & Hennemuth, 1971). Data were entered into the New England Fishery Science Center SeaSamp database, as well as CCCHFA's in-house database.

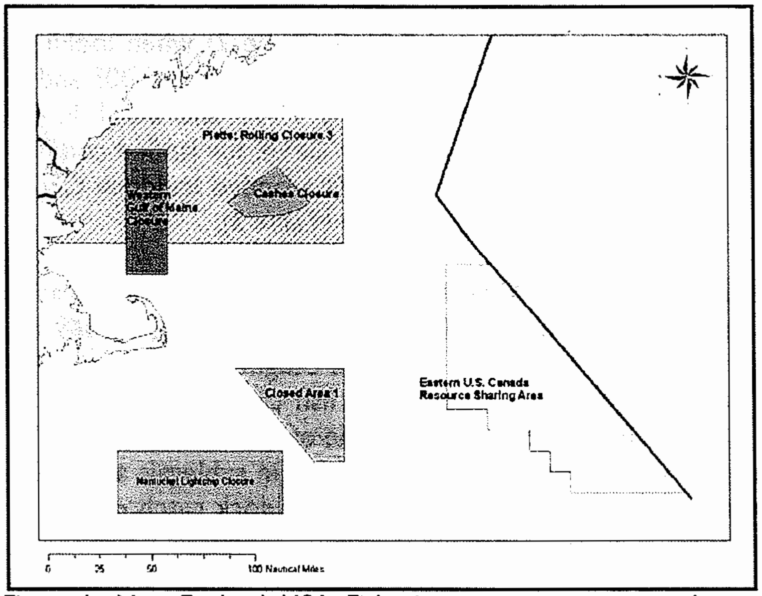


Figure 1: New England, USA: Fisheries management areas where research occurred are labeled in bold text.

Area	# Trips	# Hauls	# Hooks	Months Sampled
Georges Bank				
CAI	49	185	176,263	Feb, July-Dec
EUSCA	7	76	115,150	June, July
Gulf of Maine				
Cashes	2	10	16,700	Jan, May
WGOM	12	47	60,287	Jan, Feb, May
Platts	1	6	12,320	May
Grand Total	***71***	***324***	***380,720***	

Table 1: Effort Distribution

The data in this analysis were retrieved from the official SeaSamp database to ensure replicable analysis. The exception are the May, June and July data from EUSCA, WGOM, Platts, and Cashes which was drawn from our in-house database. The substantial amount of sampling has prohibited timely retrieval of the recent data from SeaSamp. Length frequency data were only available from SeaSamp; the data plotted does not include the recent May, June, and July data. Legal and sublegal individuals were divided based on legal size measured in total length. However, the available length frequency data were measured in fork length.

The fabricated bait used in the experiment was one of three types: Norbait, Trident, and homemade. The primary bait used was Norbait, a herring-based sausage form manufactured in Norway. Trident is similar to Norbait, but manufactured in Akutan, Alaska. The homemade bait was fabricated by Dr. Susan Goldhor in Cornell University's sausage lab and based on a recipe similar to the commercial baits, but modified to fishermen's size specifications.

RESULTS

Overall

The fabricated baits caught a total of 301,044 pounds of haddock and 5,375 pounds of cod, including legal sized fish and discarded sublegal and drop-off fish. The catch per unit effort (CPUE, lbs per hook) is 0.7907 and 0.0141, respectively (Table 2). The haddock and cod CPUEs remain relatively stable at 0.7803 and 0.0119 (Table 2) when looking at total landings (legal fish kept). Within Georges Bank, the CPUE for landed cod is 0.005 and 0.015 in CAI and EUSCA, respectively. The landed haddock CPUE is 1.191 and 0.511 in CAI and EUSCA, respectively (Table 3). Within the Gulf of Maine, the CPUE for landed cod is 0.026, 0.003, and 0.017 in WGOM, Platts, and Cashes, respectively. The landed haddock CPUE is 0.409, 0.099, and 0.143 in WGOM, Platts, and Cashes, respectively (Table 3).

Length-frequency results illustrate 3.2% of the total number of haddock caught were sublegal haddock; this is a rate of 15.4 sublegal haddock per trip, compared to 469 adult haddock per trip (Figure 2). Length-frequency results for total cod caught indicate a high relative amount of sublegal cod (45%); however, the actual number of fish caught is negligible: 119 sublegal cod were caught and released during the 22 months of the experiment, a rate of 2 sublegal cod per trip (Figure 3). The figures also illustrate the differences in sublegals and overall abundance of fish among the management areas sampled. CAI had haddock catch rates of 3.8 sublegals per trip and 418 adults per trip, with cod catch rates of 0.041 sublegals per trip and 0.49 adults per trip. WGOM had haddock catch rates of 62.7 sublegals per trip and 756 adults per trip, with cod catch rates of 10 sublegals per trip and 10.2 adults per trip. The Cashes length-frequency data only represent a single trip, with 154 sublegal and 367 adult haddock, with 27 sublegal and 31 adult cod.

	Landed, lbs	Landed CPUE	Discard, lbs	Discard CPUE	Total, lbs	Total CPUE
Haddock	297,081	0.7803	3,963	0.0104	301,044	0.7907
Cod	4,519	0.0119	856	0.0022	5,375	0.0141

Table 2: Haddock and Cod landings and discards, reported in pounds (round weight) and catch per unit effort (CPUE) measured in pounds per hook.

	Cod landed	Cod CPUE	Haddock landed	Haddock CPUE	Cod discards	Cod CPUE	Haddock discards	Haddock CPUE
CAI	908	0.005	209,935	1.191	17.1	0.0001	845	0.005
EUSCA	1,725	0.015	58,850	0.511	47	0.0004	1,353	0.012
WGOM	1,558	0.026	24,634	0.409	633	0.010	1,045	0.173
Platts	38	0.003	1,217	0.099	57	0.005	237	0.019
Cashes	290	0.017	2,395	0.143	102	0.006	533	0.032

Table 3: Total landings and discards of cod and haddock, separated by closure areas, reported in pounds (round weight) and catch per unit effort (CPUE) measured in pounds per hook.

Georges Bank vs. Gulf of Maine

On Georges Bank (CA1 and EUSCA) the fabricated baits caught a total of 90% of the total haddock and 50.2% of the total cod caught in the experiment with 76.5% of the total effort. The Gulf of Maine area (Cashes, Platts, and WGOM), 10% of the total haddock and 49.8% of the total cod with 23.5% of the effort. (Table 5). The catch per unit effort (pounds of fish per hook) in the two areas varies: cod CPUE is 0.0094 and 0.0300 for Georges Bank and the Gulf of Maine, respectively; haddock CPUE is 0.9405 and 0.3366 for Georges Bank and the Gulf of Maine, respectively.

While the amount of cod landed in the two areas is similar, the skewed effort (76.6% in Georges Bank) would imply that the CPUE is a better measure. CPUE in the two areas, for cod landed and discarded, have an order of magnitude difference (Table 6). The skewed effort is apparent in the haddock landings, with 90% of the haddock being landed from Georges Bank and a three-fold increase in CPUE. The haddock discards did have similar amounts between areas, but an order of magnitude difference in CPUE (Table 7).

	Cod Total, lbs	**Haddock Total, lbs**	**Cod CPUE**	**Haddock CPUE**
Georges Bank	2,697 (50.2%)	270,984 (90%)	0.0093	0.9299
Gulf of Maine	2,678 (49.8%)	30,060 (10%)	0.0300	0.3366

Table 5: Breakdown of cod and haddock totals by general area. Georges Bank includes Closed Area I and EUSCA data. Gulf of Maine includes Cashes Ledge, Platts and Western Gulf of Maine data. Percentage of total pounds is in parentheses.

	Cod Landed, lbs	**Cod CPUE**	**Cod Discard, lbs**	**Discard CPUE**
Georges Bank	2,633 (58.3%)	0.0090	64 (7.5%)	0.0002
Gulf of Maine	1,886 (41.7%)	0.0211	792 (92.5%)	0.0089

Table 6: Breakdown of cod landed and discarded by general area, recorded in pounds and pounds per hook (CPUE). Georges Bank includes Closed Area I and EUSCA data. Gulf of Maine includes Cashes Ledge, Platts and Western Gulf of Maine data. Percentage of total pounds is in parentheses.

	Haddock Landed, lbs	**Haddock CPUE**	**Haddock Discard, lbs**	**Discard CPUE**
Georges Bank	268,834 (90.5%)	0.9225	2,149 (54.2%)	0.0074
Gulf of Maine	28,247 (9.5%)	0.3163	1,814 (45.8%)	0.0203

Table 7: Breakdown of haddock landed and discarded by general area, recorded in pounds and pounds per hook (CPUE). Georges Bank includes Closed Area I and EUSCA data. Gulf of Maine includes Cashes Ledge, Platts and Western Gulf of Maine data. Percentage of total pounds is in parentheses.

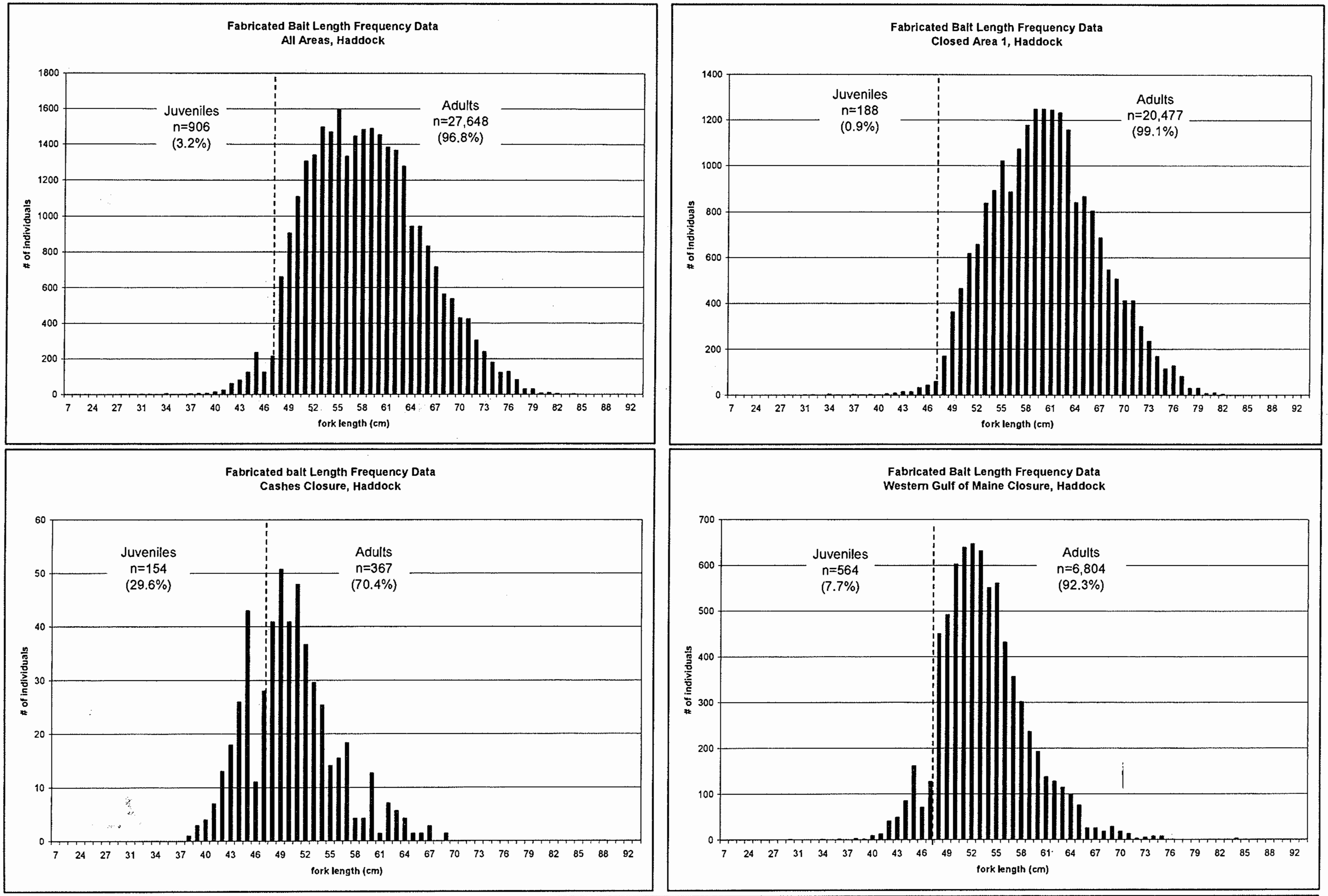


Figure 2: Haddock Length Frequency Data from Fabricated Bait Hauls. 100% sublegal haddock were measured, but only 33% of legal haddock were measured; the measured legal haddock length frequency data was extrapolated to illustrate the actual number of haddock caught. Dashed vertical line on the haddock graph indicates minimum commercial size (Total Length 19" = 48cm). Note: Cashes Closure represents a single trip.

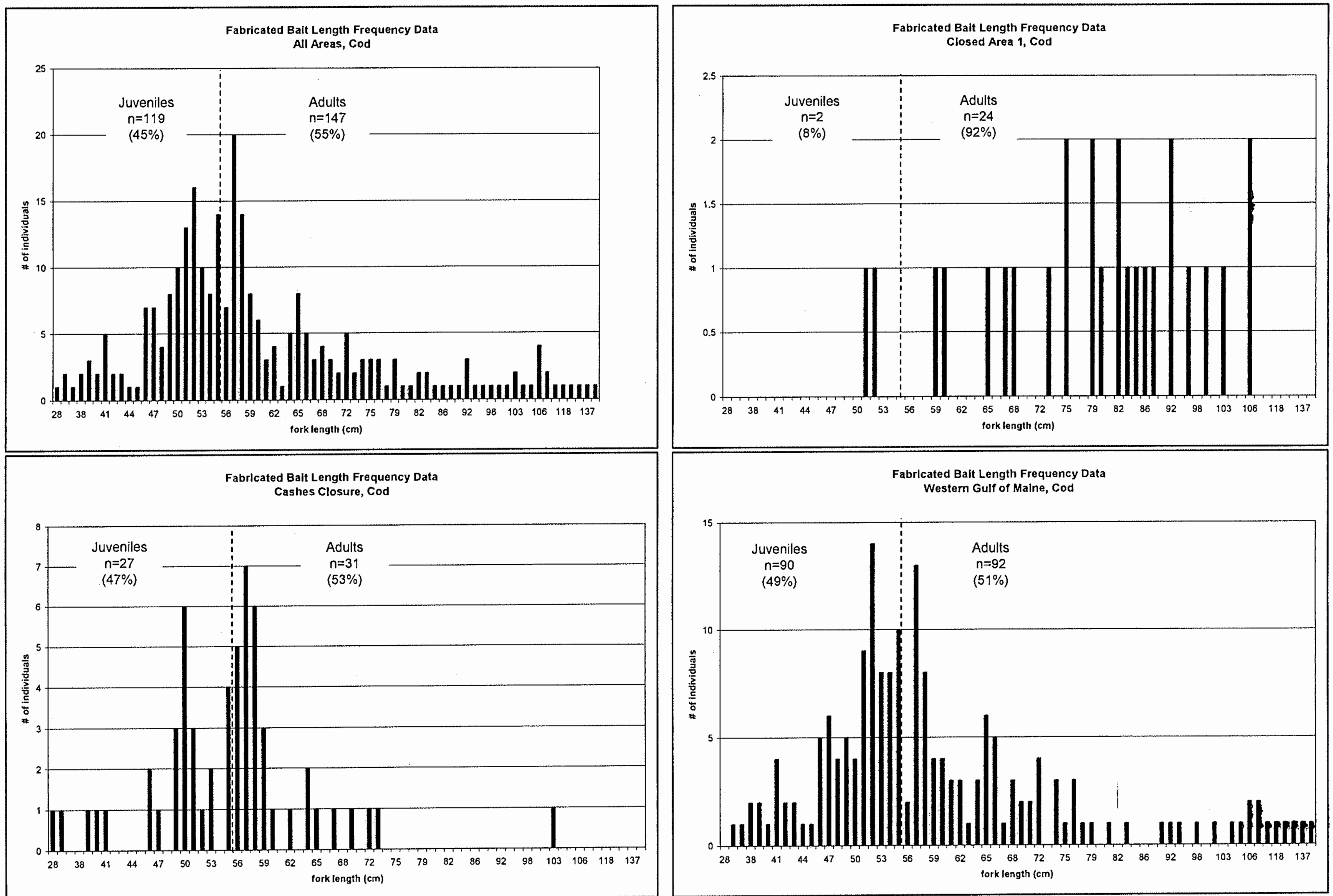


Figure 3: Cod Length Frequency Data from Fabricated Bait Hauls. All legal and sublegal cod were measured. Dashed vertical line on the cod graph indicates minimum commercial size (Total length 22" = 56cm). Note: Cashes Closure represents a single trip.

Trip by Trip Results

Descriptive statistics of haddock and cod total catch weight and catch per unit effort are detailed in Tables 8 and 9. The statistics look at all of the experimental trips, separated by Gulf of Maine and Georges Bank regions. For the purpose of this analysis, each sample equals one trip. The fishing effort on each trip varied greatly, as shown by the range of hook#: 13,026 in the Gulf of Maine and 29,717 in Georges Bank. Both regions display CPUEs of haddock and cod that are significantly different at the 95% significance level. In Gulf of Maine, cod CPUE (0.051) does not fall within the 95% confidence interval for haddock CPUE (0.361, 0.945). In Georges Bank, cod CPUE (0.007) does not fall within the 95% confidence interval for haddock CPUE (0.910, 1.224).

Gulf of Maine	***Hook #***	***Haddock CPUE***	***Cod CPUE***	***Haddock lbs***	***Cod lbs***
Mean	5953.80	0.6528	0.0512	2004.0	178.5
Standard Error	1185.94	0.1490	0.0107	323.4	34.1
Median	5450.00	0.3555	0.0465	1792.2	142.0
Mode	-	-	-	-	-
Standard Deviation	4593.13	0.5771	0.0414	1252.7	132.0
Range	13026.00	1.4723	0.1251	4789.9	524.9
Minimum	1324.00	0.0789	0.0046	311.3	18.0
Maximum	14350.00	1.5512	0.1297	5101.2	542.9
Count	15	15	15	15	15

Table 8: Descriptive summary of trip by trip Gulf of Maine data for cod and haddock. Total pounds caught were recorded in round weight. CPUE is pounds of fish per hook. Gulf of Maine includes Cashes Ledge, Platts and Western Gulf of Maine data.

Georges Bank	***Hook #***	***Haddock CPUE***	***Cod CPUE***	***Haddock lbs***	***Cod lbs***
Mean	5203.80	1.0667	0.0069	4,839.0	48.2
Standard Error	716.62	0.0801	0.0013	461.2	13.5
Median	4168.50	1.0435	0.0029	4,431.1	11.0
Mode	4500.00	-	0.0000	-	0.0
Standard Deviation	5362.72	0.5995	0.0094	3,451.5	101.2
Range	29717.00	2.7392	0.0401	18,065.9	612.3
Minimum	283.00	0.1205	0.0000	174.1	0.0
Maximum	30000.00	2.8596	0.0401	18,240.0	612.3
Count	56	56	56	56	56

Table 9: Descriptive summary of trip by trip Georges Bank data for cod and haddock. Total pounds caught were recorded in round weight. CPUE is pounds of fish per hook. Georges Bank includes Closed Area I and EUSCA data.

CONCLUSION

The data support the hypothesis that fabricated bait catches haddock with a low incidence of cod. The overall CPUE of haddock is 56 times greater than the CPUE of cod. The worst regional performance was still successful, occurring when there were not a lot of haddock in the area: The Gulf of Maine haddock mean CPUE was 0.3366, 11.2 times greater than then cod mean CPUE of 0.0300 and significantly different at the 95% significance level. The data are especially strong on Georges Bank, where haddock mean CPUE is 150 times the cod mean CPUE (1.067 vs. 0.007) and also significantly different at the 95% significance level. Evidently, when haddock catches are low, the catch rates of cod increase. This could be attributed to less haddock in the area or possibly greater numbers of cod present. While the Gulf of Maine cod CPUE is 3.2 times the Georges Bank CPUE, it is still very low: at that rate, ten thousand hooks would only catch 300 lbs of cod.

The difference between the two areas on Georges Bank is relatively small: the cod CPUE for EUSCA is 3 times the cod CPUE for CA1; the haddock CPUE for CA1 is 2.3 times the haddock CPUE for EUSCA. Once again, when haddock CPUE is low, cod CPUE increases slightly. The areas in the Gulf of Maine show more variable data. The single trip to Platts has exceedingly low CPUEs of both cod and haddock; there may have been no fish around, but the single sample does not allow for a true conclusion. The WGOM cod CPUE is 1.5 times the Cashes CPUE and 1.7 times the EUSCA CPUE. The WGOM haddock CPUE is 2.9 times the Cashes CPUE and 1.2 times the EUSCA CPUE. While the haddock CPUEs in the Gulf of Maine are lower than Georges Bank, it may be an indication of stronger recovery and higher biomass on Georges Bank. All three areas in the Gulf of Maine indicate that haddock are more likely than cod to prefer fabricated bait, with a preference magnitude of 8 to 33 fold.

The minimum and maximum CPUEs confirm, like all fishing, the variable nature of fishes. Gulf of Maine and Georges Bank both have exceptional maximum haddock catch rates, catching 1.5 to 2.8 pounds of fish per hook. Most hook and line fishermen consider catch rates of 0.3 adequate and 0.5 good. There were also trips in both areas that had low catch rates of haddock: 0.07 to 0.12 pounds of fish per hook. The fabricated bait never failed to catch any haddock. Cod catch rates for the two areas had extraordinary minimums: many trips had zero cod, up to 0.0046 pounds per hook. The maximum cod catch rates are acceptable, catching 0.04 to 0.13 pound of fish per hook. The highest maximum rate, 0.13, was on a trip that also had a high haddock CPUE, 1.4, possibly indicating a time or place where catch rates are high regardless of species. The catch rates are variable, as there was a range of effort used throughout the experiment; the only calculable mode is zero for cod pounds and CPUE. All of the data comparing Georges Bank and Gulf of Maine do need to be considered in light of sample size: there were 56 trips and 291,413 hooks in Georges Bank and only 15 trips and 89,307 hooks in the Gulf of Maine. A few trips to the Gulf of Maine that caught an above average amount of cod could have easily skewed the overall CPUE since they accounted for approximately one sixth of the dataset.

Additionally, the fabricated bait does not result in many discarded fish. When corrected for effort, haddock discards are 1% of the total haddock caught (lbs). For cod, the discards account for 16% of the total cod caught (lbs). Discarded sublegal fish represent a subset of the total discards. Calculated with numbers of fish from the length frequency data, cod sublegals accounted for 45% of the total cod, and haddock sublegals accounted for 3.2% of the total haddock. Preliminary reports indicate that many of the discarded sublegal cod survive the release process (Rudolph, 2005). The amount of sublegal fish is most likely smaller than the numbers reported through length frequencies; the fish lengths were classified as sublegal based on fishing regulations (56 cm for cod and 48 cm for haddock) measured in total length (TL), even though the measurement taken was fork length (FL) (Figures 2 and 3). This discrepancy could result in a 47cm (FL) haddock being classified as sublegal (less than 48cm, TL), when in reality, if measured to total length, it would most likely be a legal fish. The data were not corrected for this potential over-reporting of sublegal fish.

DISCUSSION

The results of this study substantiate the ability of fabricated bait to catch significantly more haddock than cod. Ideally, the study would have a control of other baits as a side by side comparison with the fabricated baits. However, the federally issued experimental fishing permit that allowed the research to occur did not allow for enough cod to be caught to create a control. If squid and herring had been used throughout the course of the study as controls, the experiment would have ended after a few trips as a result of exceeding the low cod caps set by the permit. For the permit in EUSCA, fabricated bait was the only bait allowed, preventing any type of control.

An indirect comparison of the fabricated bait data to Rudolph's (2004) squid and herring data shows that the squid and herring have, respectively, a total cod CPUE 9.3 and 4.3 times greater than the fabricated bait. The fabricated bait caught 56 times more haddock than cod, while the squid and herring only caught 12 and 22 times more haddock than cod, respectively.

We can at least verify that cod was present in the EUSCA area while our experiment occurred. National Marine Fisheries Service (NMFS) has been monitoring haddock and cod landings for all gear types in the EUSCA through vessel reporting and observer coverage. For the time period that corresponds to our EUSCA trips (June 2 - July 14, 2005), NMFS reports 170,042 and 674,780 for the cumulative reported total pounds caught of cod and haddock, respectively (NOAA, 2005). This is a 4-fold difference in cod and haddock. Our experimental trips caught a total of 1,772 lbs of cod and 60,203 lbs of haddock, a 34-fold difference. The 170,042 pounds of cod caught in the area confirms the presence of cod during our experimental fabricated bait sets.

Additionally, the Northeast Fishery Science Center indicates the 2002 biomasses of haddock and cod on Georges Bank have a 4:1 ratio (Brodziak, 2005). The fabricated bait CPUE ratios for Georges Bank show that haddock is, on average, 154 times more likely to take the bait than cod. If the bait was not selecting for haddock, the ratios should be closer to 4:1; instead, the haddock is showing a clear preference for the fabricated bait.

The verification of fabricated bait's success at selectively targeting haddock has a range of implications for fisheries management and fishing businesses, from facilitating rebuilding of species to creating new fishing opportunities.

New England groundfish are managed as a multispecies fishery and the ability to selectively target a single species prevents overfishing of depleted stocks within the fishery. In the case of Norbait, the fisherman can minimize mortality on cod while still targeting haddock. Currently, the Norbait is being successfully used by hook and line groundfishermen to catch haddock as a part of their regular fishing practices.

Selective targeting also creates management opportunities that allow stocks of concern to recover while landing healthy species. Current fishery management regulations (Amendment 13) strive to end overfishing of groundfish stocks in the long term, but have short-term social and economic costs for the New England groundfish fleet. Implementation of special access programs (SAPs) provide a way to mitigate some of these costs. SAPs provide for the creation of strictly managed, temporary fisheries targeting recovered or healthy fish stocks. Fishermen pay the majority of the costs associated with restricted management regulations and SAPs allow the fishermen to recoup these costs when their sacrifices have led to healthy stocks. Critical to SAP implementation is the ability to avoid overfished stocks during fishing.

The initial data collected in this experiment have already been used to support and implement a SAP fishery in Closed Area I for hook and line caught haddock. The initial results from the CAI experimental fabricated bait trips provided data in support of the fishermen's ability to target haddock without impacting the recovering cod stock. The 2004 SAP was a success, landing 1,041,127 pounds of haddock and 20,265 pounds of cod (2% of catch), and will continue in 2005. The opportunity to participate in an SAP saved a large portion of the Lower Cape hook and line vessels from going out of business; thus, preserving the historic community of dayboat fishermen in New England.

The assurance of minimal mortality on cod provides leverage for future haddock research projects. Experiments to measure discard mortality, movement patterns, and other life history traits can proceed without apprehension over impacts on the rebuilding process for cod. This leverage has already been illustrated through the development and successful implementation of the Northeast Consortium Cooperative Haddock Tagging Program. The tagging program uses Norbait to selectively fish for haddock inside and outside of fishery closures.

Fabricated bait derived from herring has been shown to successfully target haddock while barely catching cod. The success of this experiment offers the potential for interested parties to develop new fabricated baits that selectively target other commercial species. The creation of extremely selective fishing gear has the potential to assist fishery managers in ending overfishing and rebuilding the fisheries in New England and around the country.

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Appendix D:

Summary of CCCHFA Conservation Engineering Research: Targeting Haddock with Minimal Cod Bycatch using Demersal Longline

Introduction:

The Cape Cod Commercial Hook Fishermen's Association (CCCHFA) has tested the use of demersal longline to target haddock with minimal cod bycatch. This work now spans over three years, and has taken place through a sometimes bewildering array of different Exempted Fishing Permits (EFP's) and with support from a number of different funders, from the Northeast Consortium to the fishermen themselves. Through it all the deck protocols have remained the same, however, and some very interesting and promising trends have become apparent. The fabricated baits seem to keep the bycatch of cod, expressed in catch per unit effort (CPUE) quite low across a wide variety of times and places.

CCCHFA has experienced difficulty in finding an audience for the big picture, since many entities are focused on just their particular grant cycle or permit. CCCHFA hopes this summary will provide readers with enough background that the specific project under review will be placed in context, and dialogue will be opened on a broader front.

Background:

CCCHFA has conducted research on longline selectivity when targeting haddock since October 2003. The experimental protocol for these trips was developed in consultation with NOAA Fisheries' Northeast Fisheries Science Center (NEFSC), Northeast Regional Office Sustainable Fisheries Division (NERO-SFD) and REMSA Inc., and has been consistent throughout the work. Independently contracted Scientific Data Collectors (SDC) execute an enhanced NMFS SeaSamp protocol, with the focus on 100% enumeration of the catch (hook by hook) to certify the results. Sub-sampling is done as necessary and as intensively as possible, with the focus on round weights and length measurements for all cod and all sub-legal haddock. In addition, a sub-sample of kept haddock is measured for all strings, and all bycatch is weighed and measured for one string of each fishing event (tide). All legal haddock is retained and the dealer weigh-out is observed. Copies of the field sampling manual (protocol) are available upon request. Some trips have also been covered by Federal observers from the Northeast Observer Program (NOP), provided by the contractor AIS Inc.

Data management has also been consistent. Various project data are entered into two different databases (db). The lead SDC contracted by CCCHFA enters the data into an internal db designed and maintained by CCCHFA. All work in Georges Bank Closed Area I (CAI) is housed in an MS Excel db. Subsequent work in other closed areas and in the Eastern U.S./Canada Resource Sharing Area (EUSCA) is housed in an MS Access db. These internal databases are used for EFP monitoring and other time-sensitive work, as well as serving as a backup and error-checking tool. Concurrently, the lead SDC enters the data into the NMFS SeaSamp database under special project codes. Trips observed by AIS Inc. are keypunched by the NOP.

By and large the work was designed as a Special Access Program (SAP) Demonstration Project. This project classification was established by SFD in consultation with the Northeast Cooperative Research Partners Program (NCRPP) in 2004 to describe projects which aim to demonstrate biologically sustainable (i.e. low bycatch) and economically viable (i.e. high target catch) fishery opportunities. Once accepted such a fishery may then be incorporated into the management plan as an SAP, with carefully relaxed input controls, partial hard Total Allowable Catch (TAC) limits and higher standards of monitoring. Under this model, the inquiries aimed to cover a diverse array of times and locations, but within this framework, the investigators and fishermen targeted areas in which they could harvest haddock efficiently. The consistently required utilization of the fish revenue to fund the research further necessitated this approach.

Timeline and Description of Work:
Research began in the northwest corner of CAI in October 2003, and continued through the end of December under **EFP DA-280**. This portion of the work was largely paid for through the sale of the fish caught on the trips; vessels were paid a fixed daily rate. Additional support came from the J.M Kaplan Fund. 49 trips took place under this EFP. In addition to targeting haddock in diverse locations within the zone that would eventually become the CAI Hook Gear Haddock SAP, these trips performed side-by side analysis of different baits (herring, mackerel, squid). Late in the program, support from the **FY03 NEC PDA** made possible the acquisition and testing of three different fabricated baits (Trident™, Norbait 700E™, and the homemade product designed by Susan Goldhor), including side by side trials against other baits. This fabricated bait testing showed tremendous potential, and continued under the PDA into early 2004. A final report on the **PDA**, entitled ***"Production and Testing of an Alternative Bait Selecting for Haddock,"*** included analysis of this data and was submitted in June 2005.

The results of **EFP DA-280** were summarized in a document presented to the NEFMC and SFD entitled, ***"Georges Bank Hook Sector Closed Area I Special Access Program (SAP)"*** which is available upon request.

In 2004 the work continued on two fronts. **EFP DA-338** was secured to allow the Cape Cod fleet to survey CAI in all the previously un-sampled months except the peak spawning months of March and April, and expanded the study area to the entire northern portion of CAI (i.e. the original SAP area and additional areas to the east and south). This work took place in summer 2004 and through June 2005, and continued to be funded through fish revenue. Analysis is ongoing.

At the same time, CCCHFA worked with a group of fishermen from Portland, Portsmouth, Gloucester, and the South Shore of Massachusetts to secure **an NCRPP award (contract #EA133F-04-CN-0042)** to allow the research to be replicated in other year-round closed areas in the Gulf of Maine (GOM) and on offshore Georges Bank (GB). This NCRPP project, entitled ***"Using Hook and Line to Minimize Cod Bycatch in a Directed Haddock Fishery on Georges Bank and in the Gulf of Maine,"*** concluded field work in February 2006, and is currently in the analysis and reporting phase, with submission of the completion report expected in July 2006.

Permitting proved a substantial challenge for the CRPP project. The original EFP application was partially rejected, and the portion granted was consequently late. The Georges Bank Closed Area II (CAII) portion of the project was denied a permit, while the Western Gulf of Maine Closed Area (WGOM), Cashes Ledge Closed Area (CLCA), and GOM Rolling Closure III (RC III, Platts Bank) work was permitted to go forward in certain components of those closed areas during specific seasons under **EFP DA-448**. This work took place from December 2004 through September 2005. Additional fabricated bait testing supported by the **PDA** took place in the GOM on these trips but was not available in time for inclusion in the **PDA** completion report. It was, however, included in a white paper prepared for NMFS by CCCHFA in September 2005 entitled, ***"Selective Targeting of Haddock Using Fabricated Bait: An industry motivated special access demonstration project"*** (available upon request). This document took a broad, CPUE oriented view of fabricated bait performance and included analysis of data from CAI, CAII, EUSCA, WGOM, CLCA, and RCIII.

It should also be noted at this time that **EFP DA-448** had another component, the last piece of the puzzle in CAI: those areas east and south of the originally surveyed SAP area were also surveyed for the critical time period of October through December, filling out the survey for all areas in the north portion of CAI. This was accomplished in 2004. This work was not funded by the NCRPP.

Finally, in June 2005, **EFP DA-735** was secured to allow the NCRPP work to take place on offshore GB. Because critical grounds in the CAII Habitat Area of Particular Concern (HAPC) were omitted from the permit, additional areas were targeted in the EUSCA. This work concluded in February 2006. Analysis of this, all other **NCRPP** data, and any ancillary data deemed necessary was performed by Yong Chen, Associate Professor for Fisheries Population Dynamics at the School of Marine Science at the University of Maine.

Finally, management, budget, and especially, EFP constraints made the setting of controls difficult throughout the project. At times, for instance under **EFP DA-735**, vessels were effectively prohibited from setting anything except fabricated bait by extremely low poundage caps on cod bycatch. Interested parties seeking bait-to bait comparisons are advised to consider alternative data sources including CCCHFA data and Canadian GB data collected in 2005 by the Centre for Sustainable Aquatic Resources and summarized in a report entitled, ***"Norbait Trials in the Canadian Longline Haddock Fishery on Georges Bank to Reduce By-Catch of Atlantic Cod"*** (available upon request).

**Catch Ratios of Cod and Haddock in the Northwest Atlantic:
Comparing Fishing Gear and Bait Type**

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March 25, 2007

Introduction

Following the collapse of the Northern cod stocks in the early 1990's, bycatch restrictions have impacted fisheries targeting other groundfish species. The haddock fishery on the US side of Georges Bank has experienced closures in two of the past three fishing years before the haddock quota was caught, as a result of high bycatch of yellowtail flounder (2004) or cod (2005) (Tom Rudolph, personal communication, 2006). Efforts have been made to reduce cod bycatch, including gear substitution, gear modification for trawl gear, and alternative baits for longlines.

The Cape Cod Commercial Hook Fishermen's Association (CCCHFA) has maintained a database of catches from Georges Bank and other areas in the Gulf of Maine over several years, with multiple bait types, including fabricated baits such as Norbait. Regulatory and budget constraints have limited the CCCHFA's ability to perform side-by-side comparisons of bait performance in an experimental framework. However, there are sufficient records of catches with different gears or different baits operating in the same areas around the same time, to be able to assess their relative ability to catch haddock while avoiding cod.

In this study, we compare the catch of cod per haddock between otter trawls and longline gear in the Eastern US-Canada Resource Sharing Area (EUSCA) in the summer of 2005, and among longlines operating with squid, herring, or Norbait as bait in Closed Area I, from October 2003 to June 2005.

Cod bycatch in longlining in the Gulf of Maine has been investigated in previous work by the CCCHFA and others. The CCCHFA have looked at catch of haddock and cod in several areas over three years, with records running to many thousands of hooks. They have recorded cod and haddock catch rates using traditional baits including squid and herring, and fabricated baits including Norbait (Leach and Goldhor 2005). Over all these trips, squid had the highest percentage of cod/haddock at 9.14%, herring caught 3.62% cod/herring, and Norbait 0.28%. In 5 different areas, estimates of average cod/haddock caught with Norbait range from 0.029 to 0.118 (Sanderson et al. 2005).

Experimental side-by-side trawls with mackerel and Norbait were conducted by the Fisheries and Marine Institute at Memorial University of Newfoundland in 2005 (Walsh et al. 2006). Their catch of cod was reduced from 0.6 cod per hundred hooks with mackerel as bait to 0.2 cod per hundred hooks with Norbait. Mackerel caught cod at a rate of 0.016 cod/haddock while Norbait caught 0.007 cod/haddock in this experiment. No test of statistical significance is given but they caution that tests should also be done at locations and times with higher relative cod abundances. So there is evidence that fabricated baits can catch less cod per haddock than some traditional baits, and that cod bycatch rates can be kept to less than 10% of the haddock catch, often much less, using longlines with appropriate baits.

For trawl gear, the use of separator panels to reduce cod bycatch is being investigated and promoted by regulators. There is some evidence that using separator panels can reduce bycatch significantly. In 2004, 3 research projects on reduction of cod catch by trawlers in the haddock fishery on Georges Bank were funded by NOAA's Cooperative Research Partners Program (http://www.nero.noaa.gov/StateFedOff/coopresearch/grant.htm), but I could only find a report on one of them, a test of an experimental "Eliminator Trawl" by the University of Rhode Island. In this study Beutel et al. (2006) found that in side-by-side fishing trials, they could improve their ratio of haddock to cod from 3:1 to 20:1 with the experimental trawl design, while haddock catch rates stayed the same.

From the perspective of evaluating the performance of alternative baits in reducing cod bycatch, what has been missing is a way to compare different gears and baits when a side-by-side experiment is not possible. Looking at bycatch estimates in isolation, it hasn't been possible to rule out differences in local fish abundances as the primary cause of different bycatch rates.

Methods

Comparing gears in the EUSCA

Data on groundfish trips with otter trawls and bottom longlines in the EUSCA was obtained from the Northeast Fisheries Observer Program for from June 2005 to January 2006. This was combined with data from an in-house database of longline trips in the same area from May 2005 to February 2006, maintained by CCCHFA. Catches in the Observer Program are recorded by quarter-degree square rather than with coordinates for confidentiality reasons. Overlap between trawl sets and longline sets occurred in June 2005 in quarter-degree square 41673 and in June, July, and August 2005 in square 42671. Both are on the northern edge of George's Bank just west of the 67th meridian.

For initial analyses, records of haddock "kept" were converted from dressed to round weights by multiplying by 1.14 (the NMFS standard), and all records of haddock caught in the same haul (ie, kept or discarded for any reason) were added together to get one record for "haddock" for each haul. For any haul with no record of haddock caught, a record with a catch of zero was created. The same procedure was applied to cod records, except with a dressed to round conversion ratio of 1.17. For the CCCHFA records, "observed" and "estimated" weights were added together and treated the same way. Data from both sources was combined into a single data set and analysed together.

All CCCHFA trips were targeting haddock only, but trips in the Observer Program were targeting various species and could have up to 3 target species. Winter flounder was the most common target, followed by haddock and then yellowtail and unspecified groundfish. I compared cod bycatch rates among gears in trips only targeting haddock and again in trips with all targets. When considering all targets, hauls where the primary target was unspecified flounder or unspecified groundfish were removed.

Models were run on only the hauls in squares and months with both longline and trawl records. In order to compare across gears, I wanted to model the cod/haddock caught. The response variable modeled was the "empirical logit", log((cod+0.5)/(haddock+0.5)), or the log-odds, with the 0.5 added to prevent missing values when cod or haddock catches were zero. When no haddock or cod was caught, that observation was dropped.

Let C_y be the catch of cod in haul y and H_y be the catch of haddock in haul y. Then the dynamics are assumed to be given by:

$$\log\frac{(C_h + 0.5)}{(H_h + 0.5)} = \mu + gear_i + month_j + area_k + deep_l + e_h$$

where i is the gear used in haul h (bottom trawl or longline), j is the month of haul h, area is the quarter-degree square for haul h, and deep is a categorical variable representing whether the depth of the haul is greater than 50 m or not. I used family=quasi in R, so the model was fit with quasi-likelihood, allowing for overdispersion (with constant variance).

Comparing baits in Closed Area I

To compare between different baits, catch records were examined from longline trips conducted by CCCHFA in Closed Area I (CAI), on the Northwest edge of Georges Bank. These records cover 147 trips to CAI from October 2003 to June 2005. As with the EUSCA data in the previous section, data were obtained from the Northeast Fisheries Observer Program.

Any record for which the bait was described as "Fish with binders/casings" was assumed to be baited with one of three fabricated baits (Norbait, Trident or Goldhor). Readers interested in the comparative performance of these three products may reference the Sanderson et al. report titled, "Selective Targeting of Haddock Using Fabricated Bait: An industry motivated special access demonstration project" Also, some records had more than one bait type. If the second bait type listed was "Unknown", the haul was assumed to have used the first bait type listed. All other hauls with two bait types were dropped from the dataset. As in the previous analysis, weights for cod and haddock kept were converted from dressed to round weights using the standard NMFS conversion factors. Any haul with no record for cod catch was assigned a catch of zero, and catches of cod kept or discarded were added together to obtain a single cod catch record for each haul. The same was done for haddock. Because the goal was to compare catch rates with different baits in the same time and area, I identified records where at least two of the following three were used on the same day in the same quarter-degree square: squid, herring, or fabricated. These records were combined to form the dataset used for this part of the analysis.

Because this dataset involved a small number of comparisons on each day for many days (instead of a large number of comparisons for only a few months), a mixed-effects model was fit using the nlme package in R, with "day" as a random effect:

$$\log\frac{(C_h + 0.5)}{(H_h + 0.5)} = \mu + bait_i + day_j + area_k + depth + e_h ,$$

where C_h and H_h are the catch of cod and haddock in pounds in haul h, respectively, bait i is the bait used in haul h, area k is the quarter-degree square for haul h, and depth is the depth at the end of haul h, in metres. Day j is the date of haul h, and its effect size is a normally distributed random variable with zero mean. Model errors are assumed to be normal, and are fit with restricted maximum likelihood, not quasi likelihood as the first model.

Canadian Georges Bank

Observer records for the Canadian side of Georges Bank were also obtained from Fisheries and Oceans Canada, to determine whether cod bycatch rates could be compared between Canadian longlines and otter trawls targeting haddock.

Results

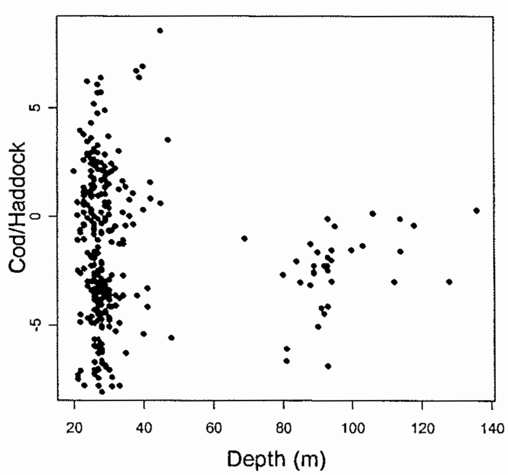
Comparing gears in the EUSCA

In the areas considered in the summer of 2005, bycatch of cod per volume of haddock caught was much lower for fishing with longline gear than with trawl gear (Tables 1). Considering only hauls where haddock was the target, longlines never caught more than an average of 0.045 lbs cod per pound of haddock. Trawl bycatch rates are more variable, from 0.726 lbs of cod per pound of haddock in square 41673 in June to 0.059 lbs of cod per pound of haddock in July in square 42671. Cod/haddock was significantly lower for longlines than for trawls in all months and areas. The proportion of cod was higher for trawlers in shallower water (<50m) than in deeper water (Table 1). Hence, differences in cod catch rates are not due to depth; see also Figure 1.

Table 1 Cod per haddock, by volume, in hauls targeting haddock with different fishing gears in summer 2005. The bracketed numbers are the 95% confidence intervals.

Square	Month	Longline	Trawl	
		<50m	< 50m	≥50m
41673	June	0.045 (0.022-0.092)	0.726 (0.644-0.795)	
42671	June	0.019 (0.011-0.033)		0.130 (0.052-0.288)
42671	July	0.008 (0.005-0.012)	0.310 (0.163-0.507)	0.059 (0.026-0.127)
42671	August	0.019 (0.007-0.051)		0.134 (0.055-0.293)

When trawl data for all groundfish targets was included, I modeled both the cod/target (ie, cod/winter flounder when winter flounder is the main target), and the cod/haddock. Longline and trawl records from the same month and area were available in 4 quarter-degree squares over June, July, and August 2005 (so the inclusion of other target species extended the spatial range over which comparisons could be made). The same pattern was seen (Table 2), in which cod bycatch rates were consistently significantly smaller in longline hauls in the same area than in the trawl fishery. Again, cod catch rates varied more in the trawl fishery, from 0.2 cod/target species to 0.461 cod/target species, than in the longline fishery (0.013 to 0.045 cod/haddock). Depth and month were not significant



predictors in this model.

Figure 1 Cod per haddock by depth for hauls targeting haddock with different fishing gears in summer 2005. Trawl records are black and longline records are in red.

Table 2 Cod catch per catch of the target species, by volume, in summer 2005. The bracketed numbers are the 95% confidence intervals.

Square	**Longlines**	**Trawl**
41674	0.045 (0.017-0.112)	0.461 (0.261-0.674)
42671	0.014 (0.009-0.021)	0.207 (0.141-0.294)
41673	0.030 (0.017-0.053)	0.363 (0.301-0.429)
42672	0.013 (0.005-0.035)	0.200 (0.096-0.371)

I also compared the cod/haddock (rather than cod/target) catch for longlines and trawls targeting any species. The patterns are similar again (Table 3), with consistently lower cod caught per volume of haddock by longlines than by trawls, in the same months and squares. Cod catches ranged from 0.013 lbs to 0.071 lbs per pound of haddock caught. For trawls, cod catches were consistently higher in shallow water (0.45 lbs to 0.826 lbs per pound of haddock caught) than in deep water (0.169 lbs to 0.541 lbs per pound of haddock caught). Trends in cod bycatch per haddock by depth when all targets were considered were similar to when only hauls targeting haddock were considered (Figure 2).

Table 3 Cod per haddock, by volume, in hauls targeting all groundfish with different fishing gears in summer 2005. The bracketed numbers are the 95% confidence intervals.

Square	**Longlines**	**Trawl**	
		< 50m	≥50m
41674	0.071 (0.030-0.154)	0.826 (0.689-0.910)	0.541 (0.312-0.754)
42671	0.013 (0.009-0.018)	0.450 (0.320-0.587)	0.169 (0.112-0.246)
41673	0.035 (0.020-0.060)	0.693 (0.640-0.741)	0.359 (0.221-0.525)
42672	0.037 (0.016-0.083)	0.709 (0.504-0.853)	0.377 (0.220-0.564)

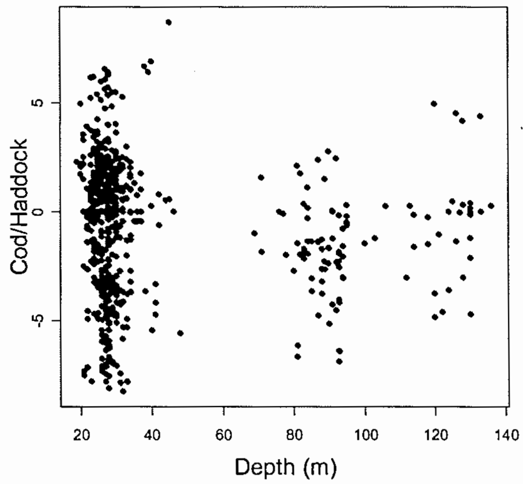


Figure 2 Cod per haddock by depth for hauls targeting all groundfish with different fishing gears in summer 2005. Trawl records are black and longline records are in red

All the analyses above included cod and haddock kept and discarded. I also wanted to characterize discarding of cod and haddock in both fisheries. Over all hauls, 5261 lbs of cod were caught by longlines, of which 334 lbs were discarded (6.3%), because they were too small to keep. Longlines discarded 6908 lbs of haddock, out of 125,197 lbs caught (5.5%), again mainly because of size. When trawls were targeting haddock, 35637.5 lbs out of 51862.5 lbs of cod caught were discarded (68.7%), mainly because of quota regulations. Trawlers caught 72927.9 lbs of haddock in hauls targeting haddock, of which 10719 lbs were discarded (14%), mainly because they were undersized.

There were only 2 trips in the Observer Program dataset which indicated that they were using an "excluder" on trawl gear, both of which had separator panels. I compared the cod caught/ haddock caught with trawls using separators to other trawls not using separators in the same areas (quarter-degree squares) and months, using ANOVA (Figure 3). A significant difference was not found in either case. Given the variability among trips in a single month and area, a larger sample of with and without separator panels would be needed to asses their impact on the cod bycatch.

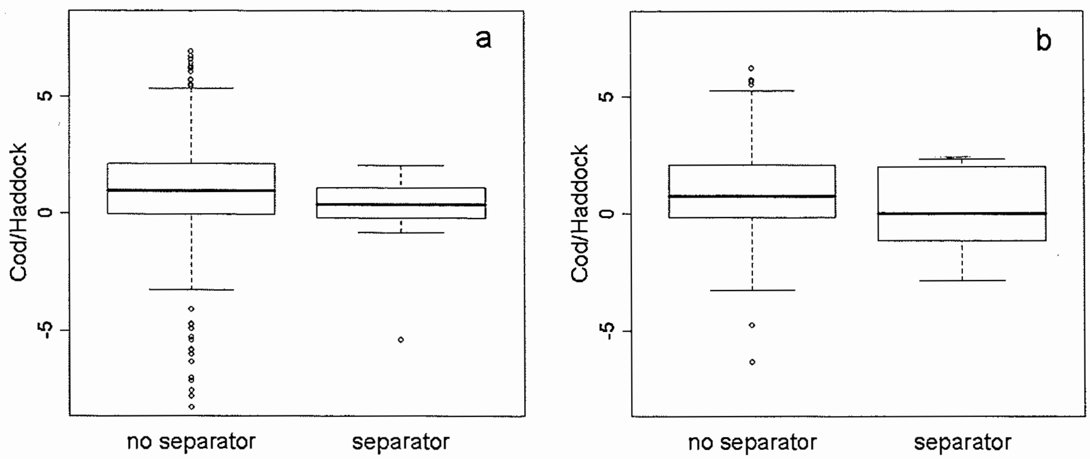


Figure 3 Cod per haddock caught, by volume, in all hauls that had a separator panel in place, and those in the same month and area with no panel. Hauls occurred in a) June 2005, square 41673, and b) July 2005, in squares 41671 and 41673. In each case hauls with a separator panel in place were from a single trip.

Comparing baits in Closed Area I

In order to correct for changes in cod to haddock ratios over time and space, I selected hauls using different baits in the same quarter-degree square on the same day. There were 267 hauls using either squid or herring on the same day in the same square, 198 hauls using either herring or fabricated bait on the same day in the same square, and 30 hauls using either squid or fabricated bait on the same day in the same square. Bait, square, and depth were all significant terms in the model, so average cod/haddock caught at the mean depth of 72m and the maximum depth of 90m are given in Table 4. Cod catch (as a proportion of haddock catch) was lower when fishing deeper with herring or fabricated bait (depth*bait term is significant for herring and fabricated bait, but not squid). All baits are significantly different at the $p<0.05$ level, and with cod catches lower with herring than squid, and lower with fabricated bait than herring. Cod/haddock catch rates were low across baits, however, staying less than 10% even for squid.

Table 4 Mean cod/haddock caught (by weight), in the degree square indicated, on days when at least two of the three baits were used in that square on the same day, with depth set at 78m (the overall average), and at 92m (the maximum depth).

Square	Depth	Squid	Herring	Fabricated
41691	78 m	0.0467	0.0121	0.0036
	90 m	0.0746	0.0251	0.0012
41682	78 m	0.0214	0.0054	0.0016
	90 m	0.0347	0.0113	0.0005

Canadian Georges Bank

Rates of cod and haddock caught on the Canadian side of Georges Bank are not comparable among longlines and trawls, or to fisheries on the US side. This is because longliners in the Canadian fixed gear fleet on Georges Bank have a cod quota which is substantial compared to their haddock quota – for example, the quotas were 642 t cod and 2742 t haddock for under 45' fixed gear vessels in 2006 (GOMAC Groundfish Working Group, pers. comm.). However, the cod quota for trawlers in the same area is very small compared to their haddock quota. Thus, while all sectors on the US side of Georges, and trawlers on the Canadian side are highly motivated to avoid cod, longliners on the Canadian side can fish such that they catch some cod, without limiting their ability to catch the haddock quota. Cod catch rates in longline fisheries on the Canadian side reflect this, and therefore were deemed to be not comparable to other gear sectors in terms of cod and haddock catch rates.

Discussion

Cod catch rates were consistently higher at shallower depths, but differences between gears and baits persisted when depth was taken into account. Longlines caught significantly lower amounts of cod than did trawlers, even when both were in relatively shallow water. Catch rates with herring and Norbait were lower than with squid, and the difference increased at lower depths.

One of the goals of this study was to be able to compare cod bycatch rates from longlines to bycatch rates of trawlers with and without separator panels in place. However, there were only two trips included which indicated that excluders were being used. Both the amount of replication and the temporal and spatial overlap is insufficient to detect differences in catch rates when separator panels were being used.

It was not possible to compare baits in the longline data from EUSCA. Almost all records from the Observer Program were listed as having "fish with binders/casings" as bait, which is most likely Norbait, but a small number were listed as baited with clams or "other". Similarly, CCCHFA records in the EUSCA area indicate that all but a very small number of hauls in this dataset used Norbait. The catch rates given for longlines in the EUSCA probably represent catch rates using Norbait as bait.

In 2005, the total commercial catch in the EUSCA included 431,298 lbs of cod and 1,044,697 lbs of haddock, for an overall ratio of 0.41 cod/haddock (NOAA Fisheries U.S./Canada Resource Sharing Monitoring, http://www.nero.noaa.gov/ro/fso/usc.htm). While the ratio of cod to haddock caught varies by time and area, the cod/haddock ratio caught by longlines in the summer of that year never exceeded 0.045 cod/haddock, less than 10% of the overall cod bycatch rate.

There are clear and statistically significant differences in the cod bycatch rates of longliners, mainly using Norbait, and otter trawls in the same months and areas in the EUSCA. Experiments in which different gears are used side-by-side are clearly preferable to the comparisons performed here, but it seems very unlikely that chance differences in cod and haddock abundances could be large enough in the same months, areas, and depths, over many trips, to produce such large differences.

Similarly, side-by-side comparisons of different bait types are best, but in this case we found statistically significant differences in cod to haddock ratios of different baits when fishing on the same days in the same area. Again, random differences in cod and haddock availability would be very unlikely to produce such a strong and consistent pattern. Fabricated bait caught significantly less cod per haddock than did herring or squid, but even with squid cod catches remained less than 10% of haddock catches.

References

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Leach, M. and S. Goldhor (2005). Production and Testing of an Alternative Bait Selecting for Haddock. Cape Cod Commercial Hook Fishermen's Association. Final Report to NEC- award #P4UZE113 Available from http://www.ccchfa.org/pages/2/20/.

NOAA Fisheries, U.S./Canada Resource Sharing Monitoring, available from http://www.nero.noaa.gov/ro/fso/usc.htm).

Rudolph, Tom. Personal communication, 2006.

Sanderson, M., T. Rudolph, M. Russo and M. Leary (2005). Selective Targeting of Haddock Using Fabricated Bait: An industry motivated special access demonstration project. Cape Cod Commercial Hook Fishermen's Association, Available from: http://www.ccchfa.org/pages/2/20/.

Walsh, P., P. Winger and W. Hiscock (2006). Norbait Trials in the Canadian Longline Haddock Fishery on Georges Bank to Reduce By-Catch of Atlantic Cod, Fisheries and Marine Institute, Memorial University of Newfoundland.

EA133F-04-CN-0042

STATEMENT OF WORK

PROPOSAL NUMBER: BAA04-1-13

TITLE: Using Hook and Line to Minimize Cod Bycatch in a Directed Haddock Fishery on Georges Bank and in the Gulf of Maine

NAME/ADDRESS of CONTRACTOR

Cape Cod Commercial Hook Fishermen's Association
210 Orleans Road
North Chatham, MA 02650
(508) 945-2432

PRINCIPAL INVESTIGATOR/S Paul Parker, Linda Mercer, Jon Brodziak

PROJECT SUMMARY

This study proposes to determine if hook-and-line gear could be used to harvest haddock with minimal bycatch of cod in order to establish a Special Access Program (SAP) under Amendment 13. The work would be conducted in a variety of closed areas, using up to 31 vessels, with 100% observer coverage.

PROGRAM BACKGROUND:

The need for this research relates specifically to the development of Special Access Programs (SAP) and to the use of "B" Days-at-Sea (DAS) as proposed in Amendment 13 to the Northeast Multispecies (Groundfish) Fishery Management Plan (FMP). This program may allow fishing in areas or during times when fully recovered fish stocks may be targeted by commercial fishing operations, while minimizing catch or mortality of groundfish stocks that are fully exploited or over-exploited.

This may be accomplished by using selective fishing practices or developing protocols for targeting certain species. The development of these programs will require research on and development of new and innovative fishing gear or conservation engineering as well as study of regulatory, monitoring, enforcement, social, and economic factors that may influence the authorization of these programs.

SCOPE of WORK

Cape Cod Commercial Hook Fishermen's Association (CCCHFA) will select study sites that will maximize the opportunity to target haddock using hook and line while minimizing bycatch of cod. The table below is a summary of proposed study sites.

# Trips	Area	Duration	Location	# Trips
8	Platts	5/05 – 5/06 2 Months	43.15 X 69.52 43.18 X 69.40 43.13 X 69.17 42.58 X 69.40	4
32	Cashes	7/04 - 9/04 12/04 – 1/05 5/05 – 6/05 7 Months	Cashes Closed	12
20	Wgom	5/05 – 6/05 12/04 – 1/05 4 Months	WGOM: North of 42.35 South of 43.00	16
40	Gb Caii	6/05 – 9/05 4 Months	CAII : N. of 42.00	16
40	Gb Caii	10/04 – 12/04 3 Months	CAII : N. of 41.40	18

CCCHFA will commence meetings with participating fishermen in late March to determine the appropriate vessels for sailing trips in the study sites and scheduling those trips. Fishermen are deeply concerned regarding their preparation for the 2004-05 fishing year. Research conducted using A Days at Sea is a high cost investment for most fishing businesses today. Therefore, it is critically important to plan out precisely which vessels will be sailing and when. CCCHFA will host bi-monthly meetings, conference calls and email correspondence with participants to maintain a high level of information exchange.

Participating vessels will negotiate and sign contracts of work with CCCHFA. Once EFPs have been granted to participating fishermen, sampling will begin. Research trips will sail in all inshore study sites on a weekly basis (weather permitting).

EFPs for Georges Bank CA II have been denied by NOAA pending further consultation with the New England Fishery Management Council. CCCHFA will initiate the discussion with the NEFMC in July 2004 with the hopes of securing permission to conduct the research by winter 2004/2005 in CA II. If EFPs are not granted, then funds allocated for CA II will be sued to sail additional trips to other closed areas.

Sampling in cashes will begin as funds are available in July or august 2004. Because trips in cashes are so expensive to sail, 12 trips will be allocated to the area. If the trips are successful at targeting haddock with low incidence of cod then revenue from these trips will generate the opportunity to sail more trips in the cashes area.

Sampling in the WGOM closed area will begin in December 2004. EFPs have been granted for 4 months in the WGOM closed area. Sixteen trips will be sailed in the area (or four trips per month during each of the months granted by the EFP). Revenues raised in the WGOM area will be used to increase the trips to that area.

An EFP has been granted for the Platts rolling closure that will be used in 2005. Four trips will be sailed in may 2005. Revenues from these trips will be used to continue sampling in June 2005 or in other areas.

In all areas, the EFP has been granted for two trips per week for the duration of the study. However, financial constraints make it impossible to guarantee sailing all of the requested trips. Instead, the sailing schedule in the table above will be met and then revenues will be used from the sale of fish to generate more trips in each of the study sites.

CCCHFA has prior experience developing requests for EFPs to conduct this type of research. Only by utilizing A DAS will the EFP process move efficiently. As such, the program has a viable source of income in the sale of the fish caught using A DAS. CCCHFA mandates that vessels working on these types of trips MUST deliver revenue from fish sold back to the program. This is necessary to: 1) avoid conflict with other fishermen by demonstrating that the research is not for financial gain but solely for the betterment of the fishery, and 2) avoid any bias that may arise if fishermen were vested in the amount of fish caught during the research.

CCCHFA will direct funds generated by the sale of fish back into the project to maximize the number of trips sailed in each of the research sites.

Setting the longline gear will be standardized by the fishermen in consultation with the NEFSC and REMSA. In past trials during EFP DA-280 and DA-338, bait types were set in "side-by-side" comparisons. For example, a vessel will set one "set" of 900 hooks baited with herring next to a "set" of 900 hooks baited with the Trident fabricated baits. Hook size or type will be standardized. As the project progresses, Dr. Goldhor will begin trials to see if bait can minimize dogfish interaction as well.

Data collectors will innumerate catch as the longline gear is hauled aboard. Length frequency data will be collected for a sub-sample of the haddock and cod. All bycatch will be weighed by species. Further refinement of the protocol will be overseen by NEFSC. Data from each trip will be key punched into the NMFS Sea Sampling database.

The Data Collectors will turn their trip report forms to the Lead Data Collector. The Lead Data Collector will then coordinate entry of the information into the NMFS sea sampling database and also concurrently maintain haul by haul data in raw form for use in monthly and quarterly reporting.

CCCHFA will ensure adequate insurance on all participating vessels as well as coast guard dockside inspections and AMSEA or equivalent cold water safety and survival training.

CCCHFA will contract one fisherman in the GOM and one fisherman for GB to coordinate the vessels, observers, and sailing times. When extra hands are needed on deck for fecundity work or other ancillary studies then the regional fisherman coordinator will be utilized. Other miscellaneous tasks including meeting coordination, bait pickup and making phone calls will be delineated to the regional fisherman coordinator by CCCHFA as deemed appropriate.

Upon concluding the study, the Maine DMR will access all of the study data from the NMFS database and provide it to Dr. Yong Chen, Population Dynamics Professor at the University of Maine School of Marine Science.

This project will also facilitate a low cost platform to conduct important fecundity research on haddock. Despite a long history of monitoring and assessing this commercially valuable stock, limited information exists on the reproductive biology, including estimates of total fecundity at age and length as well as timing of developmental stage prior to spawning. Female haddock from Georges Bank mature have a median age of maturity of 1.5 to 2.5 years at lengths of roughly 30-35 cm, depending upon year class and environmental conditions. Spawning occurs during January-June with average peak spawning during late-March-April. Timing of peak spawning activity appears to depend somewhat on water temperature in any given year. Detailed information on developmental maturity stage is not available during January to early-March. This time period is the most opportune for sampling developed adults to estimate total fecundity as a function of length and age. Although some unpublished estimates of total fecundity at length from the 1970s exist, these studies were based on small sample sizes and may not be representative of the stock in recent years. Collaboration with NEFSC will provide an estimate of total haddock fecundity at age and length and to evaluate female developmental stage and the materials budgeted for will allow for 800 female and 800 male samples.

PROJECT PERIOD

The project period will be 18 months from the start date.

DELIVERABLES/BENEFITS

- Hold bi-monthly fishermen's meetings.
- Submit monthly updates to NOAA Fisheries regarding catch and bycatch. The monthly catch reports will be generated by CCCHFA based on raw data and then submitted to NOAA Fisheries.
- Sea Sampling data will be entered into the NMFS database by REMSA data collectors.
- Submit semi-annual progress reports. Quarterly catch reports will also be based on raw data and submitted by CCCHFA.
- Submit final report by December 2005. The final report will be based on queries performed by ME DMR, and analysis performed by Chen.
- Present results at a minimum of two Cooperative Research venues and one conference.

- Present results to NEFMC and NOAA Fisheries.
- Present results in at least two fishing publications.
- Participating fishermen will present results at a minimum of five fishing organizations upon completion of the study and analysis.

BUDGET
This contract shall be in the amount of $300,000.

SCHEDULE OF REPORTING REQUIREMENTS

All financial reports and progress reports shall be submitted in triplicate (one original and two copies).

Financial Reports
Invoices are to be submitted by the 15th of each month to the Contracting Officer's Technical Representative:

Kenneth L. Beal
National Marine Fisheries Service
One Blackburn Drive
Gloucester, MA 01930

All invoices/financial reports must reference the contract number that the expenditures apply to.

Performance Reports
Semi-annual Performance Reports are required no later than 30 days following the end of each 6-month period from the start date of the contract. A cover page to each semi-annual report must include:

1) Contract #
2) Contractor Name / Address
3) Project Title
4) Period covered by the semi-annual report
5) Summary of progress to date – Describe tasks scheduled for this period and tasks accomplished for this period
6) Describe any specific problems or differences between scheduled and accomplished work

The final report is due 90 days after the contract completion. Researchers are required to submit a final report describing their research project results, or other acceptable deliverable(s), in a time frame that is specific to the type of research conducted. The format of the final report may vary, but must contain:

1) A cover page as referenced above;
2) A brief summary of the final report;
3) A description of the issue/problem that was addressed;
4) All raw data with detailed description of methods of data collection and analyses;
5) A discussion of results and any relevant conclusions presented in a format that is understandable to a non-technical audience; this should include benefits and/or contributions to management decision-making;
6) A list of entities, firms or organizations that performed the work and a description of how that was accomplished; and
7) A detailed final accounting of all funds used to conduct the research.

EXEMPTED FISHING PERMIT(S) / LETTERS OF AUTHORIZATION

Researchers may be required to obtain an Exempted Fishing Permit (EFP) or Letter of Authorization (LOA) prior to the onset of the proposed research by notifying NMFS and providing a statement of the purpose and goal of the experiment for which an exempted fishing permit is needed, including a general description of the arrangements for disposition of all species harvested under the exempted fishing permit. Researchers must also provide technical details about the experiment, including: (i) Amounts of each species to be harvested that are necessary to conduct the experiment, and arrangement for disposition of all species taken. (ii) Area and timing of the experiment. (iii) Vessel and gear to be used. (iv) Experimental design (e.g., sampling procedures, the data and samples to be collected, and analysis of the data and samples). (v) Provision for public release of all obtained information, and submission of interim and final reports. NMFS may issue an EFP or LOA to enable named vessels to carry out the project's Statement of Work.

Approval of project activities is contingent upon compliance by the applicant with all regulations and requirements, as appropriate, set forth by Fishery Management Plans under the provisions of the Magnuson-Stevens Fishery Conservation and Management Act. Associated inquiries should be directed to:

Mr. Paul Perra
Sustainable Fisheries Division
National Marine Fisheries Service
One Blackburn Drive
Gloucester, MA 01930
Telephone: 978-281-9153