The School for Marine Science and Technology

The High-Resolution Industry-Based Trawl Survey: Methods and Working Data

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Title Page

The High-Resolution Industry-Based Trawl Survey: Methods and Working Data

by

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ABSTRACT

The High-Resolution Trawl Survey project was established as a collaboration between the New Bedford commercial fishing industry and the School for Marine Science and Technology (SMAST) of the University of Massachusetts Dartmouth. One of the major incentives for the project was to recognize the desire of the commercial fishing community to participate more directly in the management of the resource. The primary focus of the project has been to create an industry-based program for the collection of trawl catch and environmental data suitable for use by researchers and fisheries managers. The SMAST High-Resolution Industry-Based Trawl Survey was a highly successful demonstration of a program to train fishermen to collect environmental and biological data. The data generated by this project is expected to provide significant information to regional managers by characterizing both the Georges Bank fishery trawling operation and its catch. The data collection goal of the project was to record catch, vessel, and environmental data for individual tows made during normal fishing operations by commercial trawlers operating on Georges Bank. The work has been conducted in collaboration with 20 vessels from the New Bedford trawl fleet, including vessels that fish primarily on Georges Bank. Trawl data were collected during two periods: November 2000 - October 2001, and August 2002-July 2003. This report provides a summary of the field collection and data processing methodology and a description of the resulting working data set provided to fisheries management and other agencies. A more detailed and comprehensive coverage of the data collection and processing methodologies is provided in the detailed report: .

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INTRODUCTION

The High-Resolution Trawl Survey project was established in November 2000 as a collaboration between the New Bedford commercial fishing industry and the School for Marine Science and Technology (SMAST) of the University of Massachusetts Dartmouth. One of the major incentives for the project was to respond to the desire of the commercial fishing community to participate more directly in the management of the resource. The primary focus of the project has been to create an industry-based program for the collection of trawl catch and environmental data suitable for use by researchers and fisheries managers. The design and implementation of the project relied on the ability of SMAST researchers to design a data collection system that made sense to fishermen and produced scientifically sound data. Goals of the project included:

- to obtain fisheries data with higher spatial and temporal resolution than available through industry-independent surveys;
- to involve industry in collection of fisheries data and management of resources;
- to develop methods for training commercial fishermen to record scientifically acceptable data during normal fishing operations;
- to demonstrate the feasibility of a cooperative project between the fishing fleet and scientists;
- to characterize the effects of environmental conditions and fishing operations on spatial and temporal patterns in catch statistics.

The purpose of this report is to document in detail the methods used to collect, process and archive the resulting data.

MATERIALS AND METHODS

The data collection goal of the project was to record fishing data for individual tows made during normal fishing operations for commercial trawlers operating on Georges Bank. Fishing data included catch, vessel, fishing operations, and environmental. The work has been in collaboration with 20 vessels from the New Bedford fleet of trawlers that fish primarily on Georges Bank (Table 1). Trawl data collections began in November 2000 and continued for a period of 12 months until temporarily stopping after October 2001. After a six- month gap (November 2001-July 2002), sampling resumed in August 2002 and continued through 2003. This report will cover the first two 12-month periods of data collection (November 2000 - October 2001 and August 2002-July

2003).

It is important to note that the participating vessels operate under a standard commercial fishing regime; they follow all normal regulations and receive no special research permits. The captains choose the methods, gear, location, and time of each trawl, based on their personal knowledge and commercial considerations. While vessels that participate in the project are paid $300/day to collect the required data, their primary role at sea is to catch fish. The vessel captains oversee data-logging activities by the crew, and are important participants in the data collection effort. SMAST researchers provide information and guidance on sampling techniques, log keeping, and observed results, and oversee the quality of the information returned. The returned log sheets and electronic sensors are processed by SMAST technicians using the methods described in this report. Since the fishing locations and catch quantity are implicitly sensitive information among economically competing commercial vendors, data availability is controlled during the processing cycle and stored on computers to which access is restricted. Except for a list of participating vessels (Table 1), vessel and captain identities are "blinded" in all data sets and reports produced by this project to preserve the confidentiality of vessel operations.

Fishing Boats

The participating New Bedford fishing vessels are groundfish trawlers that traditionally target cod and haddock during the spring and summer and flatfish during winter months (Table 1). The participating vessels' primary fishing grounds extend from Nantucket Shoals through the Great South Channel across Georges Bank. In early October 2000, vessels associated with the New Bedford Trawler Survival Fund (TSF) began to work collaboratively with SMAST to collect data while fishing. A TSF representative to the project, a fisherman and vessel owner, was instrumental as a liaison between the fleet and SMAST. The TSF boats, which are in the 75-100 foot range, are required to have current Coast Guard safety inspection. These boats normally carry a crew of five. Roughly half of the participating vessels have crews of Portuguese-speaking fishermen that are immigrants or descendants of fishermen from traditional Portuguese fishing ports found in the region between Porto in the north to Figueira da Foz in the south central region of Portugal. A smaller number come from the Azorean archipelago, Madeira and the Cape Verde Islands. The vessel captains oversee the crew data-recording activities and participate in the data collection themselves. For this project, the vessels were paid $300/day to collect the required data once they had signed a contract with the University. Due to budget constraints, only the seven vessels that performed the most complete and reliable data recording were retained for subsequent years. For a vessel to become part of the SMAST High Resolution Trawl Survey, a contract and tax information was needed to

Vessel Inspection and Training

Steps taken to train fishermen to collect fisheries data during commercial fishing operations are outlined in Figure 1. Once a vessel captain schedules a fishing trip, SMAST technicians assemble a package that includes a set of five different log sheets (Table 2), an observer manual, a common fish identification handout, and two activated Tidbit temperature recorders. They are also provided with hand-held scales and measuring boards. Before a vessel can independently collect data, it must first undergo a training trip on proper data collection and recording methods. Training trips are otherwise normal fishing trips in which an SMAST technician participates and provides training to the captain and crew. All vessels receive one training trip prior to beginning in the program, and at least one additional training trip during each year of the program. Training consists of an iterative process whereby the SMAST technician observes the fishing activities, instructs the captain and crew in the proper recording methods, and reviews the results following each tow for the duration of a fishing trip. After the initial training trip, the captain and crew record data without the aid of a technician during fishing operations on subsequent trips. The crews are initially trained by SMAST technicians when they join the project, and the technicians provide additional training and feedback on the quality of data collected thereafter. SMAST researchers provide information and guidance on fish identification, sampling techniques, log keeping, and observed results. The training specifically involves going over each of the steps necessary to collect the data, as well as numerous practices in filling out all the log sheets. The time is recorded on the logsheets as Eastern Standard Time (EST) local time on a 24-hour clock. Information on the vessel and gear used are also recorded for each vessel. SMAST observers participated on approximately 18 % of the 165 trips conducted during the two survey years (21 out of 115 in year 1, and 9 out of 50 in year 2; see Table 3).

Procedures and events for a typical training trip are outlined on the top portion of Figure 1 labeled “Setting Sail.” A meeting is arranged where introduction to the owner, captain, or both can be completed. The program is explained to the vessel’s representative. The vessel representative is required to give a tour of the vessel to an SMAST technician. During the tour the technician performs a general inspection to confirm that the vessel is seaworthy and looks for a current United States Coast Guard inspection sticker, life raft and other safety equipment. Once those criteria are established and the required paperwork (contract, tax information) is completed and recorded, a training trip is arranged. The vessel agrees to house, feed, and accept direction from an SMAST technician for the duration of a normal groundfish fishing trip in the Georges Bank fishery. The day the fishing trip is scheduled to depart, the SMAST technician meets the vessel at the dock. The technician is given a bunk and place to stow personal and work-related gear. Other preparation includes placing Tidbit temperature monitors on the fishing gear and describing what on-deck and wheelhouse duties will be required from the captain and crew on the training and subsequent fishing trips.

Overview of Field Operations

Data collection and processing is a complex task. Before describing data collection and processing for each type of data, a brief overview of the entire process will be presented below. The middle portion of Figure 1 provides a schematic flow chart overview of data collection for the "setting out," "haul-back" and "post-haul" stages of trawl tows. Before the ship leaves the dock, the captain is given a packet of logsheets, measuring boards, and length-frequency template sheets, and Tidbit temperature data loggers are placed on either the trawl doors or the nets. In the first year, the Tidbit recorders were generally placed on the nets, while in subsequent years, they were typically placed on the trawl doors. The captain generally knows what fishes he will be targeting for the trip before setting sail, but target species can change from haul to haul depending on fishing success, economic news and chance catches. The captain readies the logsheets once on the fishing ground and a trawl tow is about to take place. The location and time when the net is "set" is recorded on the environmental log. The net is set when it reaches the bottom, the doors have spread out the desirable distance, the brakes on the winch have been set stopping the free spooling of warp/wire and the engine is put into gear initiating towing. Trawl tows were typically of three-hours duration, but could be as long as 10 hours. Towing speeds were typically around three knots, but varied by vessel, gear and target species. During a tow it was often necessary for the captain to change course by turning about. During turns the net is typically, but not always, raised off the bottom to avoid fouling and tangling, but it is not taken on board ship. How high the net is raised depends on the circumstances and is at the captain's discretion. Captains were instructed to record all the data required on the environmental log (i.e., location, time, depth, wire out, weather, etc.) for each haul event. Haul events were defined to include the set, major turns, and the haul-back. The time and location for the start of the tow were recorded at the time of the set, while the time and location for the haul-back were recorded at the time the net was begun to be raised (i.e., when the wench brakes have been released and the wire/warp has begun to be reeled in). Once the codend is brought on board, the catch is released into a checker box or directly onto the deck for processing. Since this is a commercial fishing operation, the crew has often developed detailed fish processing routines that insure economic efficiency. Fishermen make minimal adjustments to their routine in order to collect scientific data.

Fishes to be kept for sale are culled from the catch and placed either into standard fish baskets or fish boxes. Fishes to be discarded are typically quickly swept, shoveled or thrown overboard. It is in the fishermen's interest to do this as quickly as possible to: 1) decrease mortality of discarded species to the extent possible, and 2) to minimize the loss of valuable time and energy better reserved for fishing and processing the kept fish. For these reasons, data on the discard species are poorly quantified. Fishermen estimate the total weight of each discarded species. They further partition the discard into weights for specific

discard reasons. For example, it's possible that a given fish might have both a minimum size limit and a maximum size limit. In that case some fish might be discarded that are too small or too large. It must be recognized that similar looking fishes of no economic value may not be distinguished by the fishermen (e.g., the various sculpin species). Likewise, similar looking species that are economically important, but that are sold under the same market name, are usually not distinguished by the fishermen. For example, although fishermen can be trained to distinguish red and white hake, it is not economically feasible for them to take the time and effort to do so during commercial fishing. Therefore, red and white hake are classified as a "red and white hake mix."

Many species of fishes kept and processed by the fishermen are dressed (i.e., butchered and cleaned) in various ways according to market demands. For this reason, the National Marine Fisheries Service has developed correction factors to convert the weight of dressed fish to an estimated whole fish weight. The SMAST trawl survey program uses the NMFS conversion data tables with a few minor changes (details can be found in a separate methods report[1]). Because the SMAST High-Resolution Industry-Based Trawl Survey was initially modeled after the National Marine Fisheries Service (NMFS) Observer Program, we strongly recommend readers to review of the NMFS Observer Manual (current copies can be downloaded @ http://www.nefsc.noaa.gov/femad/fsb/). Fishermen may estimate the weight of the catch for a given species either before or after dressing. The method used can change from haul to haul, and even between species within a given haul. Fishermen estimate weights based on visual inspection of the number of baskets or fish boxes that are filled or partially filled. It should be noted that fishermen have developed very specific methods of filling baskets and boxes because their livelihood depends on efficiency. Therefore, a packed basket or box of a particular species tends to be a standard quantity, and weights are relatively efficiently estimated. To date quantification of the weight estimation error made by fishermen during this survey has not been attempted. In the future, we hope to obtain species-specific and dressed-specific data on weight measurement variation.

Lastly, a sub-sample of one species of fish is collected during the sorting of the pile on roughly half of all hauls for use in length -frequency data. The fish are collected from the main pile in such a way as to ensure that the sample is as randomly distributed as possible. The project guidelines ask that thirty individual fish be collected per tow when a length-frequency is to be performed. In the first year of the project any species the fishermen chose was acceptable. Due to some very small sample sizes of individual species collected in year one, in year two the project asked that only six species (codfish, haddock, yellowtail flounder, winter flounder, plaice flounder, and grey sole flounder) be considered for measuring. The actual measuring of fish was performed on a wooden measuring board and recorded in cm on a reusable template.

After all on-deck duties have been completed, the haul information is recorded on a haul log. The length-frequency data is transcribed from the

measuring board onto a length-frequency data log. Usually a haul log is then prepared for the next haul. This set of processes is completed for every haul until the trip ends.

SMAST trawl project duties that must be completed by the fishermen at the end of a trip are outlined on the bottom section of Figure 1 labeled "ending the trip." These duties include removing the Tidbit temperature data loggers from the fishing gear and stowing them safely with the rest of the SMAST trawl project data. All data sheets are brought to a central location. During the fishing trip some of the data sheets are used in the wheelhouse by the captain and mate, and some are generally kept in the galley for the deck crew to complete. A crew member places all data logs and Tidbit data loggers in a package to be collected or delivered to an SMAST technician upon landing in port.

Overview of Data Keypunching and Quality Control

Data keypunching from the field logs and subsequent quality control auditing of the trawl data has undergone a series of changes since the inception of the project. During the first year and a half, all data generated by the project were keypunched by SMAST technicians, students and summer interns. Starting with Trip #223 (January 2003), keypunching was outsourced to Trade Quotes, Inc. (Boston, MA). Trade Quotes provided a professional keypunching service and significantly improved the quality of data entry. As a quality control measure, the company was required to double keypunch all data and then to cross-reference the resulting files to identify keypunching errors. Double keypunching of data is an effective way to minimize keypunching errors. However, the company was also instructed to keypunch written fields exactly as they appeared on the log, even when the data was known to be in error. This was required as it was felt that the professional keypuncher lacked adequate knowledge of the fisheries and fisheries data to make interpretive decisions regarding data. Therefore, all "problem" records were subject to review and editing by SMAST technicians that were capable of interpreting the data. In either case, SMAST technicians provided some degree of preliminary quality control by reviewing logsheets for obvious errors prior to keypunching.

Once data was keypunched, it was then subjected to two different levels of quality control auditing. During the first year and a half of the project, data were checked for errors at the trip level. Basically data were keypunched into separate files by trip number. These files were then examined in an excel spreadsheet and with various Matlab programs to check for common errors. For example, one of the checks was to plot the location of each haul to verify that the location information was consistent among hauls within a trip. However, due to temporary loss of funding and several changes in program management, no extensive auditing of the data was conducted until after the 2nd year of the survey had been completed. After this time, data from all trips were combined into a single file for each data type (trip log, environmental log, haul log, etc.). Then a

series of steps were taken to examine the data in its entirety for statistical outliers, unusual values, inconsistent records, and the integrity of data links between related files. All numeric fields were examined for trends that might indicate data errors. Usually the 1st and 99th percentile values were checked against the actual log sheets. Frequency analysis was used to detect any unusual modes that would then be checked. Character fields were checked for spelling variations, and were also subjected to frequency analysis. Coded fields were checked for valid code values, and any uncommonly occurring code values were checked.

A great deal of time was spent verifying the linkage between the environmental log data and the haul log data. Because the environmental log and the haul log contained an internal hierarchy of data, it was necessary to check for consistency of fields among levels in the hierarchy. For example, the target species value should be the same for all records in a given haul, and the total_pounds_discarded field should equal the sum of the weights recorded for all discard reasons for a given species and haul. Data auditing was first carried out on each data table separately (e.g., trip, environmental data, haul data), and then related tables were merged to check for the link integrity. For example, if there were data for cod length frequencies in the length-frequency table, there should be a corresponding entry for cod catch in the haul log. All audit checks were repeated in an iterative fashion until no errors were encountered. Typically, audit checks took the form of an SAS program that performed various manipulations (merges, reductions, transpositions) of the data, identified statistical outliers or high and low values, and checked for linkages between data tables. At other times, similar checks were done using the index function in an excel spread sheet. For example, if a particular field was supposed to contain one of three possible values, the presence of invalid values could easily be detected with the index function.

Previous auditing with MATLAB programs was superceded by auditing of combined trip files conducted after year 2. For various reasons, it became necessary to use the combined trip files (i.e., all data for all trips appended together into a single file for each data type: environmental log, haul log, length frequency, etc.) as the master data after auditing was completed. The original trip-by-trip files have been archived, but no longer maintain the data integrity. Basically because of all of the data editing, and the loss of some intermediate files, it is not possible to revert to the original trip-by-trip files without losing most of the data edits made during the auditing process. To retain these edits, we would have to generate new trip-by-trip files from the master data files.

Trawl Gear

The New Bedford Massachusetts trawler fleet uses various types of otter trawls throughout the year (Table 2). Otter trawls are large funnel-shaped nets that are pulled through the water behind the vessel. What makes an otter trawl effective is its ability to open wider than the stern of the vessel as it is being

towed. This is achieved by attaching the net to two "otter boards" or "doors" that spread the net apart due to hydraulic pressures as they are towed behind the boat. In addition, the top opening of the net is made to be positively buoyant while the bottom opening is made to be negatively buoyant. These factors cause the net to open vertically and horizontally.

Otter trawl components

The typical otter trawl net is cone shaped and has the following parts:

Warp or wire - steel wire, usually 1-1.5" in diameter, going from the vessel back to otter trawl doors. The length of warp used is an important factor in how the net performs. Warp length is determined by depth, and to some degree by vessel speed, weather and gear type.

Otter boards/doors - rectangular "doors" used to spread the net. In addition, on a bottom trawl (trawl that fishes on the sea floor) the doors create a lot of noise and a mud cloud on the sea floor that acts to herd fish in front of the net until they grow tired and fall back into the net. The size and weight of the doors used depend on the type of net deployed and the fishing power of the vessel. Using doors that are too big or too small for a given net will result in poor gear performance.

Ground cable (optional) - extends from the doors back to the bridle. Most modern ground cable is actually 1" or 1.5" cable with rubber cookies covering it. Ground cables may or may not be used depending on what the vessel is targeting. The ground cable affects the catch through its influence on fish behavior. The warp affects fish behavior in several ways. First it increases the mud cloud otherwise generated by the doors. Second, the wire itself can herd species that exhibit visual and/or acoustic fright responses to the wire. Thus the ground cable can serve to increase the effective swept area of a net to a larger area where fish are herded into the net (herein termed the "herding area"; see Fig. 2). The effectiveness of the ground cable in fish herding is dependent on the fish's behavioral response to the fright stimulus and its swimming speed. For example, slow-moving fish like monkfish may be frightened by the doors and ground cable, but are less likely to be herded into the mouth of the net because they swim slowly relative to the speed of the oncoming net (Fig. 3). In contrast, faster swimming fishes such as cod can be herded from a greater distance. The effect of the ground cable on fish behavior has received relatively little attention, and would be an interesting area of investigation.

Tickler (optional) - a chain strung between ground cables and used to rile the bottom and stir any fish that may be dug into the bottom substrate so as to make them more vulnerable to the net (Fig. 2). The tickler chain can be placed

anywhere along the ground cable from just in front of the footrope to just behind the doors (if the ground cable is relatively short). Unfortunately, data on the use of tickler chains have not been recorded during this project, as they are not recorded in the parent NOAA Observer Program log sheets. They were used most often with flat nets when monkfish or flounders were targeted. However, tickler chain use can change on a tow-by-tow basis. Tickler chains can have a strong influence on the catch, but little is known about how species-specific avoidance responses and swimming speed interact with towing speed and the distance between the tickler chain and the footrope to determine catchability.

Bridle - the place where the single wire splits forming a top and bottom sections leading to the net headrope and footrope.

Wing - A place where the split in the bridle has netting attached to it, thus forming the net opening. Some nets have an upper and lower wing.

Headrope - the top of the net extending between the wings. The headrope usually has plastic floats attached to it to add buoyancy and keep the headrope above the footrope. The headrope and footrope lengths together determine the size of the horizontal opening of the net. However, the horizontal opening is typically somewhat less than the headrope and footrope lengths because the net usually has a considerable bow or sag. Of course, the horizontal opening fluctuates as the towing speed changes, and as drag forces change during the tow. The amount and placement of floatation on the headrope has a strong influence on gear performance. Too little floatation will cause the headrope to ride lower in the water than optimal. However, too much floatation can have a similar effect by increasing net drag forces resulting in the collapse of net height.

Footrope - the bottom extension of the bridle is negatively buoyant so as to keep the bottom of the net on the sea floor. Its length, together with the headrope length, determines the horizontal width of the net's mouth opening. Although the footrope is usually set to drag along the bottom, sometimes it is raised off the bottom through the use of rollers or other means. The height of the footrope off the bottom is an important consideration, as some fishes might escape the net by passing under the footrope.

Sweep - the entire area of the bottom of the bridle, footrope, and any rollers that are added to the bottom of the net, though the sweep may be taken to mean any rollers and cable specifically inside of the wings. The construction of the sweep has importance consequences for net performance and the catchabilty of various species. Various hardware may be added to the sweep, including rollers and chains of many types and configurations.

Fishing circle - the widest opening in the net, usually measured in number

of meshes.

Belly - panels of mesh sewed together between the net mouth (bridle, sweep, etc.) and the codend.

Codend - the end of the sock shaped net where the fish are collected during fishing operations and subsequently dumped from after the haul has been brought on deck. The back of the codend is drawn closed like a purse with a rope and knotted or bound with a "pucker." The end of the codend is called the "puckered end."

Variations of the otter trawl

There are a number of configurations that are commonly used in the otter trawl fishery. Nets come in different sizes (lengths, widths, and heights) for different size vessels and fishing types. In addition, nets are built with different components for varying fish and bottom types. There are a number of net types that are marketed by net manufacturing companies. Most captains customize their nets after they are purchased.

At least fourteen otter trawl variations were used during the first two years of the survey (Table). These can all be grouped into one of three general trawl types described below. It should be noted that most if not all of the nets used in the SMAST trawl project have been modified from these general configurations in some way.

Flat nets - are a type of Yankee trawl used primarily for flounder and monkfish and in smooth bottom (sand, mud, etc.) areas. The Yankee is the "classic" flat net that the others are derived from. Some identifying characteristics of a Yankee net include a footrope that is 20' longer than the headrope and a 9' tall mouth when fishing. In most cases, flat nets are fished with a cookie sweep or small rollers. A cookie sweep is made by attaching 3" diameter rubber discs all along the sweep (bridal, footrope, etc). When fishing for flounders, fishermen usually choose a square meshed codend. The flat net is built to stay on the bottom and sweep the entire towed area. Some specific flat nets used in this project were the Levin Marine, flat 5" sweep, 76x96, and 76x97 (Table 4).

Roller and rock hopper nets - are made for fishing in the hard bottom (rocky terrain). The large rollers and rock-hopper-like sweeps allow the nets to ride, bounce, or spring over large obstructions. These nets do not stay on bottom as well as a flat net. The ability to get over obstructions without being damaged is a compromise that fishermen choose when building and designing their nets. These nets are often named after the size of the rollers used. Center roller 12", roller 18", and Yankee rock hopper nets were used in this project.

Hi-rise nets - These nets have a taller mouth opening than flat nets (Fig. 3) in order to maximize their ability to catch roundfish such as cod, haddock, pollock, and other demersal fishes that might avoid a flat net by swimming over the top of the headrope. A diamond meshed codend is also used in most cases on these nets. Types used in this project include the Shuman, Gurock and Balloon trawls (Table 4).

Gear performance

Many details of the net construction can influence gear performance and fish catchability. Some of these effects are subtle, while others are more obvious. There are at least three major factors that affect catchability: 1) encounter rate, 2) avoidance, and 3) retention. Encounter rate is the likelihood of a fish encountering the mouth of the net and is a function of interactions among the physical size of the net (net width and height), the spatial distribution of a given fish species/size class, and the speed at which the net moves through the water (and other factors related to the fish's behavior). The swept area (Fig. 2) and swept volume represent the physical aspects of the encounter rate. The swept area is the area of sea floor over which the net physically passes. It is influenced by gear performance such as fluctuations in how well the net hugs the bottom during the course of the tow, and how much the net's length and height wax and wane as the net is hauled through the water. All things considered, any fish that is present within the swept area and does not avoid the net will encounter the mouth of the net and be subject to possible capture. The swept area can be artificially enhanced through the use of ground cables and associated hardware that act to herd fish from a larger area into the mouth opening. The swept area is determined by the distance between the doors, which is a function of the ground cable length and the net width (Fig. 3).

However, the actual herding area experienced for any given fish is also dependent on the fish's reaction distance, reaction time and swimming speed. For example, the effective herding area of a slow-swimming fish like the monkfish would be expected to be much smaller than that of a relatively fast-swimming species like the cod. The monkfish would be more likely to be overtaken and passed over by the net/ground cable before it had time to be herded towards the net mouth, while the faster-swimming cod can easily move fast enough to enter the swept area and be captured (compare "a" and "d" in Figure 3). For a given fish, its likelihood of encountering the net decreases the farther to the side of the center of the trawl track it is located (compare "b" and "d" in Figure 3). A fisherman can compensate for this somewhat by towing at a slower speed. Although these relationships are intuitively obvious, few studies have been conducted to quantify the relationships between capture rate and swimming speed, reaction rate, reaction type, distribution relative to the trawl track, swept area, herding area, and tow speed. This would be another interesting area of future research.

However, mere encounter of a fish with the net does not insure its capture. Fishes can avoid the net in many ways. Some fish may be able to avoid the net by actively swimming under, around or over the net. Others may avoid capture by reacting to the doors and ground cable in different ways, such as moving laterally away from the trawl track, or by allowing the ground cable to pass over or under them instead of being herded into the net mouth. Both visual and acoustic stimuli may be important in net avoidance.

Once in the wings and belly of the net, capture may yet be avoided due to retention effects. The most obvious of these is the mesh size. If a fish is small enough to pass through the mesh, it may escape by doing so, though many fish are captured that could have escaped because of strong net avoidance behavior, or because they are caught up in the general mass of fishes in the net and fail to find a way out. Several characteristics of the net influence the ability of a fish to escape through the netting. The type of net mesh interacts with fish body shape to influence fish retention. For example, a larger flatfish can escape from a 6-inch-stretch mesh than from a 6-inch-square mesh, while the opposite is true for a typical roundfish such as a cod. The type of twine used to construct the net also has an influence on fish retention as it can make it more difficult or easier for a fish to slip through the mesh. Twine type also has a strong effect on the gear performance by influencing net drag. Thus two nets of the same configuration, but constructed of different twine types, might perform differently and result in different catch characteristics.

Logsheets

Six types of data logsheets, and an electronic temperature data logger, were used during the survey (Table 2; Fig 5). The data structure and logsheets used in the SMAST trawl survey were modified copies of data and data logsheets used by the National Marine Fisheries Service Observer Program. Over time, some of these logsheets were modified from the original NMFS format to streamline recording in order to provide simplicity and efficiency for the fishermen. However, the logsheet, the resulting data collected, and the user data set structure have been designed for maximum compatibility with the NMFS Observer Program data.

Vessel log - The vessel logsheet is completed by an SMAST technician once during each year of the survey, but can be updated as necessary when vessel data changes (for example, addition of new electronic equipment). A near duplicate of the NMFS Observer Vessel and Trip Log is used for the SMAST vessel log (Fig. 6). Data fields on the logsheet are defined in Table 5. Because the NMFS logsheet is intended to record both trip and vessel data, many of the fields on the data sheet are not applicable to the SMAST Vessel log.

Gear log- The gear logsheet is also completed by an SMAST technician once during each year of the survey (Fig. 7; Table 6). Updates are made as necessary.

Trip log- The trip log sheet is also based on the NMFS Observer Vessel and Trip logsheet, but includes the trip related data not recorded on the SMAST Vessel log sheet (Fig. 8). Explanations of the data fields on the logsheet are provided in Table 7.

Station (environmental log) - The "station" is the basic sampling unit in the survey. It consists of all the data associated with a trawl tow. The terms "tow," "haul," "trawl tow" and "station" are considered synonymous for the purposes of this report. The term “haul-back” will be used to indicate the retrieval of the trawl in place of “haul” to avoid confusion. At each station, environmental data are collected and recorded on the environmental log (Figs. 9 & 10; Table 8), and the fishermen begin a trawl tow to harvest fish. The environmental log has an additional level of complexity in that separate data are recorded for each major event during the trawl tow. Data are always recorded when the net is set and again when it is hauled-back as is typical of many research surveys, including the NMFS bottom trawl survey. However, data are also recorded whenever the ship makes a turn or other major change in its course direction. Although these data are recorded on the environmental log, they actually belong to a lower level data hierarchy termed “Events” in Figure 5, and will be separated out during data processing (see below). The environmental log underwent a series of changes during the study (Appendix E.1). The greatest change occurred when an early version was restructured to improve data collection (Figs. 9 &10).

Species (haul log)- Once the net is hauled, biological data on each species are recorded in the haul log and the length frequency log. The haul log primarily records the weight kept and discarded for each species, but includes two additional levels of complexity. First, data are recorded separately for each dressed category of a given species (see explanation below). Second, data are recorded separately by discard reason, if multiple reasons for discard occur in a haul. The haul log has undergone extensive revisions since the start of the SMAST trawl survey (Figs. 11-17; Appendices E & F). The complete series of changes are shown in Appendix E.2. Major changes are described in detail in Appendix F. Briefly, the first version was modeled after the NMFS Observer Haul Log Sheet (Figure 11). An explanation of the fields found on the haul log is provided in Table 9. Again, most fields were taken directly from the NMFS Observer Haul Log Sheet. However, it soon became apparent that the original haul log required changes to make it easier for the fishermen to understand and to eliminate data redundant with other logs. A second version of the logsheet was used throughout most of 2002-July 2003 (Fig. 12). One major change was the separation of species that are primarily kept and those that are usually discarded into separate sections of the log. This streamlined the recording for the fishermen. In addition, in recognition that the estimates of the weights of discarded species were subjective, weight bins were added to the log. Finally, additional changes have been made for year 3 to reduce confusion caused by multiple dressed type and discard reason possibilities for a given species (Fig.

13). A summary of major changes made to the haul log from the beginning of the project through the end of year 2 are provided in Table 10. Samples of all haul log variations, many consisting of minor cosmetic changes, are provided in Appendix E.2.

Length frequency log- Length frequency data were collected from species of special interest to SMAST by recording lengths on the length frequency log (Figs. 18-20; Table 11). Minor modifications to streamline the length frequency log were made over the course of the study (Appendix E.3).

Overview of Working Data Sets

Once the keypunched data have been fully audited and have passed quality control testing, they are converted into a set of working data files in a relational format (Figure 26) for use by SMAST scientists and for distribution to the public. Working data sets are provided in both Microsoft Excel and Access formats and contain extensive metadata documentation of all fields. An overview of the steps to construct these files was presented above and is illustrated in Figure 21. The working data files are organized into four folders: 1) primary data sets, 2) derived catch data, 3) field descriptions and 4) lookup tables (see Tables 32 & 33). The primary files consist of the Vessel (Table 34), Gear (Table 35), Trip (Table 36), Station (Table 37), Haul_event (Table 38), Catch (Table 39), Discard_by_reason (Table 40) and Length_frequency (Table 41) data tables. Secondary files, called "derived catch files," are also created for the convenience of researchers, but are not essential as they simply contain information derived from the catch (Table 42). The derived catch files contain a single record for every unique trip and haul (i.e., for each trawl tow) with separate fields for every species collected during the entire study. File structures and field definitions for all the working data files are provided in Tables 34-42. Lookup tables for all coded fields contained within these data sets are described in Table 33 and printed in Appendix H.

Currently, the working data files are created from the master data files using a set of three Statistical Analysis System (SAS) programs (Appendix I). The SAS programs output the working data files in excel spreadsheets that can then be loaded into Access. In addition, a great deal of metadata is provided to document the files, including tables of all file structures and field definitions. Details of the steps needed to accomplish this are documented in the SAS programs. Researchers interested in recreating working data sets from the master data are encouraged to carefully review documentation provided in these SAS programs to avoid misuse of the data. The most important SAS programs is the first one titled "trawl_master_SAS_data_set_creation_10sep04.sas". Note that the SAS program strips out extensive auditing control fields that have been added to the master data files during data processing (e.g., old_fields, edit_fields, and comment fields).

The relationships between the field data logsheets and the final derived data tables are shown in Figure 21, while Figure 26 summarizes the relationships among the working data sets. Master data sets from the vessel, trip, gear and

length frequency logs are converted directly into vessel, trip, gear, and length frequency working data tables with little structural change, although net name and net_category are added to the gear table for convenience. However, master data from Tidbit temperature records, environmental log and haul log data are each split into multiple working data tables. The continuous temperature recordings stored on 1 to 3 Tidbit recorders for each trip are consolidated to remove periods when the gear was not deployed (i.e., when the net is sitting on the deck or is in storage) to produce a data set with continuous data for each haul (Fig. 21, step a). The haul_temperature data table thus provides a record of the temperature experienced by the gear during the trawl tow from approximately the time of set to haul-back. However, this includes periods when the net is lifted off the bottom during vessel turns, and thus includes data other than the bottom temperature data. In step b (Fig. 21), intervals when the trawl is off the bottom during turns are removed so that the resulting haul_bottom_temperature data table includes a time series of bottom temperatures observed during the trawl tow. In step c (Fig. 21), mean bottom temperature and other statistics (variance, range, etc.) are calculated and inserted into the station data table. Unfortunately, at this writing the creation of the master and working temperature data has not been completed. Earlier versions of the data were discovered to have been significantly corrupted, necessitating the time-consuming re-extraction of the temperature data from the original Tidbit data records. The temperature data will be incorporated into the trawl data base as described above as soon as processing is completed.

The environmental log is converted into the haul_event table with minor changes and provides data on the environmental conditions, and ship performance during each set, turn and haul-back event during the trawl tow. In step d (Fig. 21), the environmental data are aggregated over haul events within the haul_event table to provide statistics on the tow and to create the station data table. These include conditions at the set and haul-back, as well as the mean, minimum, maximum, and variance of conditions across all tow events.

The haul log is spit into multiple data sets after extensive manipulations in the SAS programs. First, data partitioned by discard reason within a species are separated out into a separate discard_by_reason table. This includes the weight of a given species that is discarded for each different reason. The total amount discarded for a species is summed up over all discard reasons and inserted into the catch data table. The catch data table includes data on the total weight of the catch for a given species (total discard plus total kept), the total discard (summed over all discard reasons from the Discard_by_reason table), and the total weight kept. The total weight kept must be computed by calculating the total weight of each dressed type and the summing over all dressed types. In step e (Figure 21), catch data are aggregated over all species and inserted into the station table to provide data on the total catch (total weight of all species, total weight discard, number of species, etc.). Finally, several derived catch files are created from the catch table. Each derived catch file includes only one catch estimator statistic determined for all species encountered during the entire project for each trawl

tow. For example, the total_catch table contains the total catch of all 50 species (49 species plus valid "water tows") for all trawl tows; hence many species have zero weights for any given tow, but all species have at least one positive weight for at least one tow.

CONCLUDING REMARKS AND RECOMMENDATIONS

The SMAST High-Resolution Industry-Based Trawl Survey was a highly successful demonstration of a program to train fishermen to collect environmental and biological data. The resulting data generated by this project is expected to provide significant information to regional managers by characterizing the Georges Bank fishery trawling operations and catch. Summaries of the data generated by this project will be reviewed in subsequent reports. However, information contained in this report provides significant insight on how to better design future industry-based trawl fishery surveys. Probably the most difficult component of the fishery data to quantify with an industry based survey is the catch discard data. For many logistical reasons described above, fishermen have only limited opportunity and incentive to collect discard data during normal fishing operations. The collection of discard data is in direct conflict with the fishermen's need to efficiently process the kept catch and to quickly return discard species to the sea in order to clear space for subsequent hauls and reduce mortality. Nevertheless, we believe it is still possible to obtain useful discard data from industry-based surveys.

One problematic aspect of the discard data encountered during this study was the uncertainty as to whether the lack of discard data represents a true lack of discard or a lack of reporting on a haul-by-haul and species-by-species basis. This problem was partially resolved in year 2 by modifying the haul log sheet to improve discard reporting (pre-printing kept and discard species names on the form, and including discard weight estimation bins to encourage reporting). Thus discard data reporting significantly improved in year 2. However, it was still not possible to be certain that all occurrences of zero discard were valid. Sometimes fishermen may skip recording of discard data for a particular haul because of conditions at the time (fatigue, weather, lack of time, etc.). Inclusion of a field on the log sheet to allow fishermen to indicate that discard data was not reported, together with training to educate the fishermen on the importance of being able to distinguish true zero discard from non-reported discard, should help reduce this problem. Beyond that, there is a need for researchers to develop efficient and accurate methodologies that allow fishermen to quickly estimate, or measure catch discard without undue disruption of their processing of the catch.

Our industry-based study would also have benefitted from subsampling by scientists to estimate the error of the fishermen's estimate of the discard and kept catch weights by species. The chief difficulty carrying out such sampling is the difficulty of placing scientists on board vessels during normal fishing operations, and the greater difficulty of persuading the fishermen to allow the scientist to

disrupt their catch processing in order to collect the needed data. It must be recognized that having a scientist on board collecting the appropriate data for error estimation (letting fishermen record kept and discarded catch estimates, and then coming behind them to measure the actual weights of the kept and discarded catch) does represent a significant burden on the fishermen and would significantly reduce their efficiency. Obviously, the problem is greater for discard data compared to catch data because of the necessity of returning the discard to the water as soon as possible.

Data describing the reason(s) for discard were not reported as often as we would have liked, partly because the NMFS reason categories are extensive and somewhat confusing, especially when decisions have to be made quickly. In addition, it is cumbersome and confusing to record such information on the log sheets as it adds another layer onto the data structure. Changes to the haul log that were implemented at the end of year 2 (and throughout year 3) improved reporting of discard reasons, but allow for multiple discard reasons to be recorded only for lobster. Recording multiple discard reasons for other fishes basically requires hand-writing in additional lines of data by filling in one or more of the blank lines included on the log (but usually that means data from the same species get recorded in two different places).

Another improvement to the study would be to collect gear information on a tow-by-tow basis rather than on a trip basis. This is because fishermen frequently modify the nets and can change things like ground cable length and ground gear between hauls to take advantage of changing conditions and catches. Further, as described in the gear and gear performance sections of this report, more research on the effect of these modifications on catchability by species and size class is needed. In particular, the effect of changing the ground cable length and ground gear composition on fish behavior and consequently on catchability is needed.

During the course of this study we came to believe in the need for better data on the influence of various methods of dressing and preparing fish on the conversion codes used by NMFS to calculate whole body fish weights. We were unable to obtain information on how the conversion factors were determined by NMFS. No information on the sample sizes or variance of the conversion factor estimates appears to be available. We suspect that a wider variety of dressed types occurs, with potentially different conversion factors. Further, NMFS has assigned conversion factors greater than 1 to the whole body weights of several of the species collected during this study, including cusk, Atlantic halibut, Atlantic wolffish and scallop (Table 29). Since by law, scallops must be shucked at sea, it is reasonable to assume that a conversion factor should always be applied if data are always collected in port (but then, why have a whole body code category?). At least in the case of our study, weights could be estimated either from whole fish prior to dressing or from dressed fish immediately after processing the catch at sea. Therefore, no conversion should be applied when whole body codes are used.

Finally, the recording of bottom temperatures using the Tidbit data loggers was much more problematic than anticipated. Normally, on a scientific survey, the data loggers would be placed on the nets or trawl doors at the time of set and removed for data download immediately after the haul-back. In addition, clocks used by the recorder would be better synchronized with the internal clock in the temperature recorder. In contract, in the industry-based survey, the Tidbits are supplied to the fishermen already recording prior to the trip departure and are not turned off and downloaded until well after the trip returns to port. On top of that, a fishermen's concept of accurate time keeping is not the same as that of a scientist, and times recorded on the log sheets can be 30 minutes or more off that recorded by the temperature data logger. These factors make it surprisingly difficult to extract the bottom temperature data associated with each trawl tow as described above. This problem can be virtually eliminated by using data loggers that record both temperature and depth, though these are more expensive.

ACKNOWLEDGMENTS

The School for Marine Science and Technology at the University of Massachusetts Dartmouth would like to acknowledge the hard work and dedication of many of the commercial fishermen who worked so assiduously to gather fisheries data for this project under the challenging conditions that is life at sea. The success of this study would not have been possible without their efforts. Our thanks and appreciation is also extended to members of the Trawlers Survival Fund, New Bedford's local fishermen's association, and especially to the TSF's Director Bob Lane. The advice and perspectives he provided on all aspects of the program were invaluable. We would also like to thank Dr. Paul Diodati and other scientists at the Massachusetts Division of Marine Fisheries for their support. Frank Smith provided editorial assistance. This project was funded by the National Aeronautics and Space Administration under grant number NAG 5-9752, NAG 13-02042 and NAG 13-03021. Additional funding was provided by a contract to the Center for Marine Science and Technology (now SMAST), University of Massachusetts - Dartmouth, from the Northeast Region, National Marine Fisheries Service, NOAA, DOC, under the Cooperative Research Partners Initiative (Contract No. 50-EANF-0-00062).

FIGURES

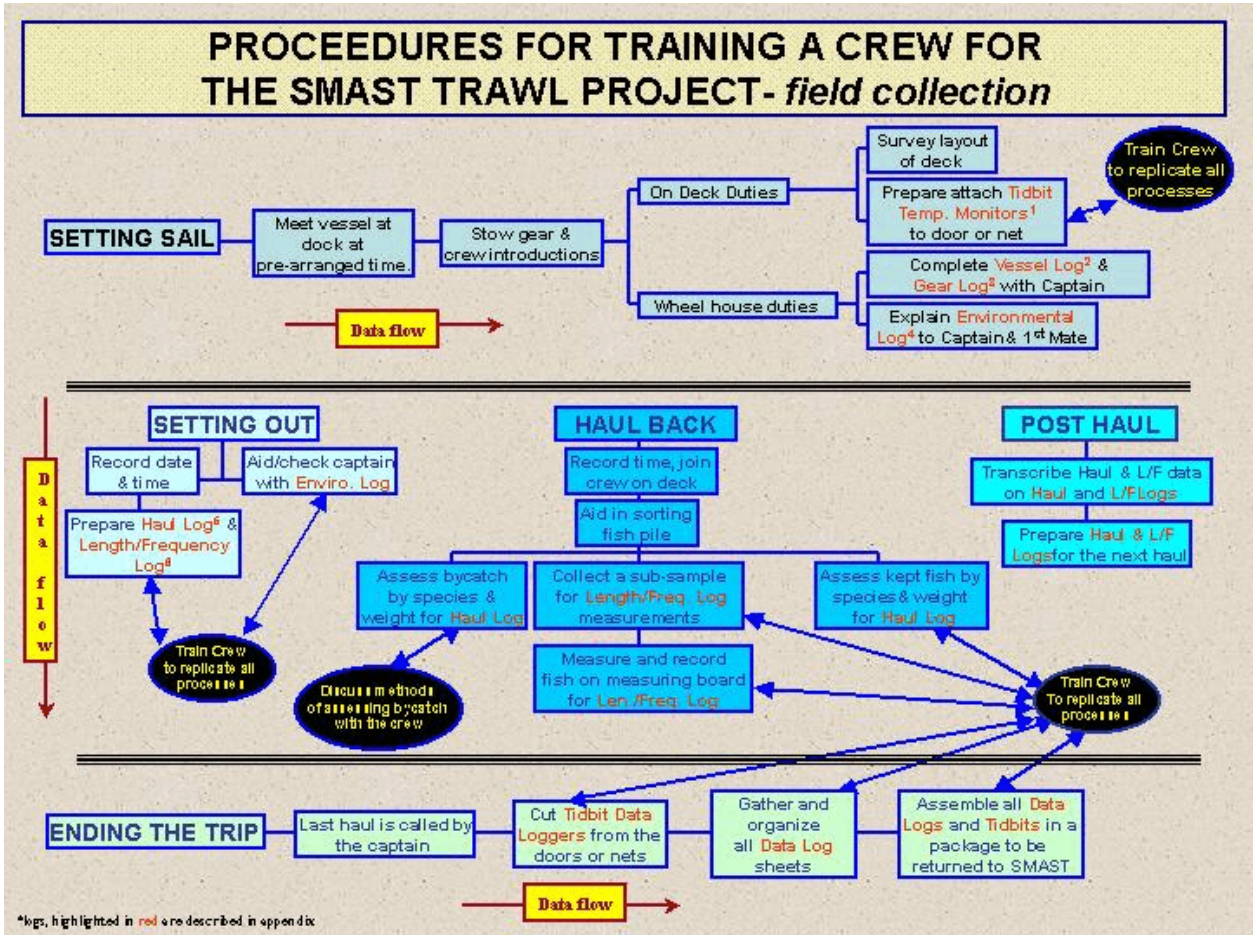


Figure 1. Flow chart illustrating the steps taken to train fishermen to conduct fisheries sampling during their normal fishing operations.

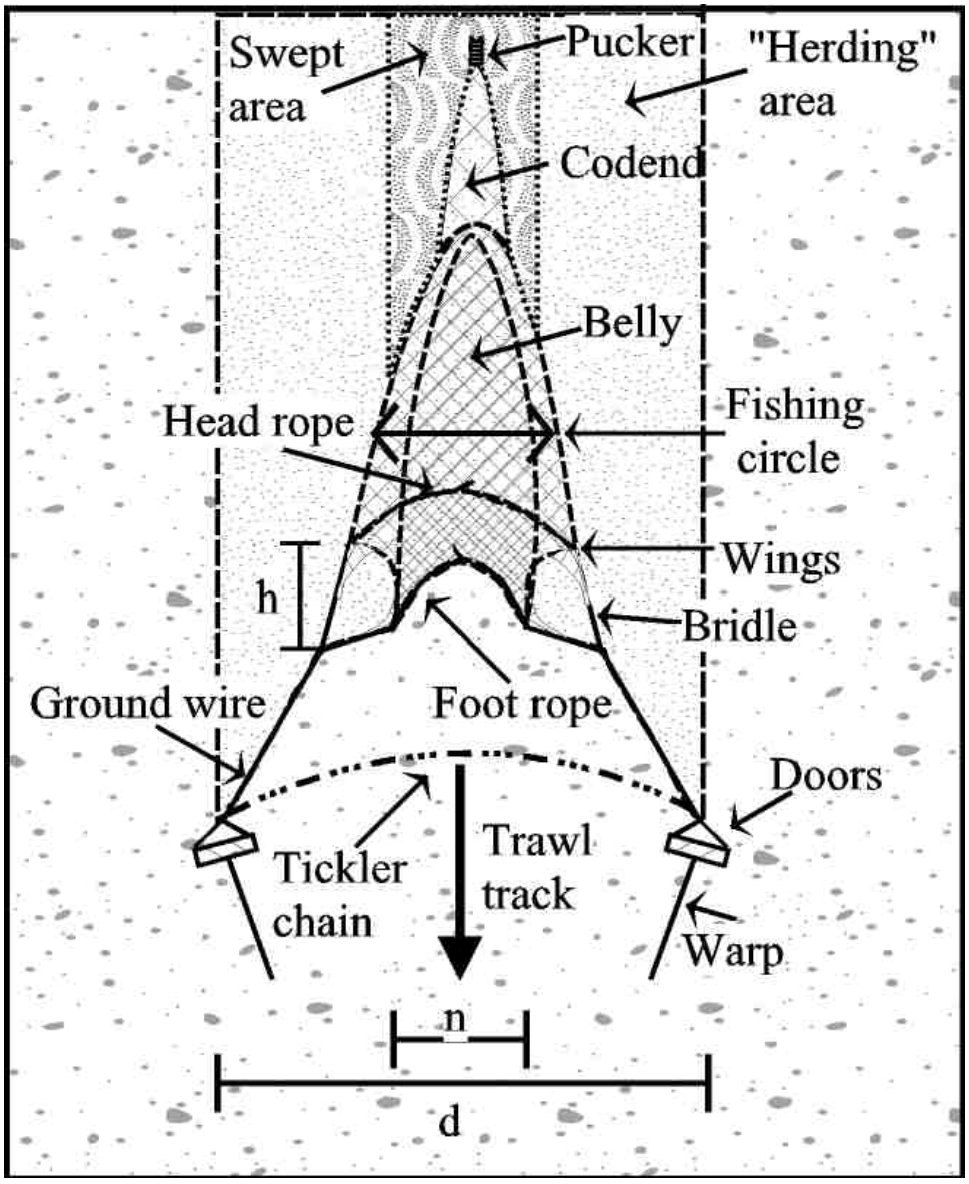


Figure 2. Schematic diagram of an otter trawl illustrating the component parts, dimensions and swept area. H=trawl height, n=trawl width, which is also the width of the swept area, d=door-to-door distance, which is also the maximum width of the potential herding area.

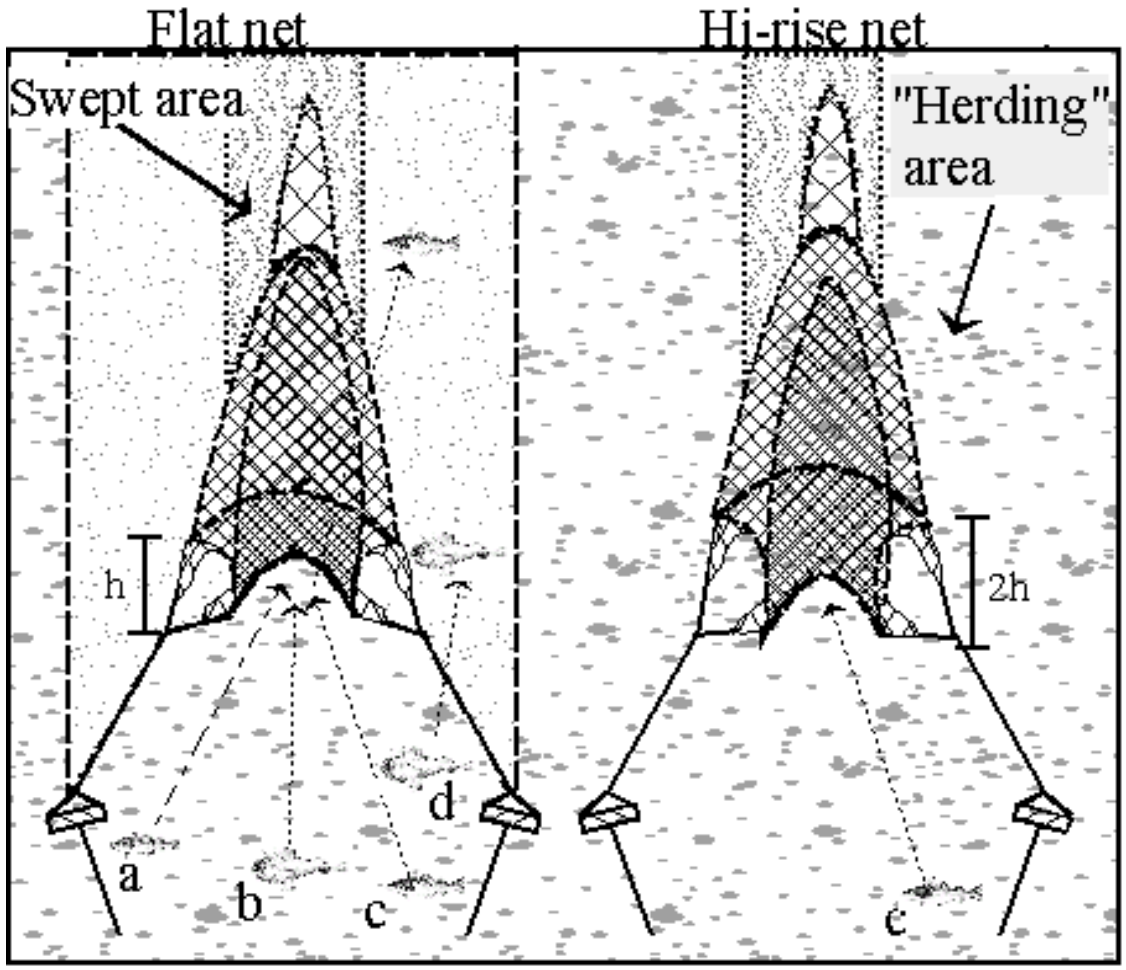
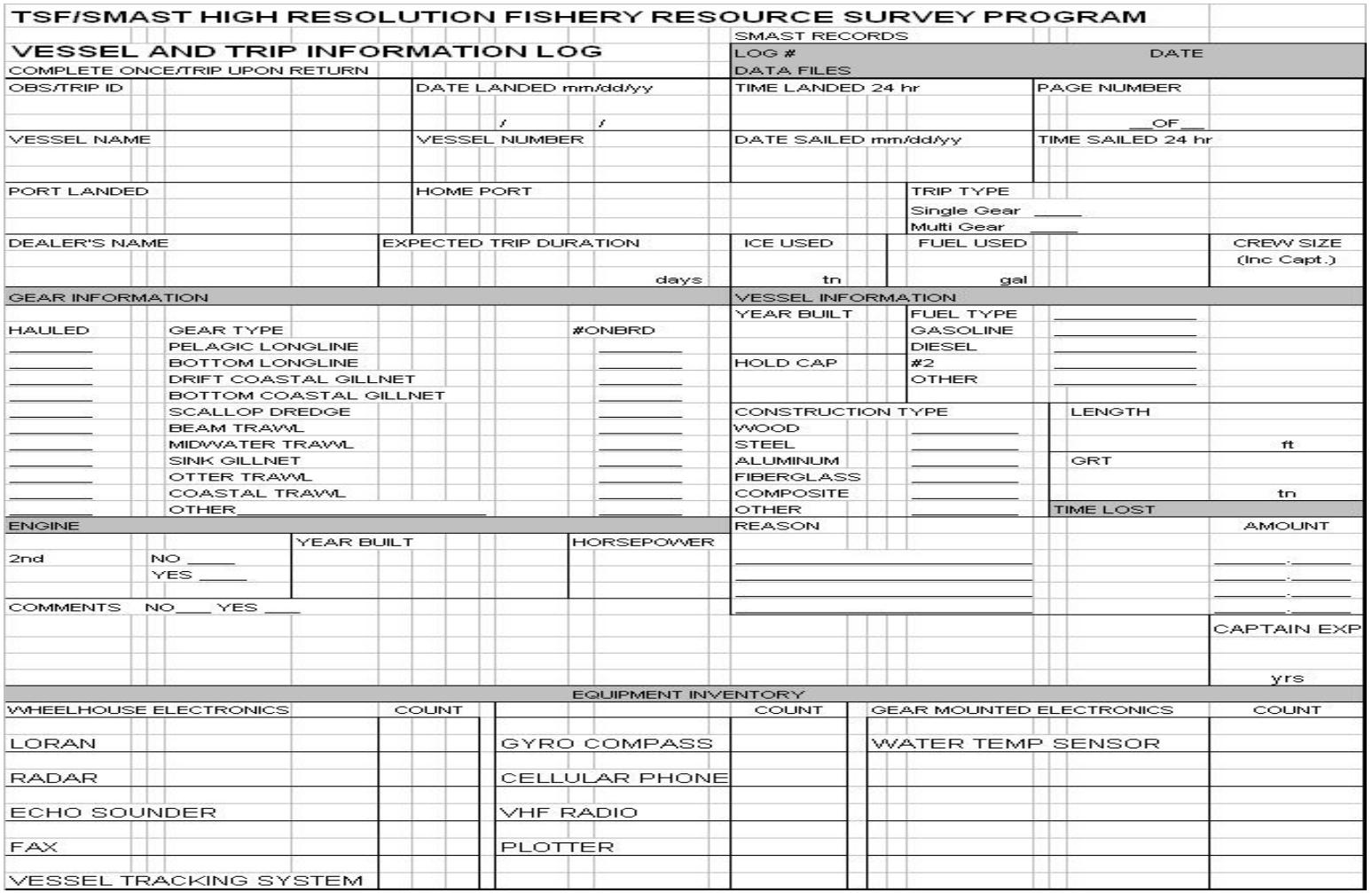


Figure 3. Schematic illustration of the effect of trawl height (h) on the bottom swept and herding areas, and on fish catchability for different types of fish: a) cod, b) monkfish located inside of the swept area, c) haddock, d) monkfish located outside of the swept area.


TSF/SMAST HIGH RESOLUTION FISHERY RESOURCE SURVEY PROGRAM

VESSEL AND TRIP INFORMATION LOG

COMPLETE ONCE/TRIP UPON RETURN

SMAST RECORDS
LOG # DATE
DATA FILES

OBS/TRIP ID
DATE LANDED mm/dd/yy ___/___/___
TIME LANDED 24 hr
PAGE NUMBER ___OF___

VESSEL NAME
VESSEL NUMBER
DATE SAILED mm/dd/yy
TIME SAILED 24 hr

PORT LANDED
HOME PORT
TRIP TYPE
Single Gear _____
Multi Gear _____

DEALER'S NAME
EXPECTED TRIP DURATION ____ days
ICE USED ____ tn
FUEL USED ____ gal
CREW SIZE (Inc Capt.)

GEAR INFORMATION

HAULED	GEAR TYPE	#ONBRD
_____	PELAGIC LONGLINE	_____
_____	BOTTOM LONGLINE	_____
_____	DRIFT COASTAL GILLNET	_____
_____	BOTTOM COASTAL GILLNET	_____
_____	SCALLOP DREDGE	_____
_____	BEAM TRAWL	_____
_____	MIDWATER TRAWL	_____
_____	SINK GILLNET	_____
_____	OTTER TRAWL	_____
_____	COASTAL TRAWL	_____
_____	OTHER_____	_____

ENGINE

		YEAR BUILT	HORSEPOWER
2nd	NO _____ YES _____		

COMMENTS NO___ YES ___

VESSEL INFORMATION

YEAR BUILT
FUEL TYPE
GASOLINE _____
DIESEL _____
#2 _____
OTHER _____

HOLD CAP

CONSTRUCTION TYPE
WOOD _____
STEEL _____
ALUMINUM _____
FIBERGLASS _____
COMPOSITE _____
OTHER _____

LENGTH ____ ft
GRT ____ tn

TIME LOST

REASON	AMOUNT
_____	_____.____
_____	_____.____
_____	_____.____
_____	_____.____

CAPTAIN EXP ____ yrs

EQUIPMENT INVENTORY

WHEELHOUSE ELECTRONICS	COUNT		COUNT	GEAR MOUNTED ELECTRONICS	COUNT
LORAN		GYRO COMPASS		WATER TEMP SENSOR	
RADAR		CELLULAR PHONE			
ECHO SOUNDER		VHF RADIO			
FAX		PLOTTER			
VESSEL TRACKING SYSTEM					

Figure 4. Illustration of the vessel logsheet used to collect data on fishing vessel characteristics during the SMAST Trawl Survey. Note that it is almost an exact copy of the NMFS Observer Program Vessel and Trip Information Log.

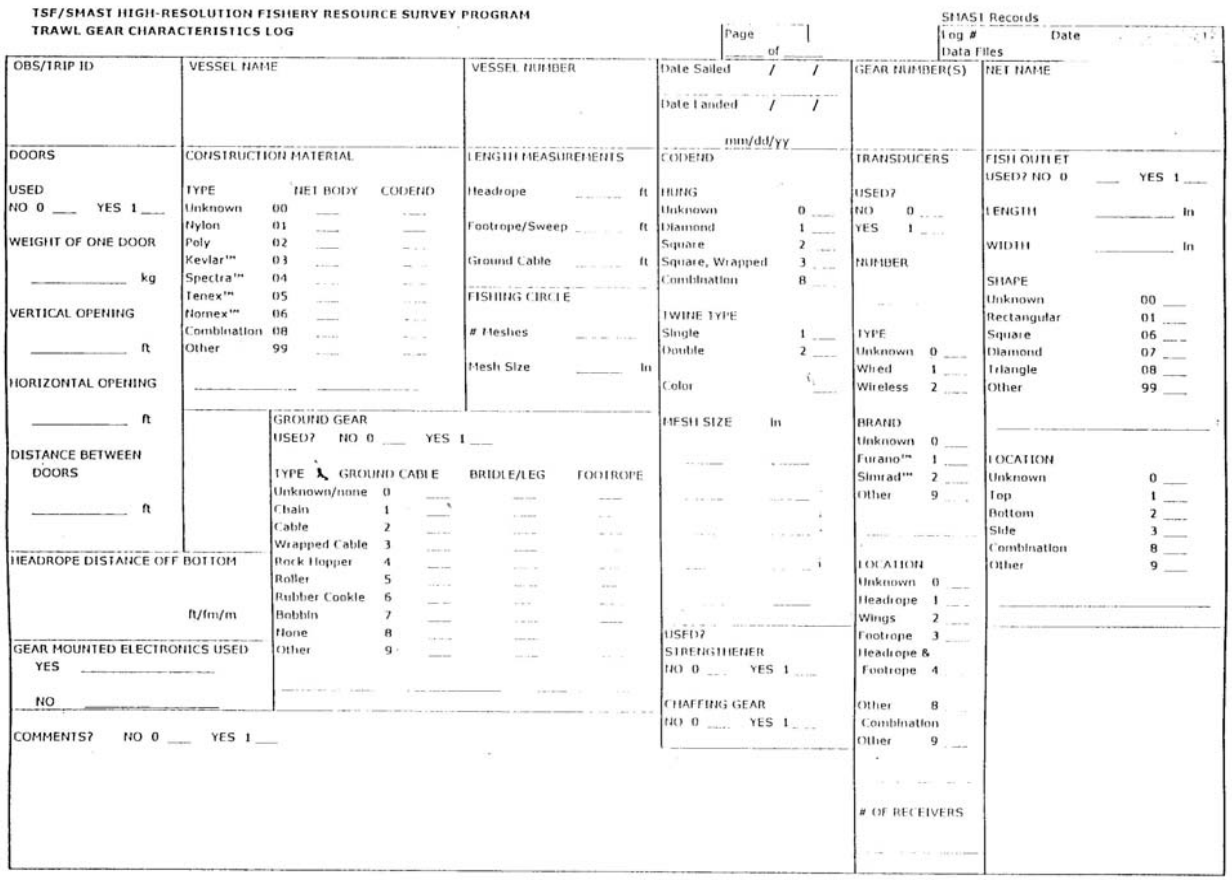


Figure 5. Illustration of the Gear log used in the SMAST Trawl Survey. It is a modification of the Gear Characteristics Log used in the NMFS Observer Program.

TSF/SMAST HIGH RESOLUTION FISHERY RESOURCE SURVEY PROGRAM

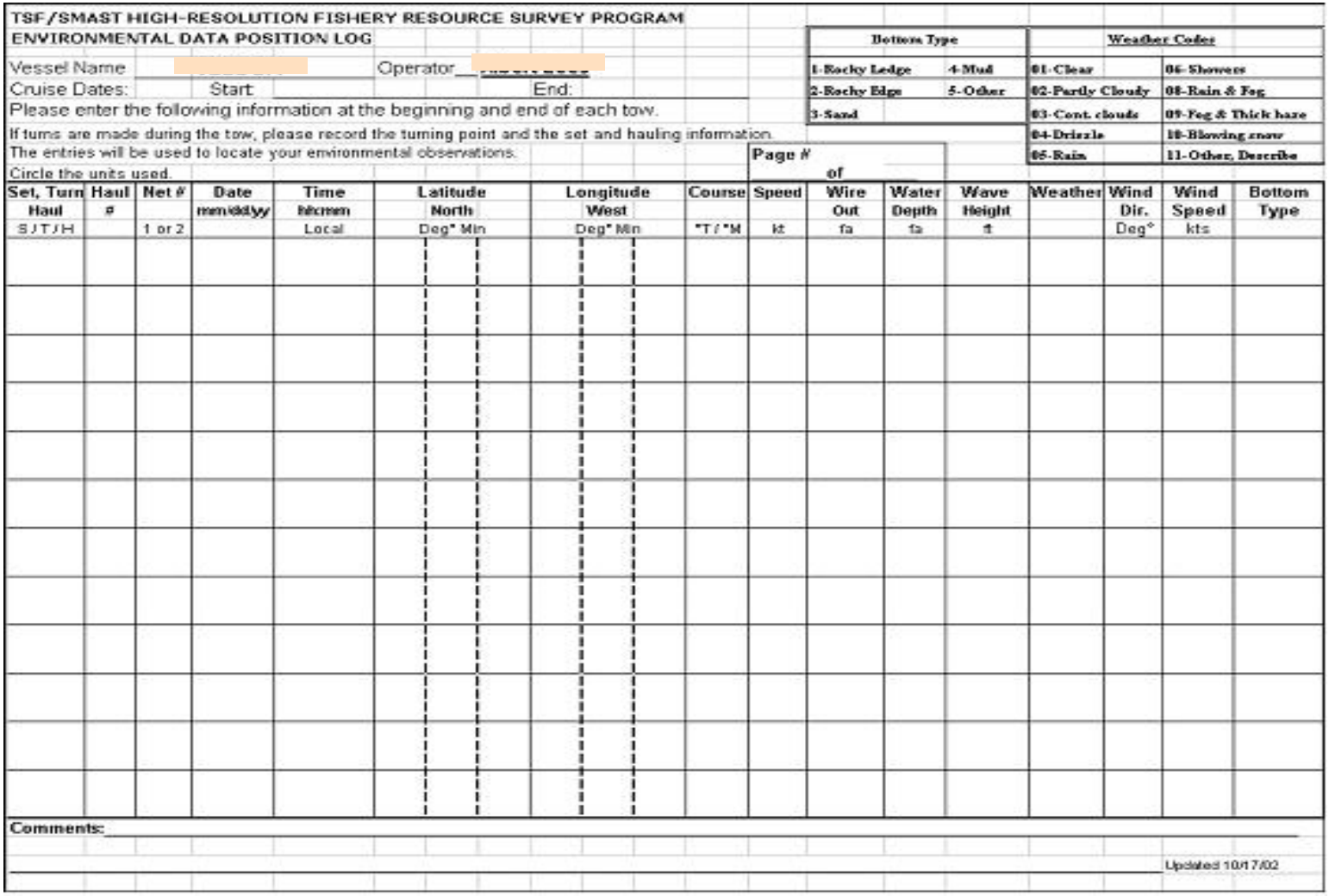
TRIP INFO LOG

Complete during trip

Vessel Name	Vessel #	Date Sailed	Time Sailed(24Hrs.) Local
Port Landed	Port Sailed	Date Landed	Time Landed
Expected Trip Duration days	Ice Used tons	Fuel Used gal	Crew Size (inc. Capt.)
Dealers Name			

Please note any gear modification (new/different nets etc.) from previous trips in this space. One of our people will get the specifics as needed.

Figure 6. Reproduction of the SMAST Trawl Survey trip log . It is derived from the trip components of the NMFS Observer Program Vessel and Trip Information Log and the Vessel and Trip Information - Six Month Questionnaire.



TSF/SMAST HIGH-RESOLUTION FISHERY RESOURCE SURVEY PROGRAM

ENVIRONMENTAL DATA POSITION LOG

Vessel Name _____ Operator _____

Cruise Dates: Start: _____ End: _____

Please enter the following information at the beginning and end of each tow.

If turns are made during the tow, please record the turning point and the set and hauling information.

The entries will be used to locate your environmental observations.

Circle the units used.

Page # _____ of _____

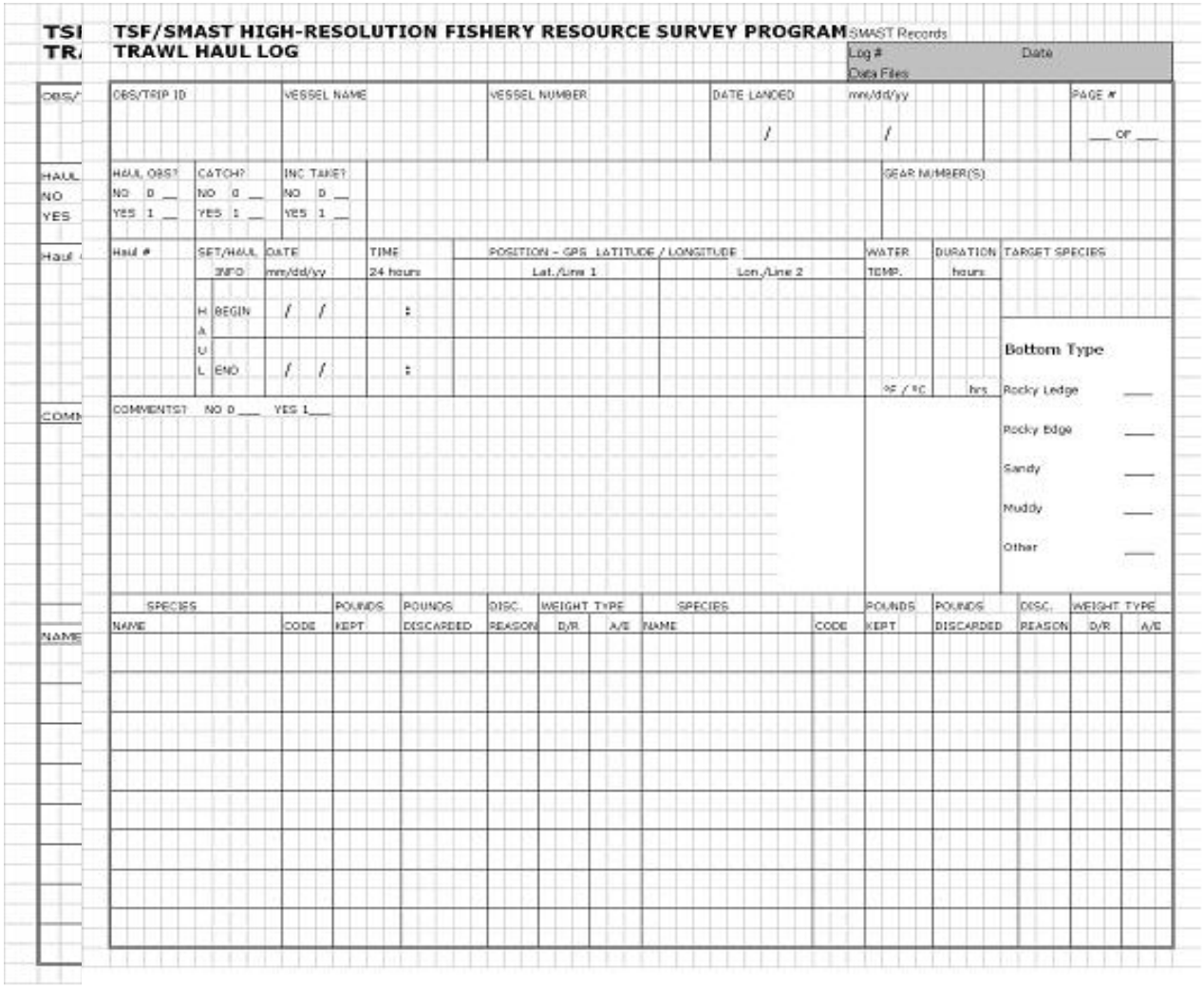
Bottom Type		Weather Codes	
1-Rocky Ledge	4-Mud	01-Clear	06-Showers
2-Rocky Edge	5-Other	02-Partly Cloudy	08-Rain & Fog
3-Sand		03-Cont. clouds	09-Fog & Thick haze
		04-Drizzle	10-Blowing snow
		05-Rain	11-Other, Describe

Set, Turn Haul	Haul #	Net #	Date mm/dd/yy	Time hhmm	Latitude North	Longitude West	Course	Speed	Wire Out	Water Depth	Wave Height	Weather	Wind Dir.	Wind Speed	Bottom Type
S/T/H		1 or 2		Local	Deg° Min	Deg° Min	°T / °M	kt	fa	fa	ft		Deg°	kts	

Comments: _____

Updated 10/17/02

Figure 7. Environmental log sheet used during most of the trips in the SMAST Trawl Survey.



TSF/SMAST HIGH-RESOLUTION FISHERY RESOURCE SURVEY PROGRAM
TRAWL HAUL LOG

SMAST Records
Log #
Date
Data Files

OBS/TRIP ID | VESSEL NAME | VESSEL NUMBER | DATE LANDED mm/dd/yy | PAGE # ___ OF ___

HAUL OBS? NO 0 __ YES 1 __ | CATCH? NO 0 __ YES 1 __ | INC TAKE? NO 0 __ YES 1 __ | GEAR NUMBER(S)

Haul #	SET/HAUL INFO	DATE mm/dd/yy	TIME 24 hours	POSITION - GPS LATITUDE / LONGITUDE Lat./Line 1	Lon./Line 2	WATER TEMP. °F / °C	DURATION hours	TARGET SPECIES
	HAUL BEGIN	/ /	:					
	HAUL END	/ /	:					

COMMENTS? NO 0 ___ YES 1 ___

Bottom Type
Rocky Ledge ___
Rocky Edge ___
Sandy ___
Muddy ___
Other ___

SPECIES NAME	CODE	POUNDS KEPT	POUNDS DISCARDED	DISC. REASON	WEIGHT TYPE D/R	WEIGHT TYPE A/E	SPECIES NAME	CODE	POUNDS KEPT	POUNDS DISCARDED	DISC. REASON	WEIGHT TYPE D/R	WEIGHT TYPE A/E

Figure 9. The revision of the SMAST Trawl Survey haul log.

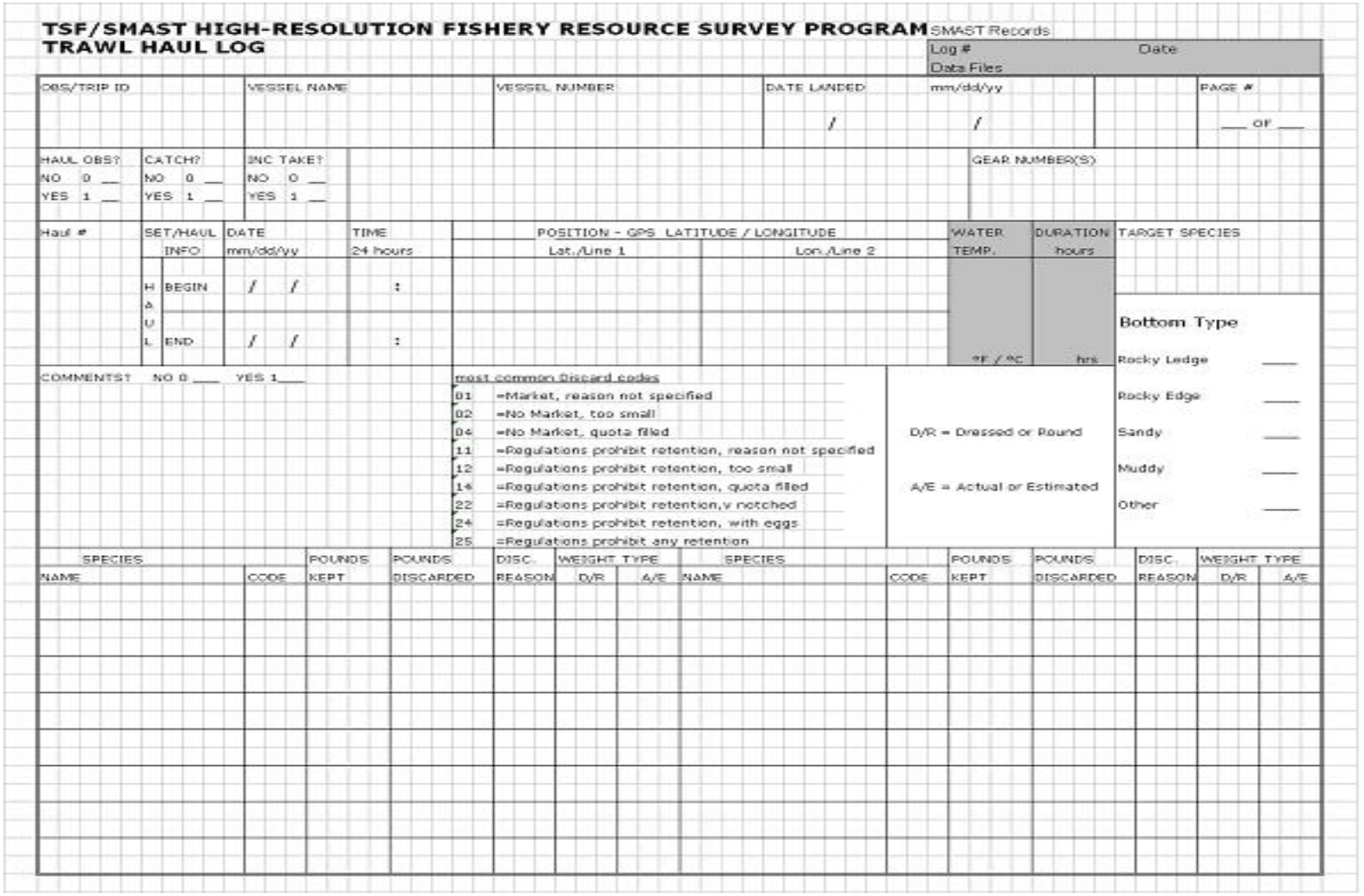
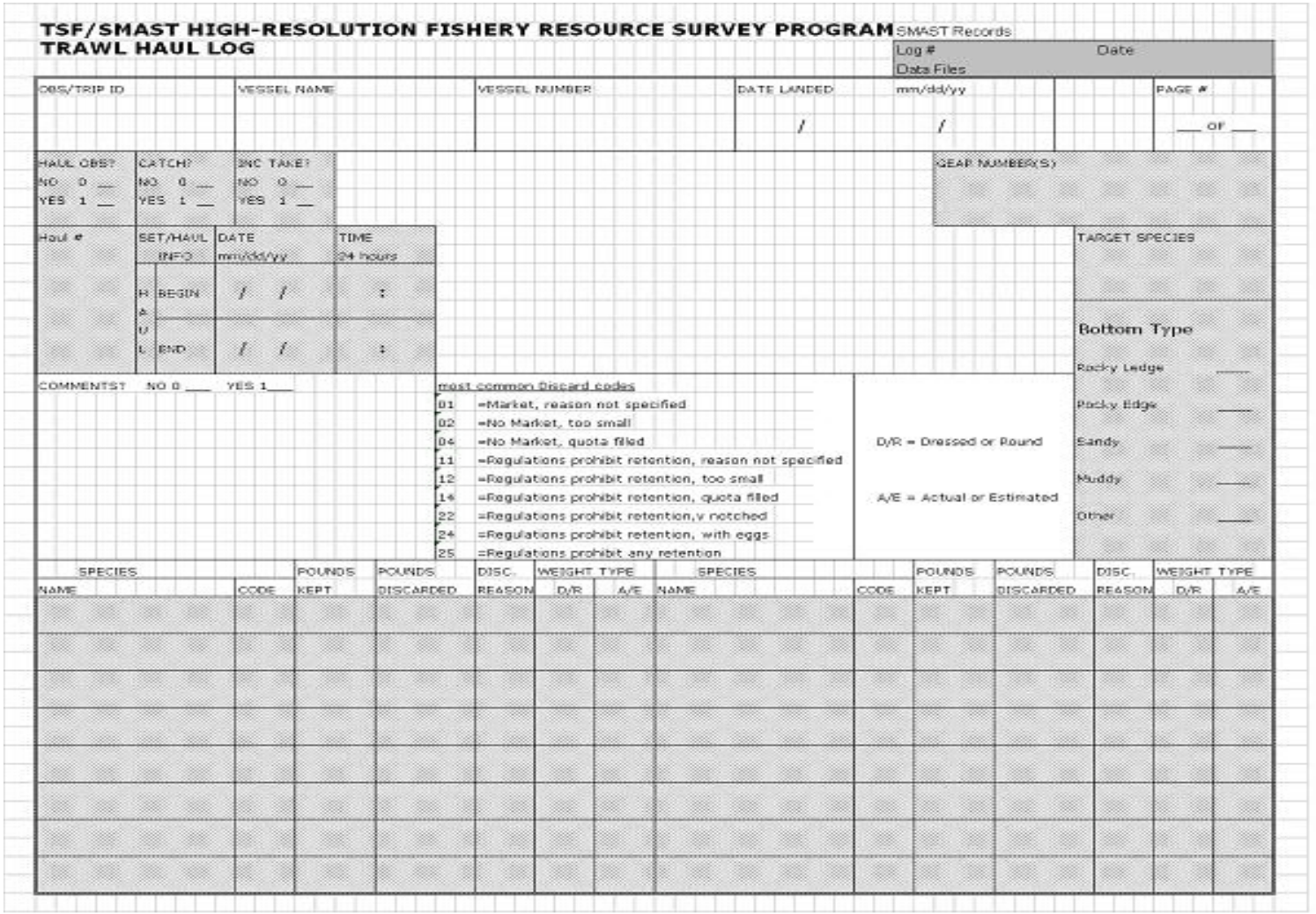


Figure 10. Fourth version of the SMAST Trawl Survey haul log.



TSF/SMAST HIGH-RESOLUTION FISHERY RESOURCE SURVEY PROGRAM
TRAWL HAUL LOG

SMAST Records
Log # Date
Data Files

OBS/TRIP ID | VESSEL NAME | VESSEL NUMBER | DATE LANDED mm/dd/yy / / | PAGE # ___ OF ___

HAUL OBS? NO 0 ___ YES 1 ___ | CATCH? NO 0 ___ YES 1 ___ | INC TAKE? NO 0 ___ YES 1 ___ | GEAR NUMBER(S)

Haul #	SET/HAUL INFO	DATE mm/dd/yy	TIME 24 hours
	HAUL BEGIN	/ /	:
	HAUL END	/ /	:

TARGET SPECIES

Bottom Type
Rocky Ledge ____
Rocky Edge ____
Sandy ____
Muddy ____
Other ____

COMMENTS? NO 0 ___ YES 1___

most common Discard codes
01 =Market, reason not specified
02 =No Market, too small
04 =No Market, quota filled
11 =Regulations prohibit retention, reason not specified
12 =Regulations prohibit retention, too small
14 =Regulations prohibit retention, quota filled
22 =Regulations prohibit retention,v notched
24 =Regulations prohibit retention, with eggs
25 =Regulations prohibit any retention

D/R = Dressed or Round
A/E = Actual or Estimated

SPECIES NAME	CODE	POUNDS KEPT	POUNDS DISCARDED	DISC. REASON	WEIGHT TYPE D/R	WEIGHT TYPE A/E	SPECIES NAME	CODE	POUNDS KEPT	POUNDS DISCARDED	DISC. REASON	WEIGHT TYPE D/R	WEIGHT TYPE A/E

Figure 11. Fifth version of the SMAST Trawl Survey haul log.

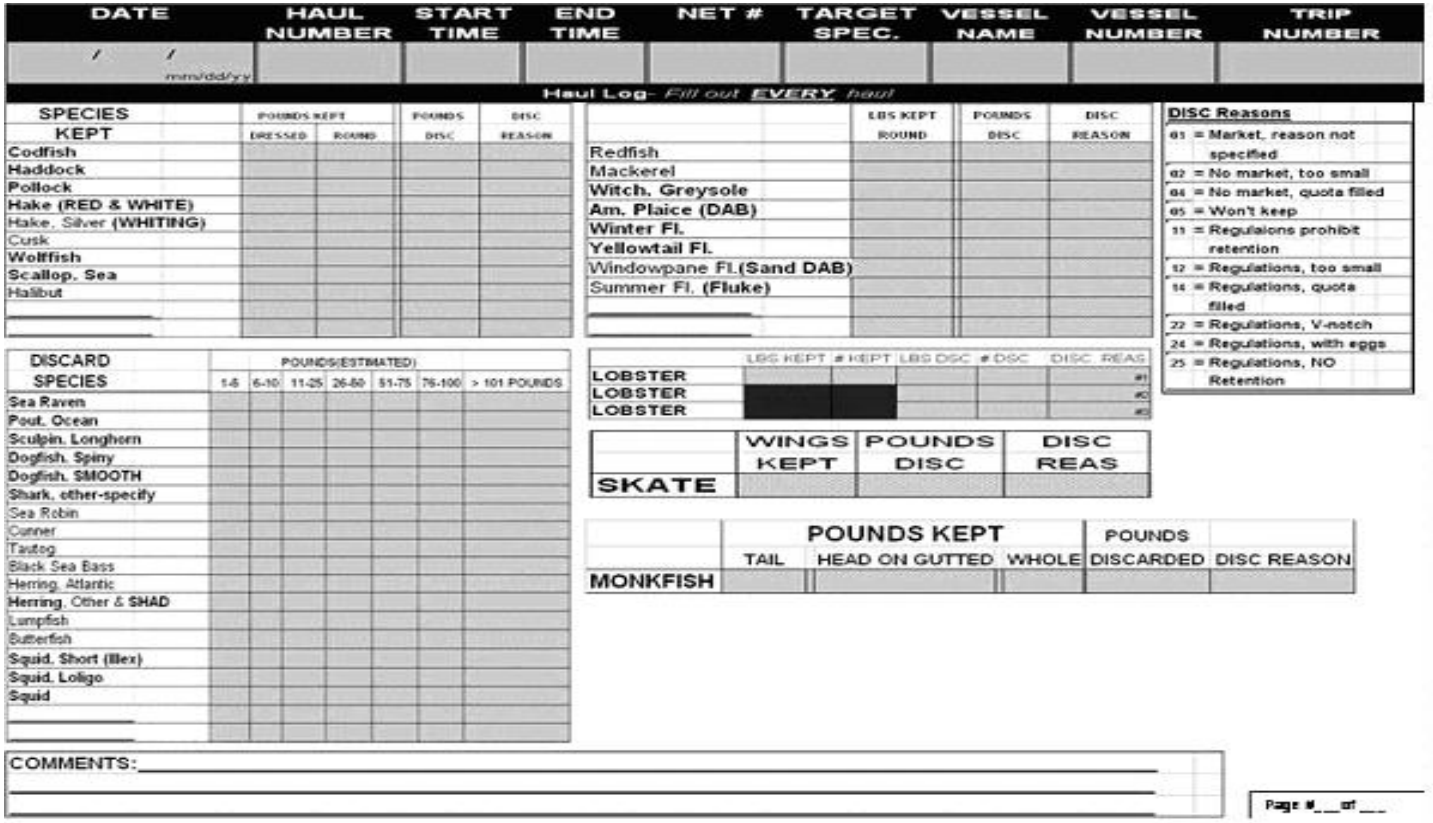
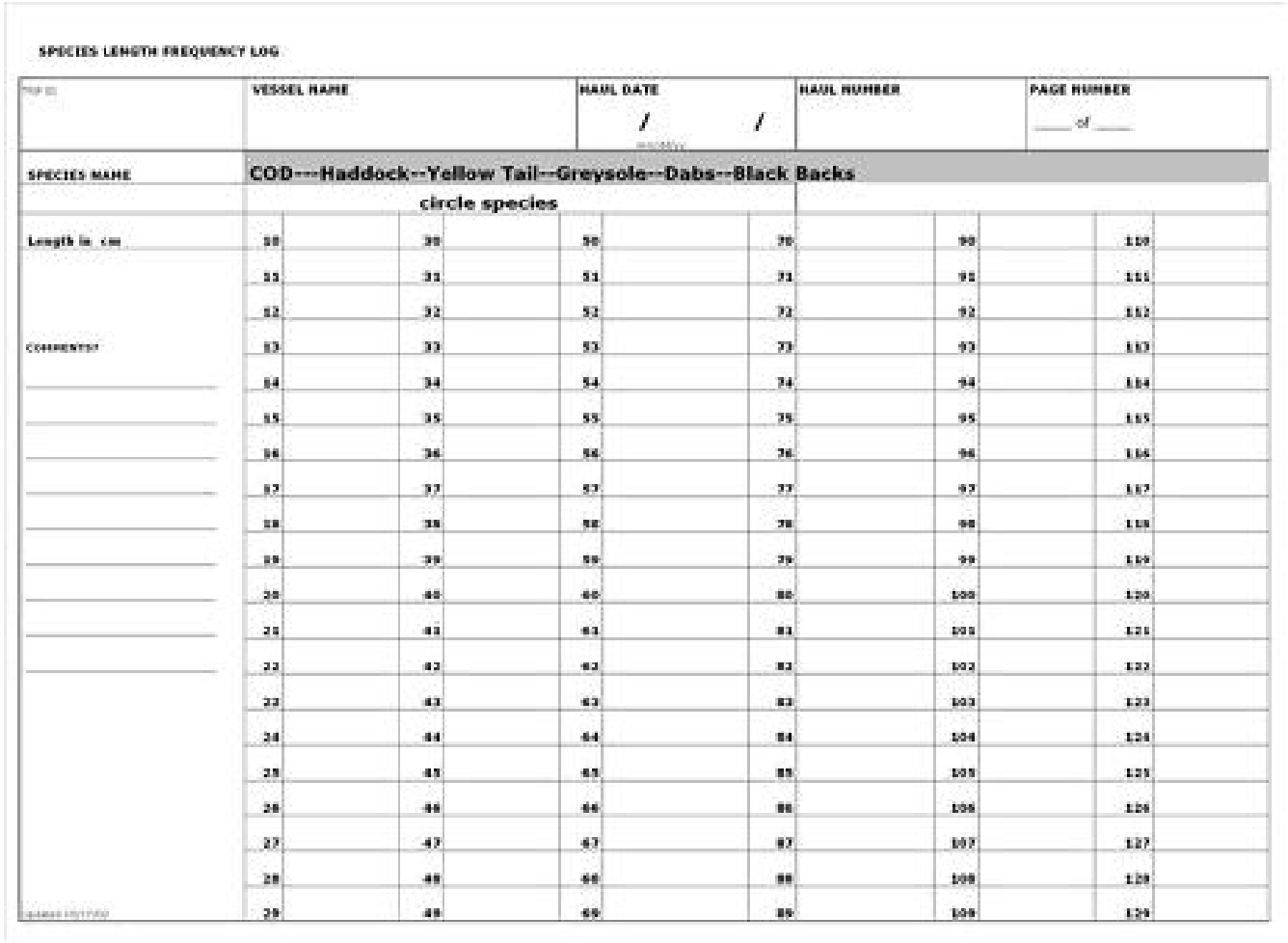


Figure 12. Seventh version of the SMAST trawl Survey haul log. It was used in year three (beginning August 2003).



SPECIES LENGTH FREQUENCY LOG

	VESSEL NAME	HAUL DATE / /	HAUL NUMBER	PAGE NUMBER ____ of ____

SPECIES NAME	COD---Haddock--Yellow Tail--Greysole--Dabs--Black Backs
	circle species

Length in cm										
	30		40		50		70		90	110
	31		41		51		71		91	111
	32		42		52		72		92	112
COMMENTS?	33		43		53		73		93	113
	34		44		54		74		94	114
	35		45		55		75		95	115
	36		46		56		76		96	116
	37		47		57		77		97	117
	38		48		58		78		98	118
	39		49		59		79		99	119
	40		50		60		80		100	120
	41		51		61		81		101	121
	42		52		62		82		102	122
	43		53		63		83		103	123
	44		54		64		84		104	124
	45		55		65		85		105	125
	46		56		66		86		106	126
	47		57		67		87		107	127
	48		58		68		88		108	128
	49		59		69		89		109	129

Figure 13. Third generation length frequency log used in the SMAST Trawl Survey.

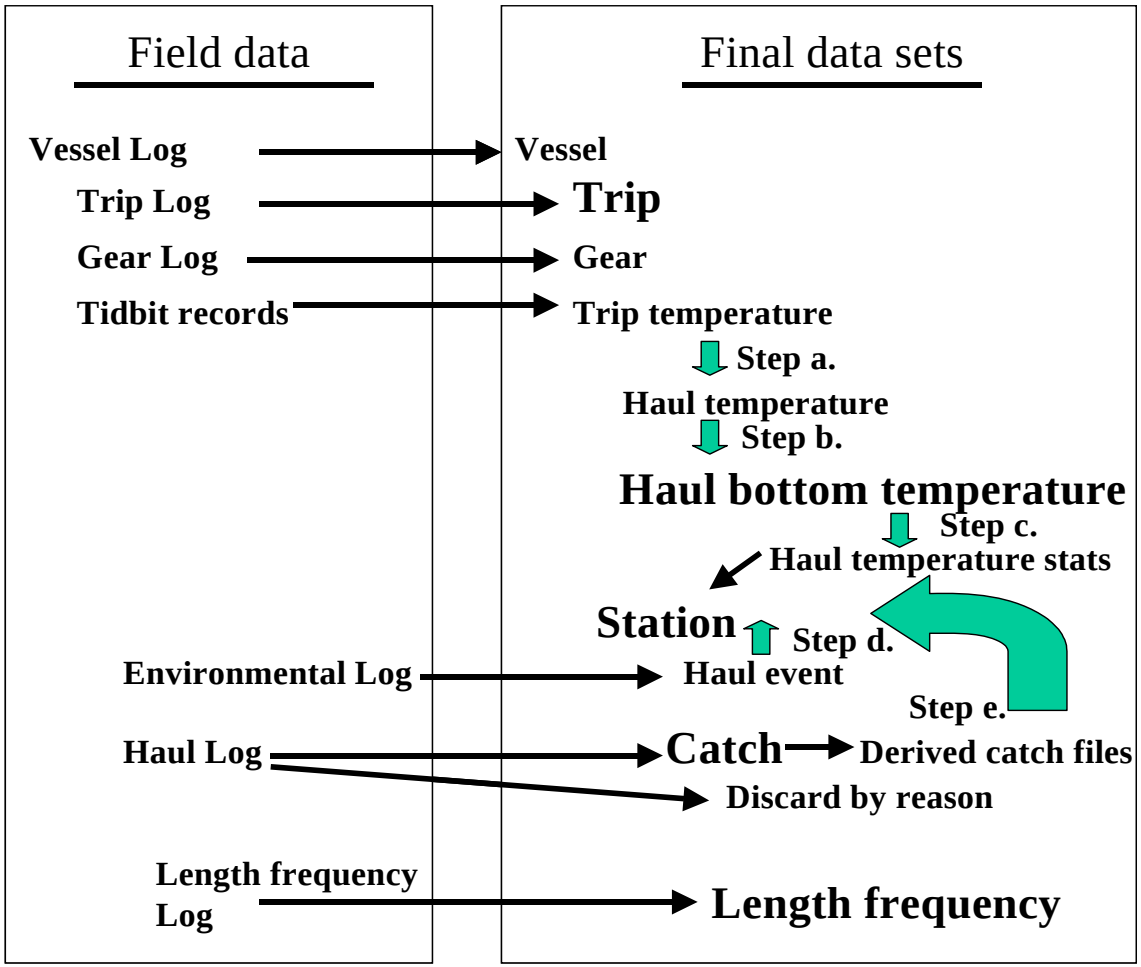


Figure 14. Relationship between the master data sets created from the field data logsheets with the final working data sets used for analysis. Steps needed to create the working data sets from the master data sets are described in the text.

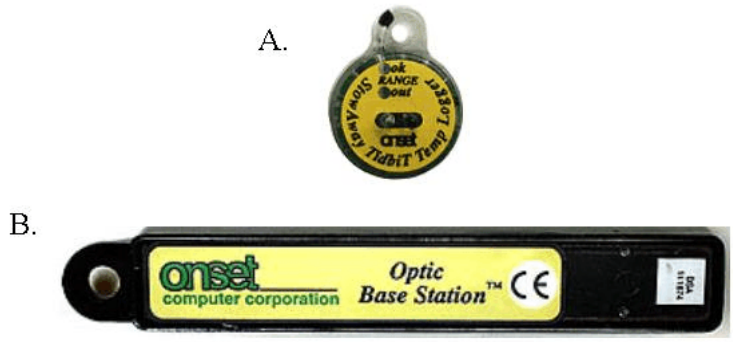


Figure 15. The Tidbit temperature data logger and optic base station made by Onset Computer Corporation (Pocassett, MA).

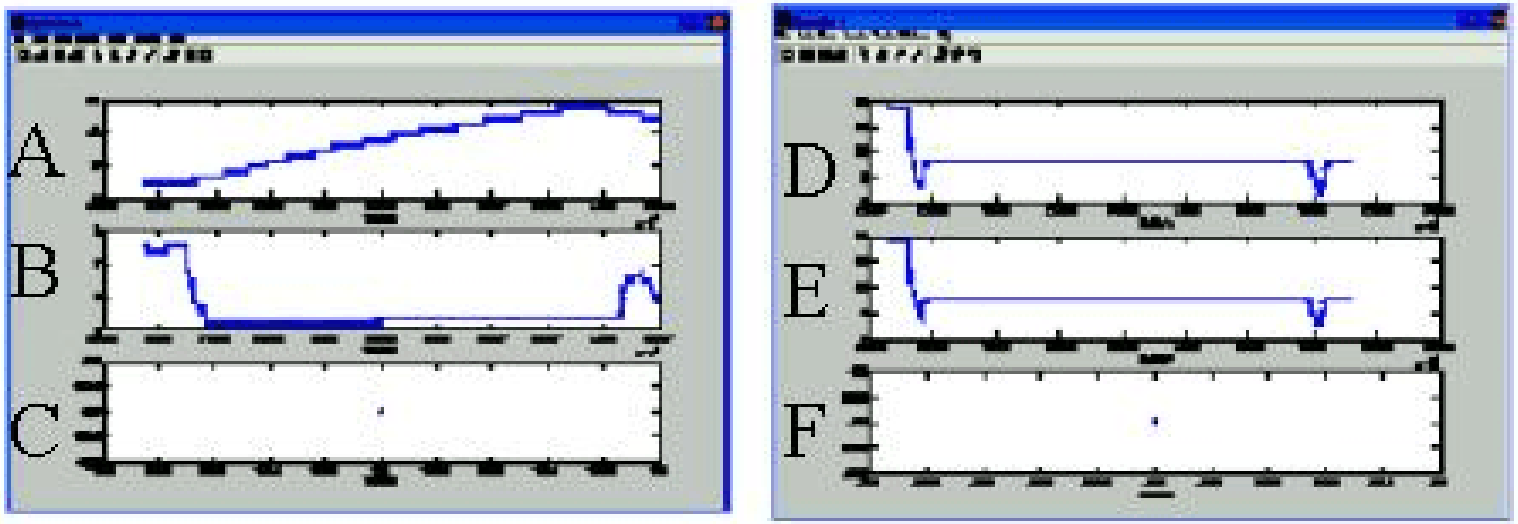


Figure 16. Examples of Tidbit water temperature data recorded on two different trips (left and right panels). Each panel depicts what is seen in the window while executing the matlab program Tidbitselect.m for each trip. In the first example, one Tidbit (B) was deployed on the gear being used during the haul, while the other Tidbit (A) was attached to another net stored on the deck. In the second example, Tidbits D and E were both deployed on the gear, one on each door. The program allows for up to three Tidbit records to be displayed for a given trip. In these cases, only two Tidbit recorders were deployed on each trip (A and B in the left panel and D and E in the right panel).

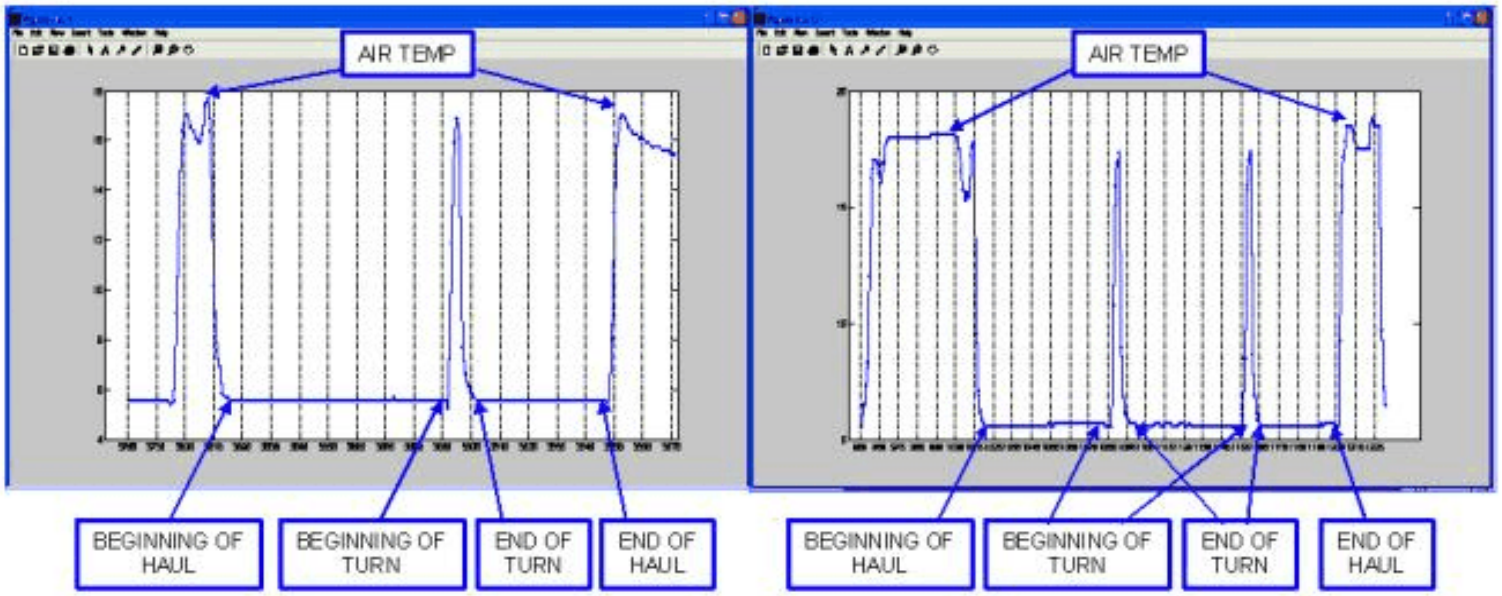


Figure 17. Two example Tidbit temperature profiles taken during a trawl tow. Both of the above panels depict typical haul profiles for boats fishing on Georges Bank. Note that the graphic on the left has one turn and the one the right has two.

Figure 18. Measuring board and length frequency tally sheet used to record fish length frequency data during the SMAST Trawl Survey. Fishermen measure individuals of a given species directly over the insert on the measuring board. The tally sheet is labeled with species, trip, haul and other information. Totals for each length are then transcribed onto the length frequency data log (Figure 20).

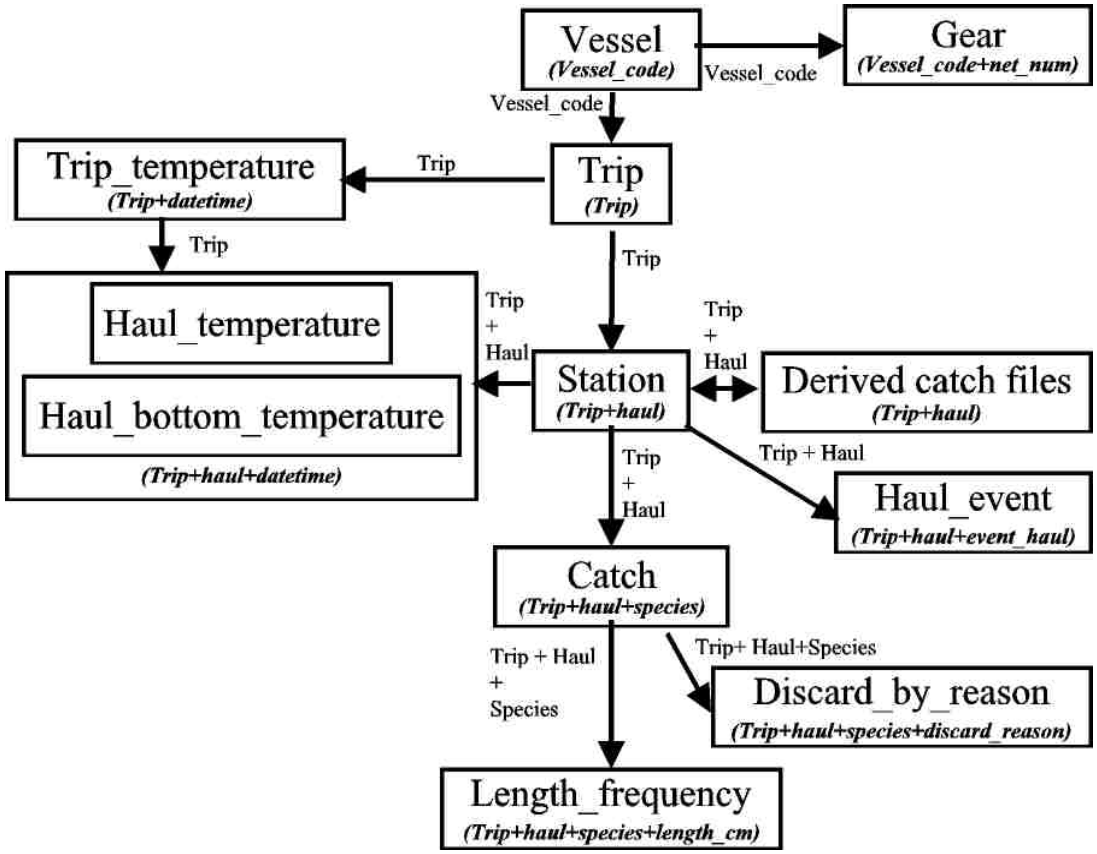


Figure 19. Schematic of the relational working data set structure. Primary fields are the minimum fields necessary to code for a unique data record (in italics under data set name). Key linking fields are those fields needed to link (merge) files together (shown next to linking arrows). Arrows indicate primary links between files (others are possible). All are one-to-many except for that between station and the derived catch files, which is one-to-one.

TABLES

Table 1. List of twenty vessels that collaborated in the High-Resolution Trawl Survey.

Vessel	Vessel Number	Home Port	Crew Size	Year Built	Year Engine Built	Horse Power	Holding Capacity (Tons)	Length (Ft)	Gross Tonnage
Blue Seas II	515716	New Bedford	5	1968	1968	425	35	73	129
Buzzards Bay	624947	New Bedford	5	1989	1989	850	100	86	198
Curlew II	297129	New Bedford	5	1964	2000	720	100	74	119
Fisherman	605059	New Bedford	4	1979	1979	760	56	82	166
Glenna & Jacob	659866	Hyannisport	2	1983	1983	365	25	62	65
Humbak	580932	New Bedford	5	1977	1998	840	55	72	139
Inheritance	1104992	Fairhaven	5	2000	2001	540	50	62	92
Isabel S	938786	New Bedford	6	1988	1988	750	85	83	181
Lady of Grace	599517	New York	4	1978	1998	625	50	76	153
Maria Angela	579484	New Bedford	4	1977	1997	575	103	75	147
Mischief	614835	New Bedford	4	1979	1993	750	50	75	129
Resolute	597484	Dennisport	5	1978	1978	800	50	82	164
Sao Marcos II	603986	New Bedford	5	1979				82	169
Sao Paolo	581723	New Bedford	5	1977	1989	565		75	147
Seel	646423	New Bedford	4	1982	1982	565	50	78	144

Vessel	Vessel Number	Home Port	Crew Size	Year Built	Year Engine Built	Horse Power	Holding Capacity (Tons)	Length (Ft)	Gross Tonnage
T Luis	572381	New Bedford	4	1976	1993	420	119	72	120
Tropico	609937	New Bedford	5	1979	2000	850	62	82	165
United States	618882	New Bedford	4	1980	1990	560	96	76	144
Victory	655922	New Bedford	4			365		74	99
Voyager I	613018	New Bedford	4	1979	1995	520	35	74	119

Table 2. Types of data logs collected during fishing operations.

Log Sheet Name	Contents	When Recorded
Vessel log	Characteristics that identify and describe the vessel	One time with updates
Gear log	Characteristics that identify and describe the gear	One time with updates
Trip log	Information for each specific trip	Once at end of each trip
Environmental log	Time, geographic position, weather, ship activity, depth, etc	Each net set, turn and haul-back
Haul log	Catch data	Each net haul-back
Length frequency log	Subsample length, weight and frequency data for a given species	Target half of all tows
Electronic data record from Tidbits	Continuous record of temperature during the trip	1-3 simultaneous recordings per trip, however, only the best record is used in the data sets

Table 3. Types of otter trawls used during the survey. Brand names or standard net type provided by the vessel captain. These generally fall into three major categories: flat nets, hi-rise nets, and roller/rock hopper nets.

Net Name Code	Net Type	Description	Net Type Category
-999	Unknown	Not recorded	Unknown
1	Shuman	Hi rise	Hi-rise
3	Levin marine	Custom made by Levin Marine Supply in Fairhaven, MA; Yankee like	Flat
4	Yankee	Primary a flatfish net, standard net foot rope is 20 longer than head rope. Net is 9 feet tall when fished (headrope distance=9 ft)	Flat
5	Float net	Custom flat net with extra floats	Flat
6	Balloon trawl	Gurock made original design, hi rise, big fishing circle and taper on wings gives height to net	Hi-rise
7	Flat 5" sweep	Flat net with cookie sweep, used primarily on smooth bottom for flatfish	Flat
8	Center roller 12"	Sweep tapers up to 12 inch roller, primarily for haddock, skate and smooth bottom	Roller
9	Roller 18"	Like the 12 inch roller but for a more uneven bottom	Roller
10	Gurock hi rise	Hi rise similar to the Shuman, about 25 ft tall, also known as reidar nets	Hi-rise
11	76x96	96 foot sweep 7 foot height	Flat
12	76x97	Standard Yankee trawl but with longer wings and a bigger sweep	Flat
13	Center roller	Middle roller on sweep without a lot of taper center of 18 inch in height	Roller

Net Name Code	Net Type	Description	Net Type Category
14	Yankee rock hopper	Yankee net on a rockhopper sweep for uneven bottom types	Roller
15	Flat net	Primarily for flatfish usually used with a square mesh cod end	Flat

Table 23. List of species or species groups targeted by commercial fishermen participating in the SMAST survey.

Target_species	Target_common_name	Target_scientific_name	T_spec_comments
-999	Not recorded	Not recorded	
1	Multispecies	Multiple groundfish species	Any combination of more than one species
124	Monkfish (angler, goosefish)	*Lophius americanus*	Also called monk
818	Cod, Atlantic	*Gadus morhua*	
1200	Flounder, winter (blackback)	*Pleuronectes americanus*	Also called blackback, georges flounder, lemonsole, channel flounder
1220	Flounder, witch (grey sole)	*Glyptocephalus cynoglossus*	Also called greysole
1230	Flounder, yellowtail	*Pleuronectes ferrugineus*	
1240	Flounder, American plaice	*Hippoglossoides platessoides*	Also called dabs
1477	Haddock	*Melanogrammus aeglefinus*	
1551	Hake, red/white mix	*Urophycis sp*	Red and white hake mixed
2400	Redfish, nk (ocean perch)	*Sebastes sp*	
2695	Pollock	*Pollachius virens*	
3650	Skate, nk	*Rajidae*	All types with market value
7270	Lobster, American	*Homarus americanus*	

Table 31. Species reported in the data that required conversion to a higher taxa level or to a mixed species group during data quality control processing due to the uncertainty of field identifications.

Old Species Code	Old Species	New Species Code	Species
0010	Alewife	1670	Herring, nk (shad)
1120	Herring, blueback	1670	Herring, nk (shad)
1730	Shad, hickory	1670	Herring, nk (shad)
3474	Shad, American	1670	Herring, nk (shad)
5080	Whiting, black (hake, offshore)	5070	Silver hake-offshore hake mix
5090	Hake, silver (whiting)	5070	Silver hake-offshore hake mix
1520	Hake, red (ling)	1551	Hake, red/white mix
1539	Hake, white	1551	Hake, red/white mix
6600	Hake, nk	1551	Hake, red/white mix
3250	Sculpin, longhorn	3260	Sculpin, nk
3660	Skate, little	3650	Skate, nk
3670	Skate, winter (big)	3650	Skate, nk

Old Species Code	Old Species	New Species Code	Species
3671	Skate, winter (big) wings	3650	Skate, nk
3690	Skate, smooth	3650	Skate, nk
3700	Skate, thorny	3650	Skate, nk

Table 32. Description of the trawl survey working data set tables. These data sets are derived from the trawl master data and are formatted for easier use by investigators and for construction of a relational data base.

Data Set Name	Primary Index Fields	Description
Trawl_catch_10sep04	trip + haul + species	Contains total catch, total kept, and total discard weights derived from the "haul_log_raw_data" after application of conversion factors and summing over species_category and discard reason levels if necessary
Trawl_discard_by_reason_10sep04	trip+haul+species+ discard_reason	Discard data partitioned by reason, separate line for each reason if more than one reason for discard
Trawl_gear_10sep04	vessel_code+net_number	Descriptive data on the gear characteristics, including type of net, net design, construction, and size
Trawl_haul_event_10sep04	trip + haul + event_haul	Derived from the environmental_log, contains environmental data for each "event" in each tow (trip-haul), including the set, haul-back, and up to 9 turns. This data is mainly useful only for those interested in the effect of turn
Trawl_length_frequency_10sep04	trip + haul+ species + size_cm	Length frequency data for selected subsampled species

Data Set Name	Primary Index Fields	Description
Trawl_station_10sep04	trip + haul	Derived from the event data so that there is a single record for each trip and haul combination, separate variables for environmental data are provided for the set and haul (given set_ and haul_ prefixes), as well as for the min_, max_, mean_, var_ of con
Trawl_trip_10sep04	trip	Data pertaining to the trip such as fuel used, etc.
Trawl_vessel_10sep04	vessel_code	Code used to mask the identity of individual fishing vessels
These are data on catch statistics that, together with the station data are of most interest to investigators		
Trawl_discard_catch	trip + haul	Weight of catch discarded for each species
Trawl_discard_cpue	trip + haul	CPUE of discard catch (lbs/h)
Trawl_kept_catch	trip + haul	Weight of catch that was kept by the fishermen for each species
Trawl_kept_cpue	trip + haul	CPUE of kept catch (lbs/h)
Trawl_percent_of_species_discard_10sep04	trip + haul	Percent of a species' catch in a given tow that was discarded, calculated from (discard_catch/species_catch)*100 in "species_catch" data set

Data Set Name	Primary Index Fields	Description
Trawl_percent_of_total_discard_10sep04	trip + haul	Percent of the total_catch composed of discard for the species (column heading) in a given tow that was discarded, calculated from total_catch in station data and discard_catch in species_catch data where (discard_catch/total_catch)*100 for each trip-haul
Trawl_total_catch	trip + haul	Total catch for each species for each trip and haul, each species that occurs at least once in the data set has a column designated by the species code and the prefix "tc" containing the total catch of that species for that trip-haul
Trawl_total_cpue	trip + haul	CPUE of the total_catch/tow_duration for each species, units are lbs/h towed

Table 33. Description of lookup tables for coded fields found in the trawl working data sets.

Data Set Name	Primary Index Fields	Description	Used in Working Data Set
Bridle_lu	Bridle	Types of gear used on the bridle (e.g., chain, roller, etc.)	trawl_gear_10sep04
Catch_log_lu	Catch_log	Table of catch log codes indicating availability and status of catch data	trawl_station_10sep04 trawl_haul_event_10sep04
Ce_color_lu	Ce_color	Table of codes for possible colors of twine used in construction of the cod end	trawl_gear_10sep04
Ce_material_lu	Ce_material	Table of codes for possible types of twine material used in construction of the cod end	trawl_gear_10sep04
Ce_twine_lu	Ce_twine	Indicates double or single strand twine used in the cod end construction	trawl_gear_10sep04
Ce_type_lu	Ce_type	Indicated mesh configuration (square, diamond, etc.) used in the cod end	trawl_gear_10sep04

Data Set Name	Primary Index Fields	Description	Used in Working Data Set
Chaffing_gear_lu	Chaffing_gear	Table of codes used to designate whether chaffing gear was used or not	trawl_gear_10sep04
Discard_data_code_lu	Discard_data_code	Table of codes used to designate whether discard data is complete and usable for the trip	trawl_trip_10sep04 trawl_station_10sep04 trawl_catch_10sep04
Discard_reason_data_lu	Discard_reason_data	Indicates if discard reason data is available, including catch weights by reason	trawl_catch_10sep04
Discard_reason_lu	Discard_reason	Table of codes designating various reasons that species were discarded	trawl_discard_by_reason _10sep04
Door_used_lu	Door_used	Table of codes used to designate whether trawl doors were used or not	trawl_gear_log_10sep04
Fish_outlet_lu	Fish_outlet	Indicates whether or not a fish outlet was used on the net	trawl_gear_10sep04
Foot_rope_lu	Foot_rope	Types of gear used on the footrope (e.g.,chain, roller, etc.)	trawl_gear_10sep04
Gear_mounted_elec_lu	Gear_mounted_elec	Codes for electronic gear mounted on the net	trawl_gear_10sep04

Data Set Name	Primary Index Fields	Description	Used in Working Data Set
Gr_cable_lu	Gr_cable	Types of gear used on the ground cable (e.g., chain, roller, etc.)	trawl_gear_10sep04
Haul_event	Haul_event	Table of set, turn, and haul event codes and definitions	trawl_haul_event_10sep04
Lf_discard_code_lu	Lf_discard_code	Table of codes used to designate whether fish that were measured for length/freq data were from the kept catch or discarded catch	trawl_length_frequency_ 10sep04
Net_material_lu	Net_material	Table of codes for possible types of twine material used in construction of the trawl net body	trawl_gear_10sep04
Net_name_code_lu	Net_name_code	Net brand or type used (note this is only indirectly referenced in the gear log, must be obtained by linking with vessel and trip log data)	trawl_gear_10sep04
Observer_present_lu	Observer_present	Table of codes to designate whether a SMAST technician was present to observe hauls on the trip	trawl_trip_10sep04

Data Set Name	Primary Index Fields	Description	Used in Working Data Set
Species_category_lu	Speccat	List of species categories observed, accounts for species that have multiple dressed types (direct copy of trawl_species_category_10sep04.xls from master data)	trawl_length_frequency_ 10sep04
Species_lu	Species_code	Species collected during the trawl survey (direct copy of trawl_species _10sep04.xls from master data)	Trawl_catch_10sep04 trawl_discard_by_reason_ 10sep04
Strengthener_lu	Stengthener	Indicates if a strengthening agent was used in net materials	trawl_gear_10sep04
Target_species_lu	Target_species	List of species targeted by the fishermen (direct copy of trawl_target_species_ 10sep04.xls from master data)	trawl_station_10sep04 trawl_haul_event_10sep04
Transducer_lu	Transducer	Indicates presence/absence of transducers mounted on the net	trawl_gear_10sep04
Turn_data_lu	Turn_data	Indicates if environmental (station and haul event) data were collected	trawl_station_10sep04 trawl_haul_event_10sep04

Data Set Name	Primary Index Fields	Description	Used in Working Data Set
Weather_code_lu	Weather_code	Table of weather codes and definitions, modeled after NMFS observer program	trawl_station_10sep04, trawl_haul_event_10sep04

Table 34. Description of variable fields contained in the primary working data set vessel (trawl_vessel_26Aug04.xls). This data is derived almost directly from the master vessel data file (Table 11), but may contain changes inserted in the SAS Program 1 (Appendix I).

Field Name	Data Type	Missing Code	Description
Vessel_code	Text	NA	Unique code assigned to participating vessels to insure confidentiality of source
Home_port	Text	NA	Home port city and state
Trip_type	Text	NA	Record whether single or multiple gears used: single in all cases
Typical_crew_size	Number	NA	Typical number of crew including captain
Gear_type	Text	NA	Type of gear that will be fished otter trawl in all cases
Second_engine	Text	NA	Present or not present; n=no (NMFS=0), y=yes (NMFS=1)
Year_eng_built	Number	-999	Year of engine manufacture
Horse_power	Number	-999	Horsepower of marine engine. If a second engine, describe in comments
Year_vessel_built	Number	-999	Year the vessel (hull) was built
Holding_cap_tons	Number	-999	Number of tons that can be stowed in fish hold
Fuel_type	Number	NA	Fuel type that is used in main engine
Hull_construction	Number	NA	Construction material of hull

Field Name	Data Type	Missing Code	Description
Length_ft	Text	NA	Total length of vessel registered on coast guard documentation
Gross_tonnage	Text	NA	Total gross register tonnage (grt) on coast guard documentation
Loran	Number	NA	Number of loran instruments; NMFS code=901
Gps	Number	-999	Number of global positioning system (gps) units; NMFS code=906
Radar	Number	NA	Number of radar instruments; NMFS code=902
Echo_sounder	Number	NA	Number of echosounders; NMFS code=903
Gyro_compass	Number	-999	Number of gyro compasses; NMFS code=910
Cell_phone	Number	NA	Number of cellular phones; NMFS code=907
Vhf	Number	NA	Number of VHF radios; NMFS code=909
Cb	Number	-999	Number of CB radios; NMFS code=930
Plotter	Number	NA	Number of chart plotters; NMFS code=905
Ssb_radio	Number	-999	Number of single side band radios; NMFS code=927
Computer	Number	-999	Number of personal computers; NMFS code=925
Sat_phone	Number	-999	Number of satellite phones
Vessel_tracking_system	Number	-999	Vessel tracking system/or vessel monitoring system; NMFS code=908
Auto_pilot	Number	-999	Vessel auto pilot system; NMFS code=922

Table 35. Description of variable fields contained in the primary working data set gear (trawl_gear_26aug04.xls). This data is derived almost directly from the master gear data file (table 13), but may include modifications resulting from data processing in the SAS Program 1 (Appendix I).

Field Name	Data Type	Missing Code	Description	Comment
Vessel_code	Number	NA	Unique random code assigned to participating vessels to insure confidentiality of source	
Net_number	Number	NA	Numerically assigned identifier for nets on a vessel	
Net_name_code	Number	-999	If net has a brand type or standard name	
Net_name	Text	NA	Brand name or other descriptive label for the net type	Descriptive label given by fishermen or technician
Door_used	Number	NA	Present or not present	Always present
Door_weight	Number	NA	Weight of one door in kilograms	
Vert_opening	Number	-999	Vertical opening in feet of net when it is fully deployed	
Horiz_opening	Number	-999	Horizontal opening in feet of net when it is fully deployed	
Door_dist	Number	-999	Total distance between doors in feet when net is fully deployed	
Head_rope_dist	Number	-999	Head rope distance in feet from bottom when net is fully deployed	

Field Name	Data Type	Missing Code	Description	Comment
Gear_mounted_elec	Number	NA	Present or not present	Never present except for SMAST temp loggers
Net_material	Number	NA	Material net is constructed from	Twine type
Ce_material	Number	NA	Material cod end is constructed from	Twine type
Gr_cable	Number	-999	Material ground cable is constructed from	
Bridle	Number	-999	Material bridle is constructed from	
Foot_rope	Number	-999	Material foot rope is constructed from	
Head_rope_len	Number	-999	Length of head rope in feet	
Foot_rope_len	Number	-999	Length of foot rope in feet	
Ground_cable_len	Number	-999	Length of ground cable in feet	
Num_meshes_in_fish_cir	Number	-999	Number of meshes present largest opening of the net known as the fishing circle	
Mesh_size	Number	-999	Mesh size in inches used in the construction of the net body and belly	6 inch in all cases
Ce_type	Number	NA	Type of configuration in the cod end meshes	Square or diamond
Ce_twine	Number	-999	Type of twine used in the cod end	Twine type
Ce_color	Number	-999	Color of mesh used in the cod end	

Field Name	Data Type	Missing Code	Description	Comment
Ce_size	Number	-999	Size of mesh used in cod end in inches measured knot to knot	
Strengthener	Number	NA	Present or not present	Always present
Chafing_gear	Number	-999	Present or not present	Always present
Transducers	Number	-999	Present or not present	Never present
Fish_outlet	Number	-999	Present or not present	Never present
Net_category	Text	Na	General type of net used (Flat, hi-rise, roller, or unknown	Added during data processing
Net_name _comments	Text	Na	Technician comment on the net type	

Table 36. Description of variable fields contained in the primary working data set trip (trawl_trip_26aug04.xls). This data is derived almost directly from the master trip data set (table 12), but may include modifications resulting from data processing in the SAS Program 1 (Appendix I).

Field Name	Data Type	Missing Code	Description
Trip	Number	NA	Trawl trip number
Vessel_code	Number	NA	Unique code assigned to participating vessels to insure confidentiality of source
Date_sailed	Date	Blanks	Date sailed
Time_sailed	Time	Blanks	Time sailed est on a 24 hr clock
Port_landed	Text	NA	Port city landed in
Date_landed	Date	Blanks	Date landed
Time_landed	Time	Blanks	Time landed est on a 24 hr clock
Exp_trip_dur	Number	-999	Expected trip duration in days
Ice_used_tons	Number	-999	Tons of ice bought and loaded for trip
Fuel_used_gal	Number	-999	Number of gallons of fuel used on trip
Crew_size	Number	-999	Number of crew on vessel including captain
Dealer	Text	-999	Dealer name
Captain_code	Text	NA	Unique random code assigned to participating captains to insure confidentiality of source
Das	Number	-999	Calendar days at sea for the trip; landed date minus departure date
Observer_present	Number	NA	Indicates an SMAST observer was on board (1) or not (2)
Discard_data _code	Number	NA	Code added during data processing to indicate if discard weight data is valid (1=presumed valid discard data, 2=invalid discard data due to under reporting)

Table 37. Description of variable fields contained in the Primary working data set station (trawl_station_26aug04.xls). This data is derived from the master env log data file (table 14) and the master haul log data (table 29). The data has been modified to remove tow event data and insert aggregate catch data by the SAS Program 1 (Appendix I).

Field Name	Data Type	Description
Trip	Number	Trawl trip number
Haul	Number	Trawl number assigned at sea, usually consecutive within a trip
Catch_log	Number	Code to indicate if catch data is available and its status
Net_number	Number	Code to indicate the individual net used by the fishermen for the haul, information on the net can be found in the gear log data, but must be linked through the vessel data first
Set_month	Number	At set: month of the year
Set_day	Number	At set: day of the month
Set_year	Number	At set: calendar year
Set_hour	Number	At set: hour of the day (est), 24 h clock
Set_minute	Number	At set: minute of the hour
Set_tow_course	Number	At set: direction traveled by the vessel (character data has been converted to degrees, e.g., n=0, s=180)
Set_tow_speed	Number	At set: vessel speed
Set_wire_out	Number	At set: amount of wire payed out in meters
Set_water_depth	Number	At set: water depth

Field Name	Data Type	Description
Set_wave_height	Number	At set: wave height
Set_weather_code	Number	At set: standardized code to designate weather conditions (See weather_code table)
Set_wind_direction	Number	At set: wind direction
Set_wind_speed	Number	At set: wind speed
Set_date_time	Date/time	At set: date and time variable
Set_latitude	Number	At set: latitude in decimal degrees
Set_longitude	Number	At set: longitude in decimal degrees
Set_hour_round	Number	At set: hour of the day rounded to the nearest hour based on hour and minute
Haul_month	Number	At haul-back: month of the year
Haul_day	Number	At haul-back:day of the month
Haul_year	Number	At haul-back:calendar year
Haul_hour	Number	At haul-back:hour of the day (est), 24 h clock
Haul_minute	Number	At haul-back:minute of the hour
Haul_tow_course	Number	At haul-back:direction traveled by the vessel (character data has been converted to degrees, e.g., n=0, s=180)
Haul_tow_speed	Number	At haul-back:vessel speed

Field Name	Data Type	Description
Haul_wire_out	Number	At haul-back:amount of wire payed out in meters
Haul_water_depth	Number	At haul-back:water depth
Haul_wave_height	Number	At haul-back: height
Haul_weather_code	Number	At haul-back:standardized code to designate weather conditions (See weather_code table)
Haul_wind_direction	Number	At haul-back:wind direction
Haul_wind_speed	Number	At haul-back:wind speed
Haul_date_time	Date/time	At haul-back:date and time variable
Haul_latitude	Number	At haul-back:latitude in decimal degrees
Haul_longitude	Number	At haul-back:longitude in decimal degrees
Haul_hour_round	Number	At haul-back:hour of the day rounded to the nearest hour based on hour and minute
Number_of_tow_events		Number of tow_events in the haul, note turns were not recorded during part of the first year
Min_course	Number	Minimum of events: direction traveled by the vessel (character data has been converted to degrees, e.g., n=0, s=180)
Min_speed	Number	Minimum of events: vessel speed
Min_wire_out	Number	Minimum of events: amount of wire payed out in meters
Min_depth	Number	Minimum of events: water depth

Field Name	Data Type	Description
Min_wave_height	Number	Minimum of events: wave height
Min_weather_code	Number	Minimum of events: standardized code to designate weather conditions (See weather_code table)
Min_wind_direction	Number	Minimum of events: wind direction
Min_wind_speed	Number	Minimum of events: wind speed
Mean_course	Number	Mean of events: direction traveled by the vessel (character data has been converted to degrees, e.g., n=0, s=180)
Mean_speed	Number	Mean of events: vessel speed
Mean_wire_out	Number	Mean of events: amount of wire payed out in meters
Mean_depth	Number	Mean of events: water depth
Mean_wave_height	Number	Mean of events: wave height
Mean_weather_code	Number	Mean of events: standardized code to designate weather conditions (See weather_code table)
Mean_wind_direction	Number	Mean of events: wind direction
Mean_wind_speed	Number	Mean of events: wind speed
Max_course	Number	Maximum of events: direction traveled by the vessel (character data has been converted to degrees, e.g., n=0, s=180)
Max_speed	Number	Maximum of events: vessel speed
Max_wire_out	Number	Maximum of events: amount of wire payed out in meters

Field Name	Data Type	Description
Max_depth	Number	Maximum of events: water depth
Max_wave_height	Number	Maximum of events: wave height
Max_weather_code	Number	Maximum of events: standardized code to designate weather conditions (See weather_code table)
Max_wind_direction	Number	Maximum of events: wind direction
Max_wind_speed	Number	Maximum of events: wind speed
Var_course	Number	Variance of events: direction traveled by the vessel (character data has been converted to degrees, e.g., n=0, s=180)
Var_speed	Number	Variance of events: vessel speed
Var_wire_out	Number	Variance of events: amount of wire payed out in meters
Var_depth	Number	Variance of events: water depth
Var_wave_height	Number	Variance of events: wave height
Var_weather_code	Number	Variance of events: standardized code to designate weather conditions (See weather_code table)
Var_wind_direction	Number	Variance of events: wind direction
Var_wind_speed	Number	Variance of events: wind speed
Tow_duration	Number	Length of tow in decimal hours (haul_date_time - set_date_time)

Field Name	Data Type	Description
Target_species	Number	Code to designate the species targeted by the fishermen for that haul
Turn_data	Text	Code to indicate if environmental data were recorded on the turns (N=no, Y=yes), code inserted by SAS program where Turn_data=N for trips 1-3
Number_species_caught	Number	Total number of species reported for the tow
Total_catch	Number	Total catch weight aggregated over all species
Total_pounds_kept	Number	Total pounds kept aggregated over all species
Total_pounds_discard	Number	Total discard pounds aggregated over all species
Number_species_kept	Number	Number of kept species reported for the tow
Number species discard	Number	Number of discarded species reported for the tow
Percent_total_discard	Number	Percent of the total catch represented by discard
Total_catch_cpue	Number	Total catch weight per hour
Total_pounds_kept_cpue	Number	Total kept weight per hour
Total_pounds_discard_cpue	Number	Total discard weight per hour
Discard_data_code	Number	Code added during data processing to indicate reliability of the discard data (1=good, 2=poor)

Table 38. Description of variable fields contained in the primary working data set haul_event (trawl_haul_event_26aug04.xls). This data is derived from the master env log data file (table 14). The data has been modified to insert a field to indicate the temporal sequence of haul events by SAS Program 1 (Appendix I)..

Field Name	Data Type	Description
Trip	Number	Trawl trip number
Haul	Number	Trawl number assigned at sea, usually consecutive within a trip
Catch_log	Number	Code to indicate if catch data is available and its status
Haul_event	Number	Code to designate the set, turn and haul components of a trawl tow. Each component has a separate record if data is available
Net	Number	Code to indicate the individual net used by the fishermen for the haul, information on the net can be found in the gear log data
Month	Number	Month of the year
Day	Number	Day of the month
Year	Number	Calendar year
Hour	Number	Hour of the day (est), 24 h clock
Minute	Number	Minute of the hour
Lat_n_deg	Number	Degrees of latitude
Lat_min	Number	Minutes of latitude
Lon_w_deg	Number	Degrees of longitude
Lon_min	Number	Minutes of longitude

Field Name	Data Type	Description
Tow_course	Number	Direction traveled by the vessel at the time of set, turn or haul as recorded by the captain (character data has been converted to degrees, e.g., n=0, s=180)
Tow_speed	Number	Vessel speed at the time of tow set, turn or haul as recorded by the captain
Wire_out	Number	Amount of wire payed out during the tow in meters
Water_depth	Number	Water depth as recorded by the captain for the set, turn or haul
Wave_height	Number	Wave height recorded by the captain for the set, turn or haul
Weather_code	Number	Standardized code to designate weather conditions at the set, turn or haul (see weather_code table)
Wind_direction	Number	Wind direction recorded at the time of the set, turn or haul
Wind_speed	Number	Wind speed recorded at the time of the set, turn or haul
Date	Date/time	Date of the set, turn or haul event
Date_time	Date/time	Date and time variable
Latitude	Number	Latitude in decimal degrees
Longitude	Number	Longitude in decimal degrees
Hour_round	Number	Hour of the day rounded to the nearest hour based on hour and minute
Event	Text	Haul event code converted into a descriptive label (set, haul, turn)
Turn_data	Text	Code to indicate if environmental data were recorded on the turns (n=no, y=yes), code inserted by SAS program where turn_data=n for trips 1-3
Event_haul	Text	Description of the trawl events also indicating time sequence, set, turn1, turn2, …turnx, haul

Table 39. Description of variable fields contained in the primary working data set catch (trawl_catch_26aug04.xls). This data is derived from the master haul log data file (table 15). The discard_data_code is derived from the master trip info log data file (table 12). Total catch and total discard data are set to missing when discard_data_code=2. The data has been modified to remove discard by reason data, and to determine species totals for catch, kept and discard by summing over species categories and applying weight conversion factors, by the SAS Program 1 (Appendix I).

Field name	**Data Type**	**Description**
Trip	Number	Sequential code number assigned to each trawl trip
Haul	Number	Trawl haul number assigned at sea, usually consecutive within a trip
Species_code	Number	Code used to designate the species or species group
Species_catch	Number	Total catch (kept + discard) after correcting weights for dressed fish
Species_convert_pounds_kept	Number	Total weight of kept fish for a species after correcting for dressed fish
Species_total_pounds_discard	Number	Total weight of fish discarded for a species after adding discards by various reasons
Discard_reason_data	Number	Code to indicate that data on the reason for discard, including weights discarded by multiple reasons, is available in a separate table
Discard_data_code	Number	Code derived from the trip data indicating if discard weight data is valid (1=presumed valid discard data, 2=invalid discard data due to under reporting)

Table 40. Description of variable fields contained in the Primary Working Data Set Discard_by_Reason (Trawl_Discard_by_Reason_26Aug04.xls). This data is derived from the Master Haul Log Data File (Table 15). This provides discard by reason data for the subset of the catch data where discard reason was recorded, often when multiple reasons were recorded for a single species. Derived by the SAS Program 1 (Appendix I).

Field Name	Data Type	Description
Trip	Number	Sequential code number assigned to each trawl trip
Haul	Number	Trawl haul number assigned at sea, usually consecutive within a trip
Species_code	Number	Code used to designate the species or species group
Discard_reason	Number	Code to designate the reason for the discard, based on NMFS observer program data
Species_pounds_discard	Number	Weight of fish discarded for the species and discard reason

Table 41. Description of variable fields contained in the primary working data set length frequency (trawl_length_frequency_26aug04). This data is derived almost directly from the master length frequency data file (table 21). Note that the variable speccat has not been converted to species. Therefore, it is necessary to combine species categories to obtain length species for a given species (use the trawlspeciescategorytable23aug04.xls in the lookup table directory).

Field Name	Missing Code	Data Type	Description
Trip	NA	Number	Sequential code number assigned to each trawl trip
Haul	NA	Number	Trawl haul number assigned at sea, usually consecutive within a trip
Speccat	NA	Number	Code used to designate the species or species group,, this code actually codes for a species category to take into account different NMFS codes for different dressed conditions of a species
Lf_discard_code	-999	Text	Designates whether the fish was discarded or kept. Not used in trips 200 and over
Subsample_weight	-999	Number	Combined weight of the fish subsampled for length frequency data Not used in trips 200 and over
Size_cm	NA	Number	Total fish length in cm
Frequency	NA	Number	Frequency (number) of fish at the given length (size_cm)

Table 42. Field definitions for the derived catch files working data set total catch (trawl_total_catch_23aug04.xls). This is an example of the "derived catch" tables created from the "primary working data set" catch (trawl_catch_26aug04.xls) by the SAS Program 1 (Appendix B).. Note the prefix "T" is used in front of the species codes to form the catch variables for each species. The other derived tables are the same, except for the prefix: "T" - Total catch, "TC" - Total catch CPUE, "K" - Kept catch, "KC" - Kept catch CPUE, "D" - Discard Catch, "DC" - Discard catch CPUE, "PD" - Percent discard of a species catch, "DP" - Percent discard of total catch.

Field Name	**Data Type**	**Description:**	**Species**
TRIP	NUMBER	Trawl trip number	
HAUL	NUMBER	Trawl number assigned at sea, usually consecutive within a trip	
DISCARD_DATA_CODE	NUMBER	Indicates whether discard data is complete and useable	
T124	NUMBER	Total weight caught of:	*Lophius americanus*
T230	NUMBER	Total weight caught of:	*Pomatomus saltatrix*
T300	NUMBER	Total weight caught of:	Water tow
T511	NUMBER	Total weight caught of:	*Peprilus triacanthus*
T818	NUMBER	Total weight caught of:	*Gadus morhua*
T930	NUMBER	Total weight caught of:	*Tautogolabrus adspersus*
T960	NUMBER	Total weight caught of:	*Brosme brosme*
T1200	NUMBER	Total weight caught of:	*Pleuronectes americanus*
T1219	NUMBER	Total weight caught of:	*Paralichthys dentatus*

Field Name	Data Type	Description:	Species
T1220	NUMBER	Total weight caught of:	*Glyptocephalus cynoglossus*
T1230	NUMBER	Total weight caught of:	*Pleuronectes ferrugineus*
T1240	NUMBER	Total weight caught of:	*Hippoglossoides platessoides*
T1250	NUMBER	Total weight caught of:	*Scophtalmus aquosus*
T1270	NUMBER	Total weight caught of:	*Paralichthys oblongus*
T1280	NUMBER	Total weight caught of:	*Trinectes maculatus*
T1477	NUMBER	Total weight caught of:	*Melanogrammus aeglefinus*
T1551	NUMBER	Total weight caught of:	*Urophycis sp*
T1590	NUMBER	Total weight caught of:	*Hippoglossus hippoglossus*
T1670	NUMBER	Total weight caught of:	*Clupeidae*
T1685	NUMBER	Total weight caught of:	*Clupea harengus*
T1880	NUMBER	Total weight caught of:	*Zenopsis conchifera*
T2100	NUMBER	Total weight caught of:	*Cyclopterus lumpus*
T2120	NUMBER	Total weight caught of:	*Scomber scombrus*
T2400	NUMBER	Total weight caught of:	*Sebastes sp*

Field Name	Data Type	Description:	Species
T2500	NUMBER	Total weight caught of:	*Macrozoarces americanus*
T2695	NUMBER	Total weight caught of:	*Pollachius virens*
T3260	NUMBER	Total weight caught of:	*Cottidae*
T3270	NUMBER	Total weight caught of:	*Hemitripterus americanus*
T3295	NUMBER	Total weight caught of:	*Stenotomus chrysops*
T3350	NUMBER	Total weight caught of:	*Centropristis striata*
T3410	NUMBER	Total weight caught of:	*Triglidae sp*
T3501	NUMBER	Total weight caught of:	*Mustelus, Squalus sp*
T3521	NUMBER	Total weight caught of:	*Squalus acanthias*
T3591	NUMBER	Total weight caught of:	*Squaliformes*
T3650	NUMBER	Total weight caught of:	*Rajidae*
T3680	NUMBER	Total weight caught of:	*Raja laevis*
T3720	NUMBER	Total weight caught of:	*Raja eglanteria*
T4180	NUMBER	Total weight caught of:	*Morone saxatilis*
T4380	NUMBER	Total weight caught of:	*Tautoga onitis*
T4811	NUMBER	Total weight caught of:	*Lamna nasus*
T4961	NUMBER	Total weight caught of:	*Cetorhinus maximus*

Field Name	Data Type	Description:	Species
T5070	NUMBER	Total weight caught of:	*Merluccius spp*
T5120	NUMBER	Total weight caught of:	*Anarhichas lupus*
T6631	NUMBER	Total weight caught of:	*Petromyzontidae*
T6730	NUMBER	Total weight caught of:	*Torpedo nobiliana*
T7270	NUMBER	Total weight caught of:	*Homarus americanus*
T8009	NUMBER	Total weight caught of:	*Patinopecten, placopecten sp*
T8010	NUMBER	Total weight caught of:	*Loligo pealei*
T8020	NUMBER	Total weight caught of:	*Illex illecebrosus*
T8030	NUMBER	Total weight caught of:	Squid

Appendix A. Look up Tables for Coded Fields Found in the Working Data Set Files.

Table A.1. Look up tables for coded fields in the primary working data trawl_trip_10sep04.xls.

DISCARD_DATA	DISCARD_DATA_DESCRIPTION
1	DISCARD DATA COMPLETE AND ACCEPTABLE
2	DISCARD DATA INCOMPLETE OR UNACCEPTABLE

OBSERVER_PRESENT	OBSERVER_PRESENT_DESCRIPTION
1	YES, AN SMAST TECHNICIAN WAS ON BOARD AND MONITORED DATA COLLECTION
2	NO, NO TECHNICIAN ON BOARD

Table A.2. Look up tables for coded fields in the primary working data set trawl_gear_10sep04.

NET_NAME_CODE	NET_CATEGORY	NET_NAME	NET_NAME_COMMENTS

-999	Unknown	Unknown	Not recorded
1	Hi-rise	Shuman	Hi rise
3	Flat	Levin marine	Custom made by Levin Marine Supply in Fairhaven, MA; Yankee like
4	Flat	Yankee	Primarily a flatfish net, standard net foot rope is 20 ft longer than head rope, net is 9 ft tall when fished
5	Flat	Float net	Custom flat net with extra floats
6	Hi-rise	Baloon trawl	Gurock made original design, hi rise, big fishing circle and taper on wings gives height to net
7	Flat	Flat 5" sweep	Flat net with cookie sweep, used primarily on smooth bottom for flatfish
8	Roller	Center roller 12"	Sweep tapers up to 12 inch roller, primarily for haddock and skate on smooth bottom
9	Roller	Roller 18"	Like the 12 inch but for a more uneven bottom
10	Hi-rise	Gurock hi rise	Hi rise similar to the shuman, about 25 ft tall
11	Flat	76x96	96 foot sweep 7 foot height
12	Flat	76x97	Standard yankee trawl but with more wings and a bigger sweep
13	Roller	Center roller	Middle roller without a lot of taper center of 18 feet in height
14	Roller	Yankee rock hopper	Yankee net on a rockhopper sweep for uneven bottom types
15	Flat	Flat net	Primarily for flat fish usually used with a squre mesh cod end

DOOR_USED	DOOR_USED_DESCRIPTION	DOOR_USED_COMMENTS
1	YES	All otters trawls use doors by definition
2	NO	Not applicable, NMFS observer program hold-over

GEAR_MOUNTED_ELEC	GEAR_MOUNTED_ELEC_DESCRIPTION
1	YES
2	NO

NET_MATERIAL	NET_MATERIAL_DESCRIPTION
0	NOT RECORDED
1	NYLON
2	POLY
3	KEVLAR
4	SPECTRA
5	TENEX
6	NOMEX
8	COMBINATION
99	OTHER

CE_MATERIAL	CE_MATERIAL_DESCRIPTION
0	NOT RECORDED
1	NYLON
2	POLY
3	KEVLAR
4	SPECTRA
5	TENEX
6	NOMEX
8	COMBINATION
99	OTHER

GR_CABLE	GR_CABLE_DESCRIPTION
0	UNKNOWN OR NONE
1	CHAIN
2	CABLE
3	WRAPPED CABLE
4	ROCK HOPPER
5	ROLLER
6	RUBBER COOKIE
7	BOBBIN
8	NONE
9	OTHER
-999	NOT SPECIFIED

BRIDLE	BRIDLE_DESCRIPTION
0	UNKNOWN OR NONE
1	CHAIN
2	CABLE
3	WRAPPED CABLE
4	ROCK HOPPER
5	ROLLER
6	RUBBER COOKIE
7	BOBBIN
8	NONE
9	OTHER
-999	NOT SPECIFIED

FOOT_ROPE	FOOT_ROPE_DESCRIPTION
0	UNKNOWN OR NONE
1	CHAIN
2	CABLE
3	WRAPPED CABLE
4	ROCK HOPPER
5	ROLLER
6	RUBBER COOKIE
7	BOBBIN
8	NONE
9	OTHER
-999	NOT SPECIFIED

CE_TYPE	CE_TYPE_DESCRIPTION	CE_TYPE_COMMENTS
0	UNKNOWN	
1	DIAMOND	
2	SQUARE	
3	SQUARE WRAPPED	KNOTLESS TWINE
8	COMBINATION	

CE_TWINE	CE_TWINE_DESCRIPTION
1	SINGLE
2	DOUBLE
-999	UNKNOWN

CE_COLOR	CE_COLOR_DESCRIPTION
1	GREEN
2	BLACK
3	GREEN AND YELLOW
-999	UNKNOWN

STRENGTHENER	STRENGTHENER_DESCRIPTION
1	YES
2	NO

CHAFING_GEAR	CHAFING_GEAR_DESCRIPTION	CHAFING_GEAR_COMMENTS
1	YES	YES IN ALL CASES
2	NO	

TRANSDUCER	TRANSDUCERS_DESCRIPTION
1	YES
2	NO

FISH_OUTLET_CODE	FISH_OUTLET_DESCRIPTION	FISH_OUTLET_COMMENTS
1	YES	
2	NO	NEVER USED

Table A.3. Lookup tables for coded fields in the primary working data set trawl_station_10sep04.xls.

CATCH_LOG	CATCH_LOG_DESCRIPTION
1	CATCH DATA IN THE HAUL LOG
2	CATCH DATA NOT RECORDED OR LOST
3	TEAR-UP TOW, NO CATCH DATA

TURN_DATA	TURN_DATA_ DESCRIPTION	TURN_DATA_ COMMENT
N	No turn data recorded	Absence of turn data results from lack of reporting
Y	Turn data recorded	Absence of turn data because no turn occurred

WEATHER_CODE	WEATHER_CODE_DESCRIPTION
1	CLEAR
2	PARTLY CLOUDY
3	CONTINUOUS CLOUDS
4	DRIZZLE
5	RAIN
6	SHOWERS
7	THUNDERSTORMS
8	RAIN AND FOG
9	FOG AND THICK HAZE
10	BLOWING SNOW
11	OTHER
-999	NOT RECORDED

DISCARD_DATA	DISCARD_DATA_DESCRIPTION
1	DISCARD DATA COMPLETE AND ACCEPTABLE
2	DISCARD DATA INCOMPLETE OR UNACCEPTABLE

Target_species	Target_common_name	Target_scientific_name	T_spec_comments
-999	Not recorded	Not recorded	
1	Multispecies	Multiple groundfish species	Any combination of more than one species
124	Monkfish (angler, goosefish)	*Lophius americanus*	Also called monk
818	Cod, atlantic	*Gadus morhua*	
1200	Flounder, winter (blackback)	*Pleuronectes americanus*	Also called blackback, georges flounder, lemonsole, channel flounder
1220	Flounder, witch (grey sole)	*Glyptocephalus cynoglossus*	Also called greysole
1230	Flounder, yellowtail	*Pleuronectes ferrugineus*	
1240	Flounder, american plaice	*Hippoglossoides platessoides*	Also called dabs
1477	Haddock	*Melanogrammus aeglefinus*	
1551	Hake, red/white mix	*Urophycis sp*	Red and white hake mixed
2400	Redfish, nk (ocean perch)	*Sebastes sp*	
2695	Pollock	*Pollachius virens*	
3650	Skate, nk	*Rajidae*	All types with market value
7270	Lobster, american	*Homarus americanus*	

Table A.4. Lookup tables for fields found in the primary working data set trawl_haul_event_10sep04.xls.

CATCH_LOG	CATCH_LOG_DESCRIPTION
1	CATCH DATA IN THE HAUL LOG
2	CATCH DATA NOT RECORDED OR LOST
3	TEAR-UP TOW, NO CATCH DATA

WEATHER_CODE	WEATHER_CODE_DESCRIPTION
1	CLEAR
2	PARTLY CLOUDY
3	CONTINUOUS CLOUDS
4	DRIZZLE
5	RAIN
6	SHOWERS
7	THUNDERSTORMS
8	RAIN AND FOG
9	FOG AND THICK HAZE
10	BLOWING SNOW
11	OTHER
-999	NOT RECORDED

HAUL_EVENT	HAUL_EVENT_DESCRIPTION	HAUL_EVENT_COMMENTS
-9	Not recorded	No environmental data collected
1	Tow set	Indicates data in row was collected at the time the trawl was set
2	Tow turn	Indicates data in row was collected at the time of a turn
3	Tow haul	Indicates data in row was collected at the time of haul-back

TURN_DATA	TURN_DATA_DESCRIPTION	TURN_DATA_COMMENT
N	NO TURN DATA RECORDED	ABSENCE OF TURN DATA RESULTS FROM LACK OF REPORTING
Y	TURN DATA RECORDED	ABSENCE OF TURN DATA BECAUSE NO TURN OCCURRED

Table A.5. Lookup tables for fields found in the primary working data file trawl_catch_10sep04.xls.

Species Code	Common name	Scientific name
124	Monkfish (angler, goosefish)	*Lophius americanus*
230	Bluefish	*Pomatomus saltatrix*
300	No fish but good tow	*Water tow*
511	Butterfish	*Peprilus triacanthus*
818	Cod, atlantic	*Gadus morhua*
930	Cunner (yellow perch)	*Tautogolabrus adspersus*
960	Cusk	*Brosme brosme*
1200	Flounder, winter (blackback)	*Pleuronectes americanus*
1219	Flounder, summer (fluke)	*Paralichthys dentatus*
1220	Flounder, witch (grey sole)	*Glyptocephalus cynoglossus*
1230	Flounder, yellowtail	*Pleuronectes ferrugineus*
1240	Flounder, american plaice	*Hippoglossoides platessoides*
1250	Flounder, sand dab (windowpane)	*Scophtalmus aquosus*
1270	Flounder, fourspot	*Paralichthys oblongus*
1280	Hogchocker	*Trinectes maculatus*
1477	Haddock	*Melanogrammus aeglefinus*
1551	Hake, red/white mix	*Urophycis sp*
1590	Halibut, atlantic	*Hippoglossus hippoglossus*
1670	Herring, nk (shad)	*Clupeidae*
1685	Herring, atlantic	*Clupea harengus*
1880	Dory, buckler (john)	*Zenopsis conchifera*
2100	Lumpfish	*Cyclopterus lumpus*
2120	Mackerel, atlantic	*Scomber scombrus*
2400	Redfish, nk (ocean perch)	*Sebastes sp*
2500	Ocean pout	*Macrozoarces americanus*

Species Code	Common name	Scientific name
2695	Pollock	*Pollachius virens*
3260	Sculpin, nk	*Cottidae*
3270	Raven, sea	*Hemitripterus americanus*
3295	Scup	*Stenotomus chrysops*
3350	Sea bass, black	*Centropristis striata*
3410	Sea robin, nk	*Triglidae sp*
3501	Dogfish, nk	*Mustelus, squalus sp*
3521	Dogfish, spiny	*Squalus acanthias*
3591	Shark, nk	*Squaliformes*
3650	Skate, nk	*Rajidae*
3680	Skate, barndoor	*Raja laevis*
3720	Skate, clearnose	*Raja eglanteria*
4180	Bass, striped	*Morone saxatilis*
4380	Tautog (blackfish)	*Tautoga onitis*
4811	Shark, porbeagle (mackerel shark)	*Lamna nasus*
4961	Shark, basking	*Cetorhinus maximus*
5070	Silver hake-offshore hake mix	*Merluccius spp*
5120	Wolffish, atlantic	*Anarhichas lupus*
6631	Lamprey, nk	*Petromyzontidae*
6730	Ray, torpedo	*Torpedo nobiliana*
7270	Lobster, american	*Homarus americanus*
8009	Scallop, sea	*Patinopecten, placopecten sp*
8010	Squid, atl long-fin	*Loligo pealei*
8020	Squid, short-fin	*Illex illecebrosus*
8030	Squid, nk	Squid

DISCARD_ REASON_ DATA	DISCARD_REASON_ DATA_DESCRIPTION	DISCARD_REASON_ DATA_COMMENT
0	No discard by reason data	Either no discard reported, or reason not reported
1	One discard reason	At least one discard reason reported
2	Multiple discard reasons	Multiple discard reasons reported

DISCARD_DATA_CODE	DISCARD_DATA_CODE_DESCRIPTION
1	DISCARD DATA COMPLETE AND ACCEPTABLE
2	DISCARD DATA INCOMPLETE OR UNACCEPTABLE

Table A.6. Lookup tables for fields found in the primary working data file trawl_discard_by_reason_10sep04.xls (also see species in table H.5).

Discard_reason	Discard_reason_description
0	Not recorded
1	Market reason not specified
2	No market too small
3	No market too large
4	No market quota filled
5	No market won't keep until trip end
6	No market but retained by vessel for alternate program
11	Regulations prohibit retention reason not specified
12	Regulations prohibit retention too small
14	Regulations prohibit retention too large
15	Regulations prohibit retention no quota in area
22	Regulations prohibit retention v notched
24	Regulations prohibit retention with eggs
25	Regulations prohibit any retention
31	Poor quality reason not specified
63	Trip quota in effect vessel retaining only certain size for best price
99	Other please specify

Table A.7. Lookup tables for fields found in the primary working data set trawl_length_frequency_10sep04 (also see speccat in Table 19d.

LF_DISCARD_CODE	LF_DISCARD_CODE_DESCRIPTION
K	KEPT
D	DISCARDED