NOAA Fisheries Protocols
For Sea Scallop Dredge Surveys

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U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

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Introduction

In response to the creation of the “NOAA Protocols for Groundfish Bottom Trawl Surveys of the Nation’s Fishery Resources,” the Assistant Administrator for NOAA Fisheries, Dr. William Hogarth, assigned the task of implementing national protocols for all surveys conducted by NOAA Fisheries, which ultimately determines some type of population index or stock assessment analysis. Since the body of NOAA Fisheries work includes a multitude of surveys, the scope of the standardization was focused on those surveys which create guidelines that may impact the fishing public and industry in various ways. Whereas the original “National Trawl Survey Standardization Workshop” created only protocols specific to trawl surveys, specifically bottom trawls and midwater trawls without the use of a rigid frame, the protocols outlined in this document will encompass sampling protocols employed by NOAA Fisheries researchers unique to sea scallop dredge surveys.

Since the principal products of dredge surveys are fishery-independent indices of stock abundance used in stock assessment models, the essential feature of maintaining “consistency from one survey to the next” is that survey catchability (i.e., the relationship between true population abundance and the survey index) must remain stationary and therefore lack any time trend. For surveys that geographically encompass the target stock, stationarity in survey catchability can often be achieved by ensuring constancy in the sampling efficiency of the dredge, which, in turn, can be achieved by ensuring constancy in the construction and repair of the dredge and the procedures used in its operation. The protocols proposed in this report are therefore focused on these issues.

Currently, the Northeast Fisheries Science Center is the only Science Center conducting an annual standard sea scallop dredge survey. Therefore, at this time, it is unnecessary to distinguish between national and regional scallop dredge protocols. It is NOAA Fisheries intent to maintain the over-arching theme through this document “to ensure that the methodology that is used currently is consistent over time”. This document will provide the framework for national protocols if another Science Center were to adopt a scallop dredge survey. Interested parties should make a clear distinction between the label of scallop dredge and other types of dredges. A sea scallop dredge, specifically, is a towed steel frame with a ring bag attached behind the frame. When fished, it tends bottom at the surface sediment layer. Sea scallop dredges are not equipped with hydrodynamic pumps to excavate below the surface layer like most clam dredge.

NOAA Fisheries Sea Scallop Dredge Survey Protocols

Length Measurement of Trawl Warp

Problem Statement

Sea scallop dredge surveys deploy only one dredge rigged to a single trawl warp (i.e. towing cable). This is due to the fact that the scallop dredge is a rigid towed body with only one tow point. There are no trawl doors or flexible panels. The scallop dredge survey does not have the same issues as the trawl surveys. For trawl surveys having two warps, consistency in the measurements of warp length is important for maintaining consistency in trawl performance in two distinct ways. First, the length of the warp relative to the water depth (i.e. scope ratio) influences door spread and other aspects of trawl geometry. Second, the length of the warp on one side of the vessel relative to that on the other side influences the symmetry of the trawl and, depending on the degree of net skew, potentially influences trawl efficiency by affecting footrope contact with the bottom, head rope height, or fish herding. Dredge surveys have only the first issue to deal with in terms of effective bottom contact during the dredge haul. It is critical to have evenly spaced deployment markings on the trawl warp so that the appropriate amount of scope is set at the dredge haul depth.

Currently during NOAA Fisheries scallop dredge surveys, warp length is determined statically by periodically measuring and marking the warp at fixed increments. Current methods of measurement have inherent problems that can lead to inaccurate measurement. For example, differential warp length can result from inaccurate measurement and marking before a survey begins, from differential warp stretch and contraction of marked warps during a survey or from inaccuracy and slippage of metering devices. As a consequence, the proposed protocol uses the comparison of redundant measuring systems to detect differences in warp length beyond a tolerance level.

Protocol 1: Length Measurement of Trawl Warp

For the single warp dredging system, two independently-calibrated measuring methods or devices shall be used, one of which will be in real time. Due to fact that only one trawl warp is deployed there is no concern of a percent difference between warp markings. The NEFSC does not regularly charter sea scallop surveys aboard commercial vessels, but if the survey needs to be completed on a commercial vessel, the wire type and marking specifications shall be clearly stated to the contract vessel.

Specifications of the two warp measurement systems used on the scallop dredge survey will be included in an Operations Plan provided by the NEFSC to the officers and crew of the survey vessel.

Sub-Protocol 1a: Physical warp markings

Physical marking of trawl warps generally involves spooling the wires off the drums and onto a flat surface to measure the wire intervals relative to a standard measurement tool (metal wire of known length and marked). The NOAA Fisheries standard for such measurements, for two wires, has been that both port and starboard wires will be measured and marked side-by-side to assure that the relative warp measurements between marks are exact. Even though scalloping requires only one warp, the spacing of marks on such a warp, details of marking method (fiber marks interwoven in wire rope strands or painting of marks), and the degree of tension on the wire will be specific to the Regional Sea Scallop Standard Survey protocols. These marks will be checked and re-calibrated at least annually and rechecked after a survey or whenever un-reconcilable discrepancies between warp intervals and a redundant measurement system persist.

Sub-Protocol 1b: In-line wire meters
In-line wire meters measure wire lengths directly using running line tensiometers or instrumented blocks over which the warp travels as it is payed out or retrieved. Such systems deflect the running wire by a known amount to facilitate measuring under tension and may be subject to deviations from true measurements due to wire slippage. These devices should be calibrated using known lengths of wire at least annually, using manufacturer recommended procedures, with moving parts (bushings, sheaves, etc.) inspected and replaced, as required.

Sub-Protocol 1c: Block wire counters
Block wire counters are not used for the standard NEFSC sea scallop survey to measure trawl warps, real time.

Sub-Protocol 1d: Geometric wire counters
Geometric wire counters are not used for the standard NEFSC sea scallop survey to measure trawl warps, real time.

Discussion

The proposed protocol requires that two independent warp measurements be reconciled when the differences in cumulative warp length varies from the metering system by +/- 5% at any scope value. The metering system should be set to zero when the scallop dredge is at the water surface. Periodic checking of physical marks on the ship and wire should be made versus the metering system. A table of wire-out at depth with locations on the back deck for cross reference is used to check the metering system.

Use of Auto-trawl Systems

Protocol 2: Auto-trawl systems
The Albatross IV, the research fisheries vessel that is used to conduct the NEFSC sea scallop survey, is not outfitted with an auto-trawl system. This application is not critical for sea scallop operations.

Survey Operational Procedures

Problem Statement

Standardization of station selection, gear deployment, dredging operations, and retrieval procedures are critical for maintaining consistency in survey catchability over time. Factors that can affect gear performance and catchablility of marine organisms include selection of tow location; speed during setting, towing, and retrieval of gear; determination of scope ratio; estimation and standardization of tow distance; tow direction; and minimum towable sea state. Written unambiguous protocols specifying these and other issues may affect survey consistency provide a mechanism for communication between scientific staff and the officers and crew of the research vessel which maintains continuity in procedures as personnel and vessels change overtime.

Protocol 3: Survey Operational Procedures

For the Groundfish Protocols, each Science Center was tasked with providing a written Operations Plan to their staff and the crew of the survey vessels that provides clear and unambiguous definitions of all procedures required to properly conduct trawl sampling. This process will be followed for the scallop protocols, as well. The Operations Plan will be discussed by the Chief Scientist and the vessel crew at the start of each survey and again when crew changes occur. The Operations Plan may include, but is not limited to, the following issues:

a. Scope
b. Speed of tow
c. Duration or distance of a tow
d. Direction of tow
e. Location of sampling sites, and procedures to use if stations are suitable for towing
f. Criteria for determining the success of a tow and procedures to use if a tow was unsuccessful
g. Vessel and winch operation during trawl deployment and retrieval
h. Methodology for warp measurement and verification
i. Dredge construction plans, at-sea repair instructions and repair verification check-list
j. Defining responsibility (i.e. survey scientists or vessel crew) for decisions regarding various aspects of the operations

Trawl Construction and Repair

Problem Statement

Standardization of scallop dredge construction and repair is unquestionably the most critical element for survey standardization because, on NOAA Fisheries scallop surveys, standard scallop dredges are not simply devices to capture sea scallops but are scientific instruments used to sample scallop populations and, as such, must conform to higher levels of tolerance in their construction and repair than commercial scallop gear. The difference in the objectives of commercial fishing and scientific sampling, and its concomitant effects on scallop dredge design and repair, are rarely appreciated and often have contributed to misunderstanding between NOAA Fisheries and the commercial scallop industry. This misunderstanding can directly impact scallop dredge survey standardization in two distinct ways. First, the NEFSC lacks the ability to completely build their own survey scallop dredges and must partially rely on commercial dredge manufacturers to supply commercially standard materials that are then assembled by NEFSC staff. Second, all members of the crew of NOAA Fisheries research vessels that make at-sea repairs to survey scallop dredges have gained their expertise from their past experience as commercial dredge fishers or trained on the scallop research vessel. The repair techniques used by commercial fishers, however, are typically those needed to return the gear to service as soon as possible rather than those needed to return it to service in the same condition as before damage. Because NOAA Fisheries scallop survey dredges are true scientific sampling instruments, the protocols considered in this section are designed so that scallop dredges are constructed and repaired with a level of detail needed to ensure, within specified tolerances, that the identical scallop dredge is used every sampling site on every cruise.

Protocol 4: Trawl Construction and Repair

Construction plans for each scallop dredge design will be maintained be each Science Center (NEFSC is the only Center, at this time, that conducts a standard scallop dredge survey) and included in the Operations Plan. The plans must include engineering drawings of the scallop dredge and supporting materials with a level of detail at least as specific as that in the ICES recommended standard (ICES C.M. 1989/B:44 Report of the Study Group on Net Drawing). In addition, each plan must contain a description of all materials used, and the quantities of these materials considered important for proper scallop dredge function.

A checklist will be developed for each scallop dredge design (presently one design) specifying the dimensions, and their tolerances, or other design features considered important for proper scallop dredge function. The checklist will be used to verify that each newly constructed or repaired scallop dredge is within operational tolerances before use.

Verification that scallop dredges are within operational tolerances will be conducted by members of the scientific staff of each Science Center (NEFSC) who are trained in scallop dredge construction and repair verification.

Methodology for at-sea trawl repairs will be specified in an Operations Plan and communicated by the Chief Scientist to the crew of the vessel at the start of each cruise. A scallop dredge repair checklist will be included in the Operations Plan and used by a member of the scientific staff to verify that the repaired scallop dredges are within operational tolerances.

At this point there is no need for a national training course in scallop dredge construction and repair, because there is only one Center conducting scallop dredge surveys. A regional training course will be developed in the future for the NEFSC.

Discussion

The intent of this protocol is to ensure that, through more exacting specification and verification. The dredges used in a survey will perform identically regardless of the circumstances under which the scallop dredg1e was constructed and repaired.

Changes to Regional Scallop Dredge Protocols

Protocol 5: Approval of Regional Dredge Protocols

Changes to scallop dredge survey operational protocols will be at the discretion of the appropriate Science Director who may approve of such changes directly or specify a peer review process to further evaluate the justification and impacts of the proposed changes.

Recommendations for Additional Work to Implement Protocols

Sea Scallop Standardization Working Group (SSSWG)

Recommend the creation of a Sea Scallop Standardization Working Group that will coordinate the development of national and regional standards and protocols, and share information to improve the precision and accuracy of such surveys. Information and technology would be exchanged among Science Centers facilitated by a National Marine Surveys Workshop, similar to those conducted periodically for stock assessments.

Regional Protocols

At present there is only one standardized sea scallop survey nationally conducted by the Northeast Fisheries Science Center in Woods Hole, Massachusetts. The items contained are specified in general terms for National Protocols to allow other Centers to adopt the approach developed by the NFSC. In the Regional section, the specific methodology used by the NEFSC is detailed in either a complete Field Operations Plan.

Appendix 1 Northeast Fisheries Science Center

Northeast Standard Operating Protocols for Summer Sea Scallop Dredge Survey

Appendix 1

March 11, 2005

Regional Operating Protocols For Standard Sea Scallop Dredge Survey

Prepared by Personnel from NOAA Fisheries
Northeast Fisheries Science Center

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Introduction

The Northeast Fisheries Science Center (NEFSC) conducts an annual summer sea scallop dredge survey in the Western Atlantic continental shelf region off the Eastern United States from North Carolina, U.S.A to Nova Scotia, Canada. See figures 1 and 2 for the regional strata sets that display the sampling coverage. The survey began in 1975 and has been conducted annually since 1977 to monitor and assess abundance, population composition and recruitment of the off-shore sea scallop resource. Presently, this is the only sea scallop dredge survey conducted by NOAA Fisheries. The dredge survey collects data on a variety of fishes and invertebrates, but the target species is the Deep-sea Scallop, *Placopecten magellanicus*. Since 1975, the NEFSC sea scallop survey has utilized an industry standard 2.44 m (8') wide sea scallop dredge, equipped with a bag composed of 5.1 cm (2') rings and a 3.8 cm (1.5") polyethylene mesh liner, towed for 15 minutes at 6.5 km/hr (3.8 knots) with a 3:1 warp scope. The survey has mostly been conducted by a Fisheries Research Vessel, Albatross IV. There were a few instances where the Albatross IV could not finish the survey and a commercial dredging vessel was contracted to finish the survey.

The goal of the standard sea scallop survey is to develop long-term fishery independent indices of relative abundance for several commercially important bivalve species and other by-catch fish and invertebrates and to characterize their distribution. Additionally, specimens and other recorded data from the survey will be used to improve our understanding of biological conditions, temporal and spatial trends in population dynamics, identify community relationships and characterize habitat and catch relationships.

The following Regional Protocols have been designed to document our established survey standard protocols, act as a reference to ensure data quality and consistency, and to show adherence to the NOAA Fisheries Trawl Survey Protocols in terms of document format and general survey topics. Due to gear differences, some of the topics listed within this document may not apply to scallop gear operations and will clearly be labeled as such.

Warp Measurement Standardization

Protocol 1: Warp Measurement Standardization

As stated in the NOAA Fisheries Sea Scallop protocols, sea scallop dredge surveys deploy only one dredge rigged with a single trawl warp (i.e. towing cable). This is due to the fact that the scallop dredge is a rigid towed body with only one tow point. There are no trawl doors or flexible panels. The sea scallop dredge survey does not have the same issues as the trawl surveys. For trawl surveys having two warps, consistency in the measurements of warp length is important for maintaining consistency in trawl performance in two distinct ways. First, the length of the warp relative to the water depth (i.e. scope ratio) influences door spread and other aspects of trawl geometry. Second, the length of the warp on one side of the vessel relative to that on the other side influences the symmetry of the trawl and, depending on the degree of net skew, potentially influences trawl efficiency by affecting footrope contact with the bottom, head rope height, or fish herding. Dredge surveys have only the first issue to deal with in terms of effective bottom contact during the dredge haul. For this reason, it is critical to have evenly spaced deployment markings on the trawl warp so that the appropriate amount of scope is set at the selected dredge haul depth.

Currently, during NOAA Fisheries scallop dredge surveys, warp length is determined by periodically measuring and marking the warp at fixed increments. Current methods of measurement have inherent problems that can lead to inaccurate measurement. For example, differential warp length can result from inaccurate measurement and marking before a survey begins, from differential warp stretch and contraction of marked warps during a survey or from inaccuracy and slippage of metering devices. As a consequence, the proposed protocol uses the comparison of redundant measuring systems to detect differences in warp length beyond a defined tolerance level.

Sub-Protocol 1a: Warp

The responsibility of procurement, installation, and maintenance of the dredge warp(s) resides with the NOAA Marine and Aviation Operations (NMAO), the division of NOAA currently responsible for the operation of fishery research vessels utilized to conduct NEFSC surveys. The warp installed aboard the RFV Albatross IV and used for the annual standard NEFSC sea scallop survey is a 7/8 inch 6x19 class (6x26) seale die-form strand, right hand lay, fiber core wire rope designed for trawling and scallop dredge operations. Two spools of approximately 2,000 meters of this wire are installed for each yearly survey. The NEFSC has two spools of this warp material and will alternate the usage of each spool. Currently it is removed after every survey and re-installed prior to the next scallop survey.

Sub-Protocol 1b: Warp Marking

Warps used for scallop dredging shall be marked by an independent wire contractor according to specific marking guidelines specified to the contractor by the NEFSC. An in depth discussion regarding this exercise can be found in the NEFSC Sea Scallop Operations Manual. In short, the current guidelines dictate that the scallop dredge warps are to be inspected (re-measured) and possibly re-marked before and after every annual survey. The NEFSC has adopted a tolerance value of 1% allowable scope deviation at all marks as a decision rule during the inspection process on land. When measurement of the warps occurs, a table of values will be generated. If a deviation at a certain position along the warp is not within the 1% tolerance then a re-marking will commence from that position to the end of the warp (eyes). Currently, the Albatross IV does not have the ability to completely re-measure the dredge warp markings at sea, so it must be done at the dock.

To conduct the measurement process, one Ecosystems Surveys Branch staff member and one member of the NOAA Corp shall be present to witness the marking of the warp(s). The warps used for the sea scallop survey are marked every 25 meters with a polypropylene fiber weave. Physical marking of dredge warps involves spooling the warp off the trawl winch onto a flat surface to measure the wire intervals relative to a standard measurement tool (metal wire of known length and marked). The warp should be retrieved, marked and reinstalled under tension (200 lbs).

If the primary warp is damaged at sea and needs to be remarked, then the same marking process shall be conducted as during the inspection process. The same mark types, spacing and segment marking should be consistent with the on-land protocols. Because of the deck limitations, damage repair (broken or frayed section of warp) is limited to just the first few 25 meter sections. The process is to remove the leading damaged sections and convert one of the deeper marks to an eye splice and then next mark to a triple mark. If a significant amount of the primary dredge warp is damaged or lost, the Chief Scientist will instruct the Chief Bosun to switch to the other marked dredge warp.

Sub-Protocol 1c: Length Measurement of Dredge Warp

For the single warp dredging system, two independently calibrated measuring methods or devices shall be used, one of which will be in real time. Due to the fact that only one warp is deployed, there is no concern of a percent difference between corresponding warp marks just cord length (25 meters) between successive marks for a single warp. The NEFSC does not regularly charter the standard sea scallop survey aboard commercial vessels, but if this occurs the NEFSC shall supply operational documentation concerning wire requirements and marking specifications critical to the mission.

1c.1 In-line wire meters

In-line wire meters measure wire lengths directly using running line tensiometers or instrumented blocks over which the warp travels as it is payed out or retrieved. Such systems deflect the running wire by a known amount to facilitate measuring under tension and may be subject to deviations from true measurements due to wire slippage. These devices shall be calibrated using known lengths of wire at least annually, using manufacturer recommended procedures, with moving parts (bushings, sheaves, etc.) inspected and replaced, as required. The NEFSC uses a 200-meter section of warp of known length to check the metering system. The warp will be used prior to the first leg of the survey to check the meters. Refer to Sea Scallop Operations Manual for procedure and calibration information. The metering system is used when deploying the dredge. The meter is set to zero when the dredge is at the water surface and then set based on the scope value. During regular deployment, if a deviation of greater than 5% (difference between metering system and marks) occurs due to slippage, the survey vessel shall retrieve the warp and redeploy to double check the initial haul. If the problem persists, then the 200-meter section of cable can be used to check the meters. If the problem is not due to the out-of -calibration warp meters the next step would be to check wires with a table of values that list length of warp at certain points along the deck. See section 1.3.3.

1c.2 Block wire counters

NEFSC currently does not use block meters to measure dredge warps.

1c.3 Geometric wire counters

The NEFSC uses the metering system and a table of values to periodically check (3 times per survey leg) the wire for stretching during operations. The table lists 25-meter cord lengths and the corresponding amount of cable deployed relative to several points along the back deck of the Albatross IV. See the NEFSC Sea Scallop Operations Manual for the table of warp to deck positions and instructions. The scope log has been developed to visually verify mark spacing periodically during the survey. The real purpose of the log is to for use if the electronic wire counters become disabled or inaccurate and to double check that the meters are reading correctly. The log indicates where on the back deck of the vessel (landmarks) to place dredge warp markings to achieve a desired scope. The Chief Scientist will be instructed to use the log to visually verify that the warp marks are in agreement with the electronic line meters. Because it is difficult to get accurate verification in this way, a tolerance level of +/- 5 % deviation at each mark interval from the electronic counters. If a significant deviation occurs in the first 100 meters, the warp can be cut and remarked to the appropriate interval lengths. If the deviation is deeper along the warp, the Chief Scientist should instruct the Chief Bosun to switch to the other dredge warp. The stretch of the warps will be addressed during the official re-marking process. If damage occurs to both warps and cannot be remarked accurately at sea, the vessel must return to port to have the warp re-measured by the Contractor.

Use of Auto-trawl Systems

Protocol 2: Use of Auto-trawl Systems

The Albatross IV, the Fisheries Research Vessel that is tasked with conducting the annual standard sea scallop dredge survey, is not outfitted with an auto-trawl system of dredge deployment. This application is not critical for sea scallop dredge operations.

Survey Operational Procedures

Protocol 3: Survey Operational Procedures

For the Groundfish protocols, each Science Center was tasked with providing a written Operations Plan to their staff and the crew of the survey vessels that provide clear and unambiguous definitions and descriptions of all procedures required to properly conduct standard trawl sampling. This process is followed for the standard sea scallop dredge protocols, as well. The Regional Protocols present the standard protocols in general terms, while the Operations Plan (Operations Manual) attempts to describe all protocols, gear, and materials in great detail.

Procedures for maintaining consistency in survey catchability of marine organisms include selection of tow location; speed during setting, towing, and retrieval of gear; determination of scope ratio; estimation and standardization of tow distance; tow direction; and maximum sea state. Written unambiguous protocols specifying these and other issues that may affect survey consistency provide a mechanism for communication between scientific staff and the officers and crew of the fisheries research vessel which maintains continuity in procedures as personnel and vessels change over time.

The Regional and Operations Manual shall be discussed by the Chief Scientist and the vessel crew at the start of each survey and again when crew changes occur.

There are several dredge haul guidelines that encompass the time period before a dredge haul is started, during the haul, and after the dredge haul is completed. A standard dredge haul conducted at sea can be defined as being 15 minutes in duration, with the correct scope, towing speed, and no gear damage encountered. However, it is outside the scope of this document to discuss all possible contingencies and threshold values related to conducting a dredge haul. Below is the general topic headings outlined in the National Protocols for Sea Scallop Surveys. In depth details about how to deal with all non-standard situations can be found in the NEFSC Operation Manual for Sea Scallops.

The Regional Protocols include, but are not limited to the following issues and are not presented in time sequence or event order.

Sub-Protocol 3a: Scope

The wire-out (amount of warp) for a dredge haul is based on the depth as read from a depth sounder (EQ-50). The standard ratio of length of warp in meters to depth of water in meters is 3:1. This means there are 3 meters of warp for every 1-meter of water depth.
It is understood that some events, including current velocity and weather, may create a need to deviate from the specified value of scope. Should a deviation occur, before the tow begins, the NOAA Officer-on-Deck (OOD) shall record in electronic comments the reason for the deviation. The OOD shall keep the scope value consistent throughout a tow unless there is an underwater hazard or other issue related to vessel safety. Presently, the NEFSC does not deploy a realtime data collection device to determine bottom contact. But NEFSC does deploy an archiving bottom contact device, inclinometer, during most dredge hauls. The inclinometer device measures angle changes during the dredge haul. The data is offloaded using an optic shuttle after every dredge haul and archived on SCS. Recent camera verification of the inclinometer will allow the NEFSC to normalize dredge hauls in the future. At present, these data are not used. Methods will be developed to use the inclinometer to independently determine vessel tow distance by translating bottom contact into distance over ground. If the warp is spooled off due to a hang during a dredge haul, the OOD and Chief Bosun have been instructed not pull back the extended length. They are to indicate the amount of wire taken and the time during the tow. The Watch Chief will make a decision as to whether to repeat the dredge haul or not. As long as the extended warp amount is less than 15 % of the total scope, it is not necessary to repeat the dredge. The NEFSC has electronic tools that alert the Watch Chief that a scope problem exists

for a tow that was just completed. At that time the Watch Chief can decide to repeat a dredge haul with the correct scope value.

Sub-Protocol 3b: Speed of Dredge Haul

The OOD is responsible for acquiring and maintaining a constant dredge haul speed of 3.8 knots (over the bottom) from the time the brakes are set on the trawl winches until the end of the fifteen minute dredge haul. Speed variations between 3.4 and 4.2 are acceptable, but the target dredging speed of 3.8 knots should be adhered to as closely as possible. Monitoring the dredge speed during the haul will be accomplished in real time using differential GPS and manual adjustments to pitch and rpms. Multiple speed signals are recorded during the dredge haul by the Scientific Computer System (SCS) and a subset is supplied to a digital capturing system called FSCS (Fisheries Scientific Computer System). Variations in approaches to getting the vessel and gear up to 3.8 knots due to weather or current factors need to be inspected in more detail. The Sea Scallop Dredge Operations Manual describe in detail the methodology used to deploy the dredge and how to get the vessel to dredging speed. Usually sea-state precludes the problem of not acquiring and maintaining the target speed.

Sub-Protocol 3c: Duration or Distance of a Dredge Haul

Dredge haul distance should not be used as a primary indicator of speed over ground; distance versus time can provide a convenient double check. NEFSC survey standardizes speed which in general, results in a standard distance covered over the 15-minute tow. The designated 3.8-knot speed over ground equates to about .9 nautical miles traveled during a 15-minute dredge haul. Based on this speed, the approximate distance covered at various points in the tow are as follows:

@10 minutes into tow	0.63 NM
@15 minutes into tow	0.95 NM

Distance traveled should only be used as a secondary check of primary speed indicators. Speed should never be adjusted during the tow to achieve a target distance.

Sub-Protocol 3d: Direction of Dredge Haul

The dredge haul station locations are selected using a stratified random selection process. Stations are occupied according to the most efficient cruise track and not to any predetermined set of stations. Dredge haul direction shall be from the current station location towards the next available station location unless one of the following occurs:

- Towing to the next station location puts the dredge haul (approximately 1 NM), greater than one half the tow distance into adjacent strata.
- When the OOD has to follow a depth contour, generally offshore.
- Bad bottom, wrecks, cables or other underwater obstructions in the dredge path.
- Fixed gear in the dredge path and a clear dredge haul exists in another direction.
- Heavy traffic.
- Moderate to heavy seas in one direction, but still towable in another direction.

Sub-Protocol 3e: Location of Sampling Site

3e.1 Location (Determination) of Sampling Site, specifically

The NEFSC sea scallop survey employs a stratified, random sampling design that has remained constant throughout the survey time series that started in 1975. Survey strata are based on fixed depth ranges and regions of bathymetry along the continental shelf of the survey area, ranging from Virginia to Nova Scotia, Canada (Fig. 1 + 2). Strata coverage and the target number of stations to be sampled within each stratum are determined prior to conducting each survey.
All strata are subdivided into blocks 5 minutes of latitude by 10 minutes of longitude. These large blocks are further subdivided into 10 small blocks measuring 2.5 minutes of latitude by 2.0 minutes of longitude. The large blocks are defined as being the largest area that can be characterized by one tow.

Exceptions occur with very long, narrow strata, and strata with irregular borders. In these cases, the strata are subdivided directly into 2.5 X 2.0 minute blocks. These smaller blocks are then grouped into larger blocks so that the numbers of small ones are evenly distributed throughout the large ones. At least two large blocks are formed within each stratum. Each large block is composed of, as nearly as possible, 10 small ones. No large blocks are formed if there are an insufficient number of small blocks.

Stations selected within each stratum are determined using a Perl program called sta_selector. This program was written to generate a random selection of stations within each stratum. Each small block within a stratum is numbered sequentially. The number of small blocks contained within the stratum in which the numbers are being selected determines the range of random numbers. A random number selected then corresponds with a numbered small block. The center point of the selected small block will be the starting location of the tow. The numbering of tows is directly related to the order of random number selection (tow no. 1 is selected first and so on). A stratum number and the tow number within that stratum then identify stations. Once a small block is selected, all members of the corresponding large block are excluded from the selection population until there is at least one station selected in every large block within the stratum.

The sta_selector program creates several output files: a station data file (station_location.xls), nav.txt file, and a station.dat file. The Chief Scientist uses the station data file in Excel, in conjunction with charts, to create the cruise track by visually determining the most efficient or shortest distance between two stations. The nav.txt file is imported into a navigation software package (Navtrek), which is used by the bridge officers to set up the routes once the Chief Scientist has provided the sequential list of stations to occupy. An Arc-Info program employs the station.dat file to create 8" X 11" charts and the large bathymetric charts that have the station locations plotted.

Arc-info programs are employed to create strata lines and stations on digital rasterized copies of NOAA nautical charts. Rasterized renditions of the NOAA charts currently used are "Georges Bank and Nantucket Shoals" (No. 13200); "Approaches to New York, Nantucket Shoals to Five Fathom Bank" (No. 12300); "Cape May to Cape Hatteras" (No. 12200); and, "Cape Hatteras to Charleston" (No. 11520). The bridge officers continue to navigate by using the official NOAA charts.

Geographic positions, loran lines-of-position, and charts are saved internally at the NEFSC the completion of a cruise and made available to stakeholders.

3e.2 Non Suitable Sites - Procedures to Resolve Once Arrive On Location

There are some fundamental dredging guidelines that a Research Vessel OOD must attempt to comply with when attempting to conduct a NEFSC standard sea scallop dredge haul, which include those in sections 3.1 – 3.4. Some of these dredging guidelines are addressed prior to conducting the dredge haul and others are addressed during or after the dredge haul is completed. Either way, the purpose of the guidelines is to facilitate the completion of a standard dredge haul. Below is a discussion about the guidelines and what to do if the guidelines are not met. These guidelines should be thought of as what the OOD is thinking about as they approach a possible dredge location and how a successful dredge haul is conducted.

a. Never change warp length (scope) after the dredge haul starts (winches locked), set scope length and described in section 3.1
b. Speed is 3.8 knots during the haul, see section 3.2
c. Dredge hauls shall be 15 minutes in duration, see section 3.3
d. Dredge haul shall start at the marked location and be towed in a direction towards the next station, see section 3.4
e. Conduct dredge haul within stratum boundaries
f. Never tow in less than 30 feet/9 meters/5 fathoms
g. Never tow in greater than 1200 feet/ 366 meters/200 fathoms
h. Relocation of the station location is limited to 1 nautical mile radius from original station location without permission from Chief Scientist

These guidelines describe the reasoning and thought process the OOD must apply to the decision making process (tactics) when planning for, setting up for, and conducting a standard scallop dredge haul.

Whenever possible the standard number of available station locations (presently 506) should be occupied year to year. The section below talks about how to qualify and possibly repeat a tow, which will affect the decision to maintain the standard number of dredge hauls per stratum. The amount of time searching for bottom, avoiding traffic and gear, and repeating bad dredge hauls will affect the overall success of the survey and may limit the survey coverage. For this reason, it is not critical to get all station locations for each stratum. It is more important to conduct tows in all strata available over the whole range.

The underlying role of the OOD is to occupy the safest and most timely cruise track considering all other factors; weather, traffic, fixed gear, underwater hazards, etc. Each station location is reviewed prior to arrival by the Chief Scientist, Operations Officer, and the Commanding Officer. The station locations are plotted on nautical charts and reviewed for chart identified restrictions. Some movement of station location (starting position and direction) is completed before arrival if underwater hazards can be identified (cables, wrecks, etc). In this case, the Chief Scientist can supply a randomly chosen location within the 1 nautical mile radius to start the dredge haul. When the station locations look reasonable on the charts, but there is an issue once the FRV reaches the station location, this is where these guidelines are helpful. Whenever possible the direction of tow should be altered before moving the actual station location. Next, are some of the problems with dredge haul locations that are addressed by the OOD prior to conducting the tow.

3e.3 Marginal to Un-towable Bottom

The OOD has the clearance to pre-run (scout) the bottom topography and decide if it is safe to deploy the gear. If they decide not to tow at a specific site, then they can randomly choose a new station location within 1 nautical mile of the original station location, record the reason in the station comments, without consulting the Chief Scientist. Un-officially the time limit for searching for good bottom is about a one-half hour before moving on to a totally new site. The Chief Scientist shall be consulted for this decision.

3e.4 Traffic

The OOD has the clearance to modify the starting position and possibly the direction of the station location to adjust for traffic in and around a station location. Again, within the one nautical mile radius, the Chief Scientist does not need to be consulted.

3e.5 Fixed Gear

The OOD has the clearance to modify the starting position and possibly the direction of the station location to adjust for fixed gear in and around a station location. Again, within the one nautical mile radius, the Chief Scientist does not need to be consulted.

3e.6 Sea State (current, wind, waves)

Dredge haul direction (or the ability to dredge haul at all) may be determined by sea state. If the conditions are as severe as to pose a safety issue or data quality issue operations may be affected. Safety related decisions shall be made by the vessel Commander, while data quality decisions shall be made by the Chief Scientist.

Tow direction relative to prevailing current has historically been treated as a random variable. Conscious efforts to tow into the current or avoid cross currents will impart an undesirable bias to the data, which is to be avoided. The only exceptions are avoiding a cross current severe enough to continuously flip the dredge on setting to the bottom. The rule of thumb is to attempt two tows in the direction of the next station and if both are flips to tow with the current with the third. If the third flips, move the station location, work with the Chief Scientist.

Wind direction is generally not a factor for dredging operations. Sustained high winds with a long fetch often cause the waves and swells to come from the same direction. In this case, the direction of dredge haul may have to be based on the seas. In open waters, canceling of operations is considered when sustained winds of 35 knots are observed because this speed usually corresponds to sea states that are excessive for safe work on deck and proper gear performance.

The next section describes what to do if the dredge haul has been conducted and is not within the pre-described description of what a standard tow is.

Sub-Protocol 3f: Determining the Success of a Tow

3f.1 Determining a Successful Dredge Haul

There are two phases of determining if a dredge haul was successful. The guidelines described in section 3.5 should have been met before or during the dredge haul in order to conduct the dredge haul in the first place, which is phase 1. The guidelines described above along with performance during, and any gear damage and flips after the tow will dictate the success of the second phase. Each dredge haul is coded with a qualitative three digit numeric value (Station-Haul-Gear [SHG]) value indicating some level of gear damage, dredge haul time difference other than 15 minutes, fixed gear interception, etc. A dredge haul that was conducted in the standard manner with no gear damage will be coded with a code of “111”. This coding system is used by the assessment biologist to distinguish between standard dredge hauls and non-standard dredge hauls. See the NEFSC Sea Scallop Operations Manual for a more detailed description of the coding details. The most important result of these coding details is to facilitate the ability to occupy and conduct the standard number of biologically valid dredge hauls. There is no set number of stations with SHG codes greater than “111”. It is a method to highlight dredge hauls to the assessment biologists that may not be usable. The NEFSC has explicit descriptions of what each of these codes mean. Basically, the Chief Scientist attempts to get the default number of dredge hauls accomplished within a given strata, but the dredge hauls have to be standard. For example, if the cruise is working in strata “X” and the random number of selections given to the C.S. prior to the survey is 10, and the cruise has accomplished 8 successful dredge hauls (SHG < 136), then the C.S. would less likely repeat a bad dredge haul if they occurred during the last two station locations. If this occurred during the first 5 - 8 dredge hauls, then the C.S. would attempt to get standard dredge hauls for those locations or just nearby. Because the survey is on a tight schedule, the occupation of station locations is dynamic each year depending upon gear damage, weather, and expertise of the crew and scientists. The survey does not always occupy all stations.

3f.2 Procedures for Repeating Unsuccessful or Aborted Dredge Hauls

Occasionally it is necessary to repeat a dredge haul because of malfunction, damage to the dredge, or did not satisfy the first phase of guidelines. In cases of severe malfunction (flip) or severe damage (whole portions of the liner or ring bag), the tow will not be counted as a standard dredge haul and must be repeated. It may be sampled for biological data, which is independent of abundance and biomass information. For recording purposes, the tow is recorded as a valid station, but the coding for Station-

Haul-Gear (SHG) value shall be greater than 1-3-6, indicating a non-valid catch for assessment purposes.

In some cases, it may be difficult to determine how to properly code a dredge haul that has encountered problems. The following guidelines should be used:

- It is essential to indicate a minimum of 2 for haul value, which flags data auditors that something abnormal occurred during the tow.
- If in doubt about SHG coding consult with the Chief Scientist
- Ensure that the catch is worked up at least to the point of weights and lengths
- An accurate and complete account of what occurred to the gear must be given in the Station Initialize Watch Chief comments field; the lead fisherman or boatswain must be interviewed to determine details on gear condition.
- When significant gear damage occurs, the Chief Scientist should be informed, and the decision to re-tow must be made based on the severity of the damage.
- A plot of the starboard line tension should be printed out and saved for the auditors, to help determine at what point the gear encountered problems.

The decision to repeat a tow is made by the Chief Scientist. The following factors may override this decision:

- The probability of the same or greater damage to the dredge occurring; in this case, the station location should be moved
- The current progress of the cruise as a whole (when time remaining in the cruise threatens the completion of the entire survey area)
- The status of shipboard gear inventory, i.e. how many undamaged dredges are left

The following factors must be weighed with every decision to override a retow:

- The overall progress of the cruise (does time in the context of the entire survey permit extended effort on any one station)
- The phase of the cruise (a subset of above) i.e. risking the last undamaged dredge on the last day of leg I may not be a serious risk for the cruise at all, as the ship will return to port and can replenish the supply of nets without much loss of operational time
- The number of stations completed in the stratum in question (higher priority would be placed on a station that represents the sole tow in the stratum, lower priority would be placed on a station that would represent the 8th successful tow in the stratum)
- The current relative importance of the stratum in question (is it a critical stratum for certain assessment species)
- The geographic coverage within stratum that the tow represents

Sub-Protocol 3g: Vessel and Winch Operation during Dredge Deployment and Retrieval
To ensure comparability between dredge hauls and years of standard surveys, vessel operators will be asked to follow standard procedures when setting, towing, and retrieving the dredge gear. The descriptive procedures are available in the NEFSC Sea Scallop Operations Protocols and in a sub-document called “Scallop Bridge Operations”. If the OOD has satisfied the pre-dredge haul general guidelines, they can then conduct a standard dredge haul. The general goals that are set out as the basic protocols are as follows:

3g.1 General Guidelines for Setting the Scallop Dredge
Once the OOD has the vessel in the appropriate position to set the dredge they will communicate a scope value and give permission to the winch operator to set the dredge. The OOD will bring the vessel up to a standard setting speed (3.8 knots) and prepare for deployment and speed adjustment. The Chief Bosun will deploy the dredge using the winch metering system (double checked with warp marks) over the back deck and set the appropriate amount of warp to achieve the desired scope. The metering system is set to zero at the water surface during deployment. The dredge is free spooled down to the bottom and the winches are secured. The primary goal during this phase is to achieve a good set on the bottom.

3g.2 General Guidelines for Towing the Scallop Dredge
Once the trawl winch has been set, the “standard tow” begins. The vessel should be at 3.8 knots and the timer should be engaged for a 15-minute dredge haul. During the tow the Chief Bosun should be aware or any changes in warp length due to hangs. The primary goal during towing is to maintain a constant speed and straight course whenever possible.

3g.3 General Guidelines for Retrieval of Scallop Dredge
When the tow timer sounds off, the Chief Bosun starts to retrieve the scallop dredge. The vessel speed is maintained at 3.8 until the last 25 meters then speed is reduced to 0 thrust (pitch) so not to flip the dredge. When the dredge comes close to the surface the Chief Bosun will inform the bridge to slow down. The dredge is slowly brought onboard using the rear frame and set on the back deck and dumped.

Sub-Protocol 3h: Defining Responsibility for Decisions Regarding Operational Protocols
All aspects of the scallop survey operation will be overseen by the Chief Scientist. Final decisions regarding station locations and station scheduling are the responsibility of the Chief Scientist. Vessel operation including safety, dredge gear deployment and retrieval, and all matters to vessel safety will be the responsibility of the Fisheries Research Vessel Commanding Officer. Day to day operations per 6-hour watch is the responsibility of the assigned Watch Chief.

Training in Fisheries Scientific Computer System (FSCS) and standard sampling of the dredge hauls is the responsibility of the Chief Scientist and Watch Chiefs.

It is the responsibility of both the Chief Scientist and the Commanding Officer to keep lines of communication open between crew and scientists, not only for safety purposes, but to ensure that all standard operations are proceeding in the manner outlined here.

See the NEFSC Sea Scallop Operations Manual for detailed descriptions of “prior to sailing”, “during operations” and “after a cruise” instructions for Chief Scientist, Watch Chief, and FSCS administrator.

Scallop Dredge Construction, Repair, Inspections

Protocol 4: Scallop Dredge Construction, Repair, Inspections

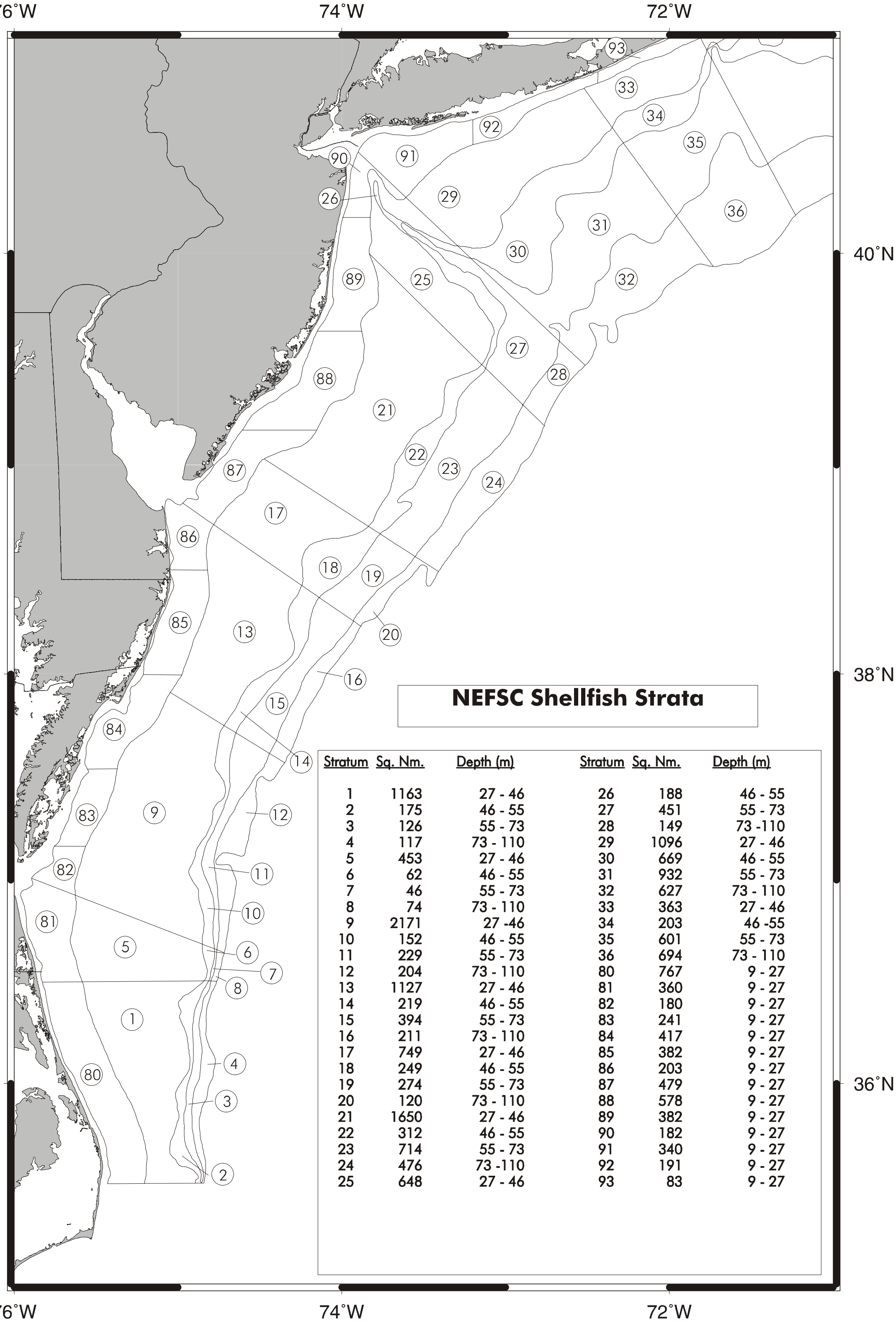
Sub-Protocol 4a: Scallop Dredge Construction and Repair
The NEFSC sea scallop survey utilizes an industry standard 2.44 m (8’) wide sea scallop dredge, equipped with 5.1 cm (2’) rings and 3.8 cm (1.5”) polyethylene mesh liner. The metal ring bag is attached to the aft section of the dredge behind the pressure plate (Figure 3 – 7). The 1.5” liner is placed inside the ring bag to capture small scallops.
Construction plans for the standard scallop dredge are included as figures 3 - 7. The plans include engineering drawings of the dredge. In addition, each plan contains a description of all materials used, and the qualities of these materials considered important for proper dredge function.

A checklist needs to be developed specifying the dimensions, and their tolerances, or other design features considered important for proper dredge function. The checklist will be used to verify that each newly constructed or repaired dredge is within operational tolerances before use. Members of the scientific staff of the NEFSC, who are trained in dredge construction and repair verification, will verify that the dredges are within operational tolerances. The inspections of all dredges and components shall be conducted annually.

Sub-Protocol 4b: Scallop Dredge Repair at Sea
After every tow, the Chief Bosun and Watch Chief should inspect the gear for damage to the dredge or liner. Repairs to dredges at sea should follow the same construction plans and procedures mentioned in section 4.1. Significant damage to the liner or dredge may require the dredge haul be repeated. See section 3.5 for detail about re-towing due to gear damage.

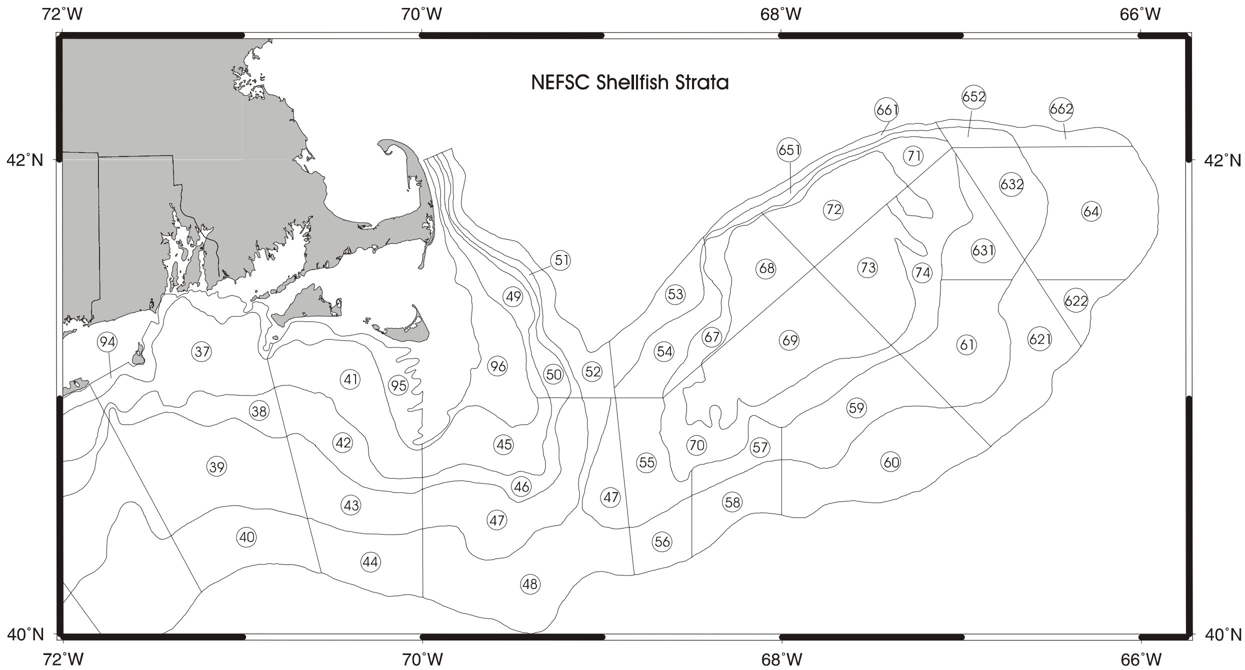
Sub-Protocol 4c: Scallop Dredge Gear Inspections/Certification
Presently, scallop gear inspections and certifications protocols are being developed. Specific guidelines and recording forms for gear inspections will be created in the near future. In the past the dredges were inspected as they were put together.

Figure 1. Southern Shellfish Strata Set



Stratum	Sq. Nm.	Depth (m)	Stratum	Sq. Nm.	Depth (m)
1	1163	27 - 46	26	188	46 - 55
2	175	46 - 55	27	451	55 - 73
3	126	55 - 73	28	149	73 -110
4	117	73 - 110	29	1096	27 - 46
5	453	27 - 46	30	669	46 - 55
6	62	46 - 55	31	932	55 - 73
7	46	55 - 73	32	627	73 - 110
8	74	73 - 110	33	363	27 - 46
9	2171	27 -46	34	203	46 -55
10	152	46 - 55	35	601	55 - 73
11	229	55 - 73	36	694	73 - 110
12	204	73 - 110	80	767	9 - 27
13	1127	27 - 46	81	360	9 - 27
14	219	46 - 55	82	180	9 - 27
15	394	55 - 73	83	241	9 - 27
16	211	73 - 110	84	417	9 - 27
17	749	27 - 46	85	382	9 - 27
18	249	46 - 55	86	203	9 - 27
19	274	55 - 73	87	479	9 - 27
20	120	73 - 110	88	578	9 - 27
21	1650	27 - 46	89	382	9 - 27
22	312	46 - 55	90	182	9 - 27
23	714	55 - 73	91	340	9 - 27
24	476	73 -110	92	191	9 - 27
25	648	27 - 46	93	83	9 - 27

Figure 2. Northern Shellfish Strata Set



Stratum	Sq. Nm.	Depth (m)	Stratum	Sq. Nm.	Depth (m)	Stratum	Sq. Nm.	Depth (m)
37	672	27 - 46	52	307	73 - 110	651	115	55 - 73
38	280	46 - 55	53	268	73 - 110	652	60	55 - 73
39	967	55 - 73	54	278	55 - 73	661	122	73 - 110
40	513	73 - 110	55	364	55 - 73	662	173	73 - 110
41	602	27 - 46	56	209	73 - 110	67	210	46 - 55
42	343	46 - 55	57	184	55 -73	68	370	0 -46
43	432	55 - 73	58	300	73 - 110	69	938	0 -46
44	383	73 -110	59	538	55 - 73	70	520	46 - 55
45	392	27 - 46	60	816	73 - 110	71	146	46 - 55
46	416	46 - 55	61	576	55 - 73	72	504	0 -46
47	871	55 - 73	621	551	73 - 110	73	501	0 - 46
48	1109	73 - 110	622	150	73 - 110	74	433	46 - 55
49	244	27 - 46	631	345	55 - 73	94	229	9 - 27
50	150	46 - 55	632	368	55 - 73	95	446	9 - 27
51	139	55 - 73	64	988	73 - 110	96	495	9 - 27

Figure 3: Top Ring Bag (Apron) with Twine Back

Dimensions of each section are shown on the attached plan. Rings for the dredge are 2" by 5/16" case hardened steel connected by single 5/16" compression links for top ring bag (apron) and extensions. The apron is built with 32 by 18 rings, while the forward extensions are built with 4 rows with a staggered set of rings at the attachment point of the dredge frame.

Top ring bag (apron) with mesh twine top

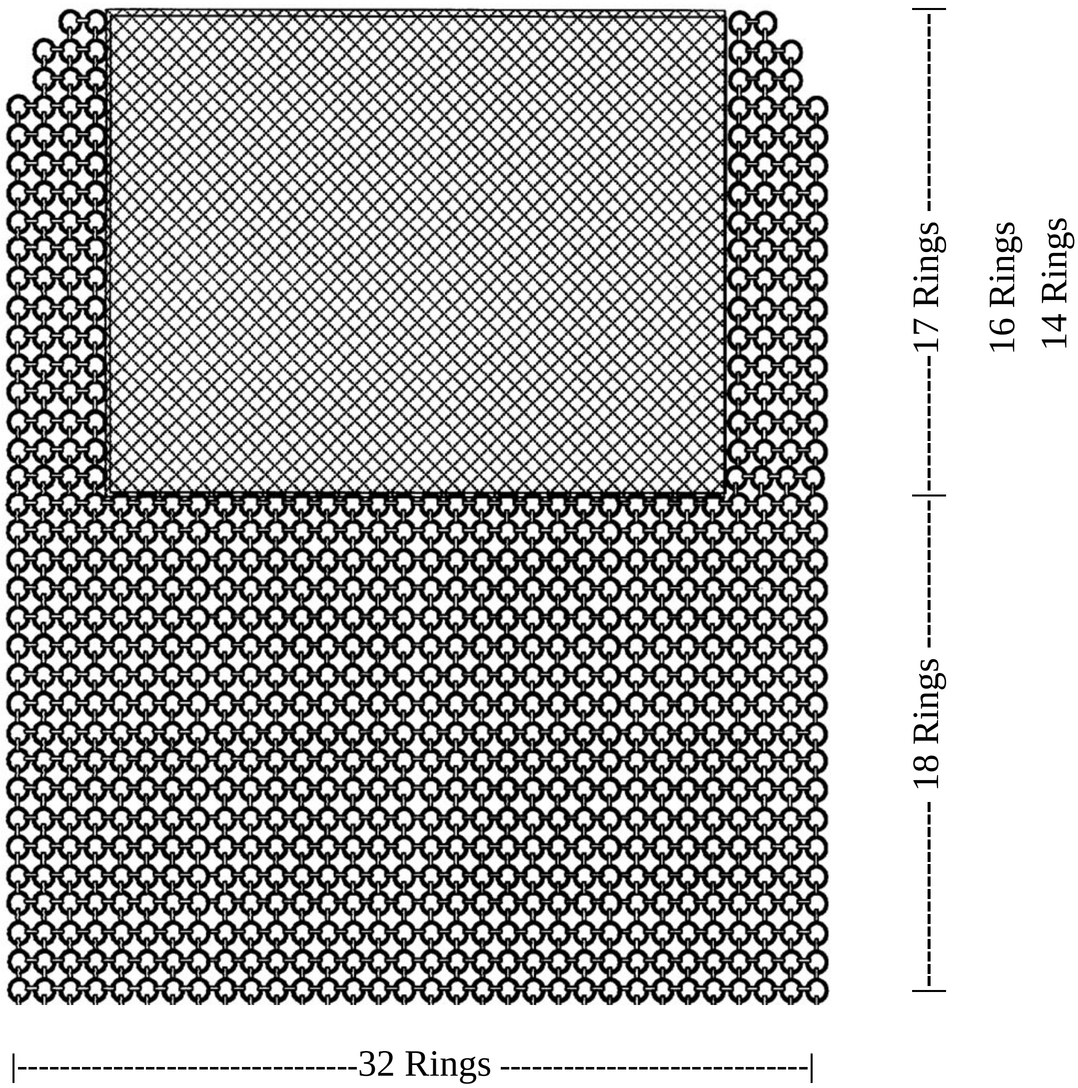


Figure 4: Bottom Ring Bag and Extensions (Diamonds)

Rings for the dredge are 2" by 5/16" case hardened steel connected by double 5/16" compression links for the bottom ring bag and extensions (diamonds). The bottom ring bag is built with 32 by 15 rings, while the extensions (diamonds) are built with 4 rows with a staggered set of rings at the attachment point of the dredge frame.

Bottom Ring Bag and Extensions (Diamonds)

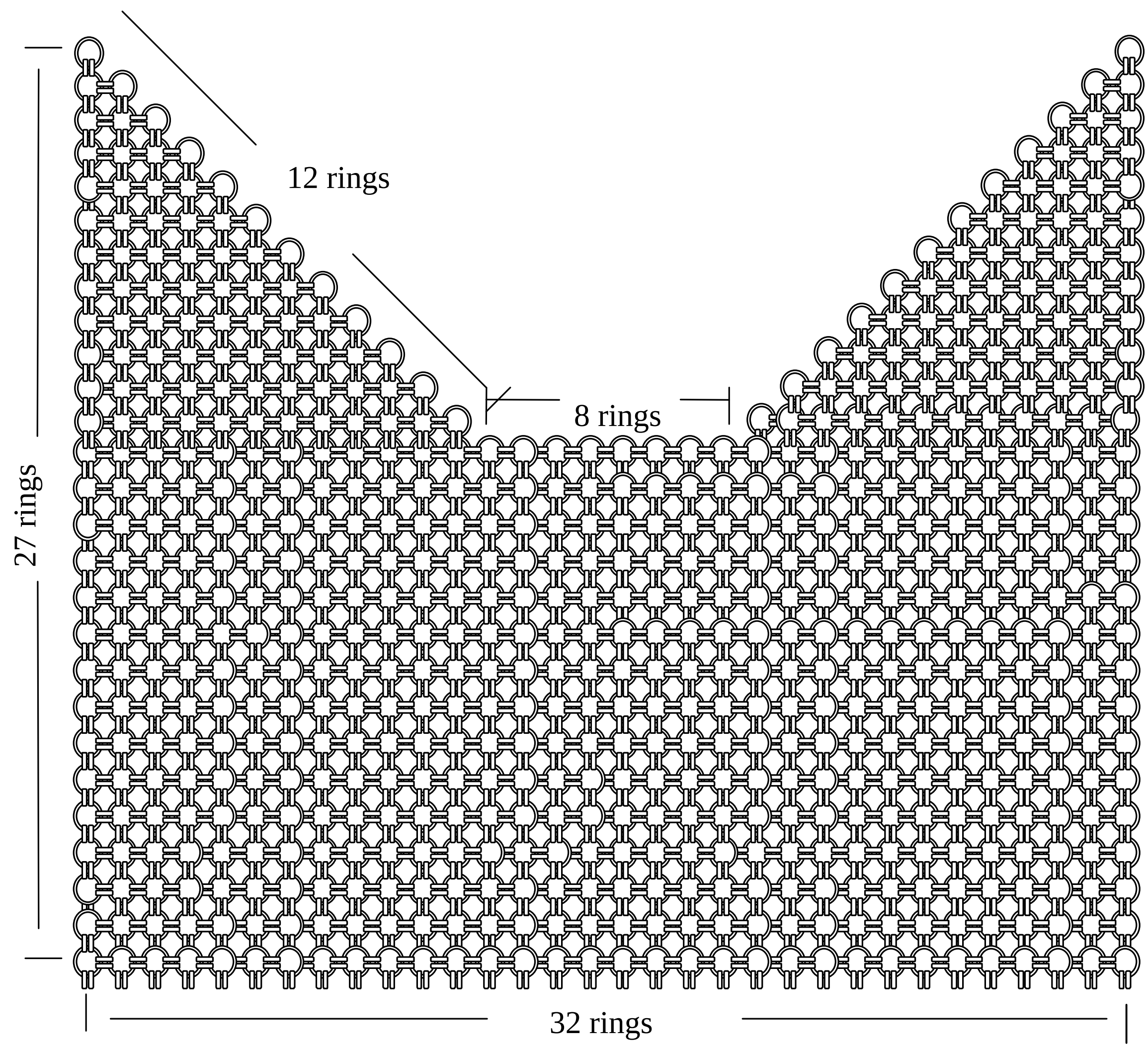


Figure 5: Dredge Frame (bail)

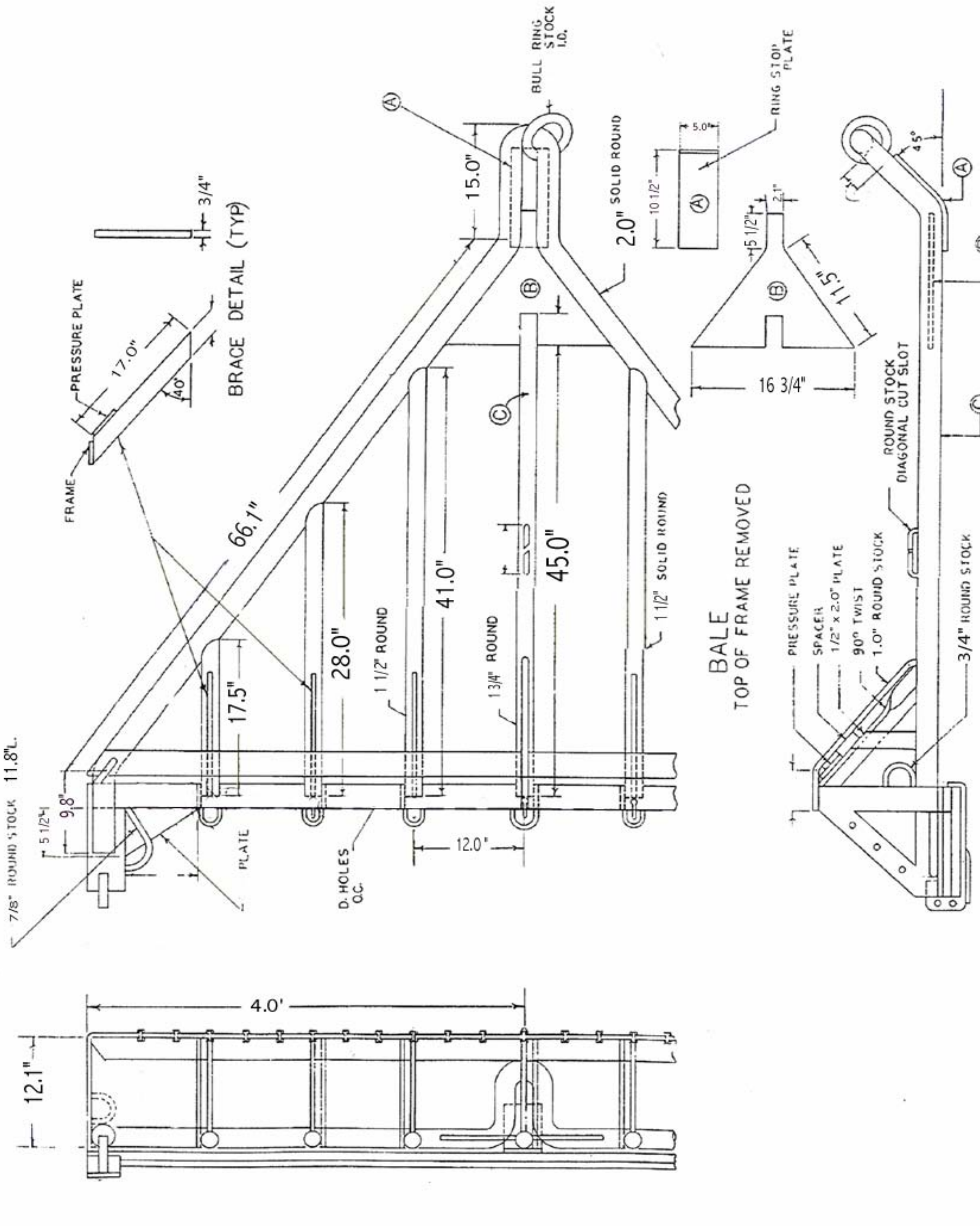


Figure 6: Club Stick and Dumping Chain

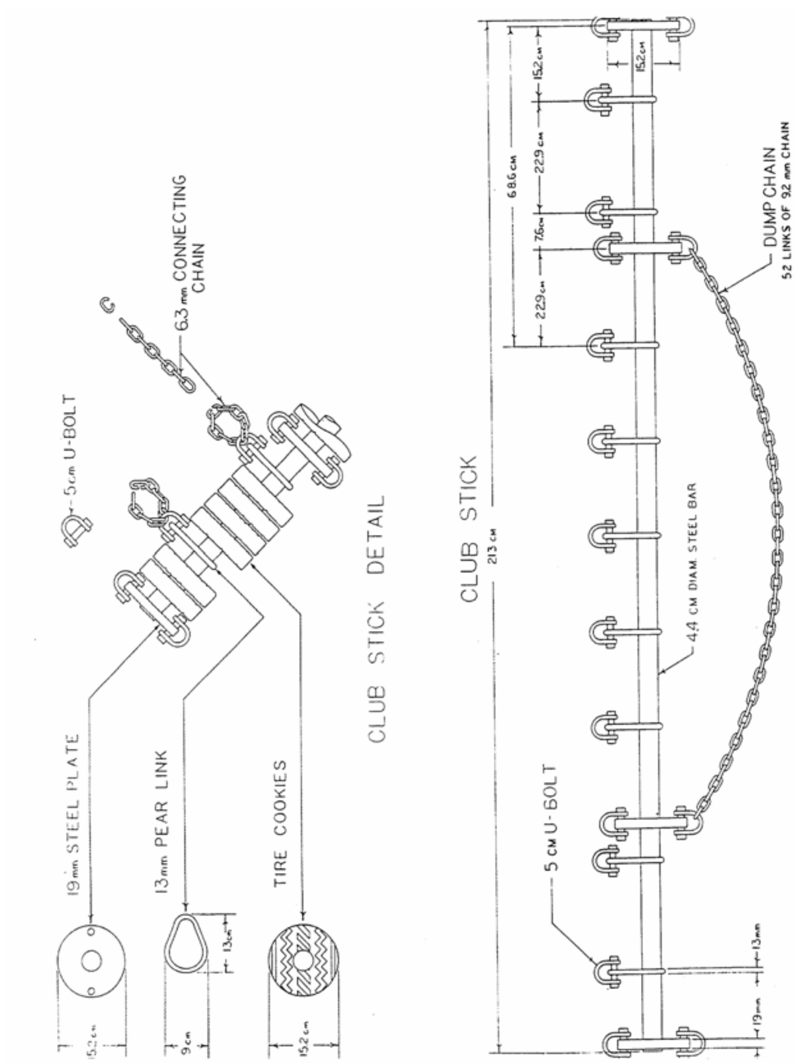
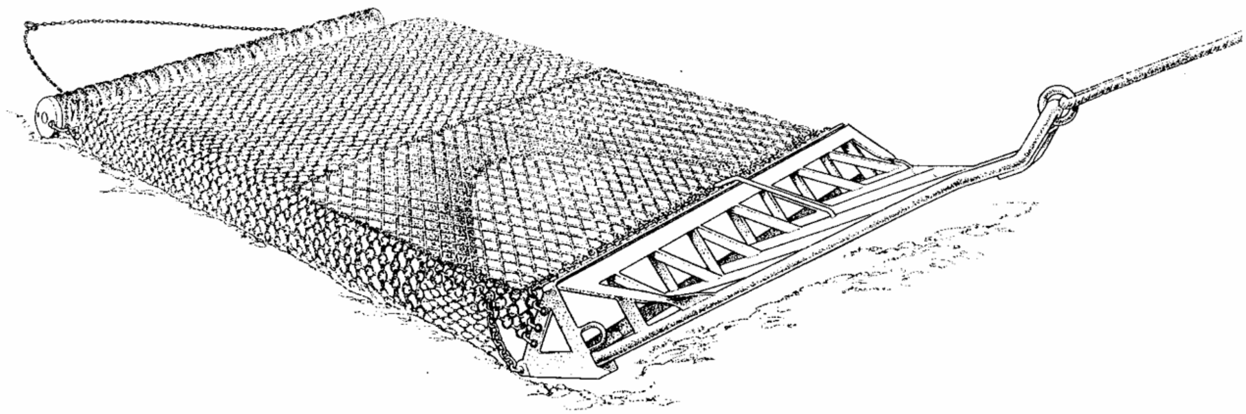


Figure 7: Standard Sea Scallop Dredge



Specifications:

Apron (top)	32 rings x 18 rings
Bag (bottom)	32 rings x 15 rings
Front length	6'3" long (from eye to bag attachment)
Front width	8’ wide
Rings	2" x 5/16"
Sweep chain	77 links of 5/8" casehardened steel
Top twine	4" SM. nylon with 1½" Poly - 63" deep
Weight	1425 lbs.
Liner	1 ½” polyethylene #21 twine (2.2 mm) (rtex 2299)