EXECUTIVE SUMMARY

This document describes the standard operational protocols for conducting the Northeast Fisheries Science Center spring and autumn Multispecies Bottom Trawl Survey aboard the NOAA Ship *Henry B. Bigelow.* This manual documents current survey protocols and standard sampling gear implemented in spring 2009 after the 2008 survey calibration with the NOAA Ship *Albatross IV* and the NOAA Ship *Henry B. Bigelow.* It is intended to serve as a reference manual to ensure survey standardization and aid in the training of new personnel.

1.0 OVERVIEW

Since 1963, the Northeast Fisheries Science Center (NEFSC) has conducted standardized bottom trawl surveys (BTS) along the northeastern continental shelf of the United States. The Ecosystems Surveys Branch (ESB) is responsible for implementation of NEFSC BTS operations. Using the NOAA Ship *Albatross IV* as the primary research vessel and a standardized Yankee 36 survey bottom trawl as the primary sampling gear, these multispecies bottom trawl surveys targeted demersal fish and invertebrate species in the area comprising the Western Scotian Shelf of the Gulf of Maine, south to Cape Lookout, North Carolina (Yankee 36 sampling gear is described in Appendix A). With the decommissioning of the NOAA Ship *Albatross IV* in 2008, the NEFSC transitioned to the NOAA Ship *Henry B. Bigelow* as their primary research vessel, using a standardized 3-bridle, 4-seam survey bottom trawl rigged with a rockhopper sweep as the primary sampling gear (4-seam, 3-bridle sampling gear is described in Appendix B). An extensive calibration study was conducted in 2008 to evaluate relative catchabilities and estimate calibration coefficients between the 2 trawling systems to allow comparability of historical and future datasets (Miller et al. 2010). These protocols are intended for use as a reference manual to ensure survey standardization and aid in the training of new personnel.

1.1. Sampling Design

The NEFSC BTS employs a stratified random sampling design. The area of operation is divided into strata based primarily on depth and secondarily by latitude generally related to fish distribution (Grosslein 1969) (Appendix C). Locations of trawl stations are randomly selected within each stratum prior to each cruise. The number of stations within each stratum is generally proportional to the area of the stratum but also includes consideration of the overall variability in multispecies distribution among strata. Generally, a minimum of 3 stations are planned within each stratum, and a minimum of 2 stations must be successfully sampled in each stratum to obtain an estimate of variability. Random sampling within each stratum produces unbiased abundance indices with measurable statistical precision. Abundance estimates obtained from this survey are relative abundance indices rather than absolute abundance indices because catch efficiency of the sampling gear is less than 100%. Relative abundance indices are comparable through time because survey catchability is held constant through standardization of gear, vessel, and methodology.

1.2 Closed, Management and Conservation Areas

Vessel command must be cognizant of areas closed to fishing, fishery management areas, and conservation areas. However, NEFSC research vessels are permitted to survey in most areas closed to fishing activities for conservation and management purposes. Notable exceptions to

this are deepwater coral conservation areas in U.S. and Canadian waters. Survey stations are not plotted in coral conservation areas. Closed area boundaries do not constitute strata boundaries, unless otherwise noted. ESB will notify the vessel of any known modifications to closed, management, and conservation areas prior to the cruise as necessary. Specific geographic information and details regarding such areas can be found in 50 CFR Part 648[1].

2.0 PREDEPARTURE

Communications between ESB, vessel command, and the Chief Bosun are critical to maximize efficiency of the organization and planning of all NEFSC BTS cruises. The vessel must be available for loading survey equipment prior to the scheduled departure. Delivery of any gear requiring the vessel's heavy lifting equipment will be done in coordination between ESB and the Chief Bosun.

2.1 Cruise Scheduling

Cruise schedules are distributed through the NEFSC Vessel Coordinator and are organized by fiscal year and vessel. The schedules are set in advance through agreement by NOAA's Office of Marine and Aviation Operations (OMAO) and the NEFSC. Published cruise schedules will be made available prior to the start of the fiscal year.

2.2 Canadian License

A license to operate in Canadian waters must be obtained by the NEFSC Vessel Coordinator and transferred to the Commanding Officer (CO) of the vessel. Access to Canadian territorial waters is not permitted without this paperwork physically present aboard the vessel.

2.3 Cruise Instructions

Official cruise instructions will be submitted by the ESB to the NEFSC Vessel Coordinator 3 months prior to the ship's scheduled departure. The cruise instructions will contain the necessary authorities mandating the cruise and will outline cruise objectives, itinerary, methods, administrative requirements, and requested vessel support.

2.4 Cruise Staffing

ESB will coordinate scientific staffing for all NEFSC BTS cruises. A list of the scientific roster will be submitted to vessel command no later than 1 week prior to the departure of each cruise leg. Scientific staff must have medical clearance from the Health Services office of OMAO to be eligible to sail. ESB is responsible for obtaining security and foreign national clearances required for scientific participants. The vessel command is responsible for identifying any health or security related issues (e.g., missing paperwork or approvals) to the ESB cruise staffing coordinator a minimum of 48 hours prior to the scheduled cruise departure.

[1] http://www.greateratlantic.fisheries.noaa.gov/regs/fr.html

2.5 Scientific Equipment

2.5.1 Sampling Gear

The ESB will provide the necessary scientific sampling gear to the vessel along with detailed sampling gear plans (Appendix B). All sampling gear provided to the vessel must be in standard condition and configuration as certified by the detailed ESB survey gear inspection process. Specific BTS sampling gear includes trawl nets, sweeps, doors, rigging, cod-ends, cod-end liners and repair materials. Sampling gear will be maintained and repaired by the vessel, as practical, during the course of the survey.

2.5.2 FSCS Equipment and Scientific Supplies

Portions of the Fisheries Scientific Computer System (FSCS) equipment are owned and maintained by both the vessel and ESB. For the current equipment supply, the vessel owns and is responsible for maintenance of 2 large catch scales and 3 fish-meter scales. Additionally, the vessel is responsible for the wiring of all FSCS hardware, including fish-meters, scales, barcode readers, and printers, to the networked computers for FSCS 2.0 and the Scientific Computer System (SCS). ESB is responsible for the maintenance and setup of the monitors, fish-meters, 2 backup fish-meter scales, small scales, barcode readers, and printers. Additionally, ESB is responsible for the staging of all FSCS hardware and supplies for all cruises requiring the use of FSCS.

2.6 Trawl Winches and Towing Warps

The vessel's autotrawl system must be operated in tension-based mode during all NEFSC bottom trawl survey trawling operations. The NEFSC BTS requires redundant measurement of tension during all NEFSC survey bottom-trawling operations. The vessel is required to arrange for a winch technical representative to calibrate the autotrawl system prior to each bottom trawl survey cruise season. Both the winch-calculated tensions, based on system pressures, and turning block load cells should be calibrated simultaneously to ensure each measuring device is calibrated to an equal quantity. Proper calibration requires that full ship power be available during the procedure so that the system can be operated in "Autotrawl Mode." Additionally, the settings of all programmable winch parameters must be standardized and recorded during each calibration procedure. Per the current national protocol for trawl surveys, physical markings need not be inserted into the warps if an autotrawl system is employed (Stauffer 2004). However, the protocols do require redundant measurement of warp length. The vessel's trawl warp measuring systems are required to be operational during all NEFSC BTS operations.

2.7 Station Selection

No later than 2 weeks before a cruise, ESB will provide the vessel with a list of the randomly preselected station locations for the entire survey. ESB will submit electronic files containing the complete list of station positions and strata boundaries in a format that conforms to the vessel's current navigation software. The vessel must give advance notice regarding any changes in navigation software. In the event of a change, the vessel will determine the new system requirements and report these to ESB. In addition, stations at which plankton sampling is planned will be reported to the vessel. Vessel command and/or Navigation Officer must plot and examine the station locations and identify any stations that are problematic for the vessel in terms of depth, obstructions, or other issues. Any stations identified as problematic must be

brought to the attention of the Chief Scientist to discuss alternative locations or operational procedures prior to departure. Additional stations may need to be planned during the actual operation of the cruise to account for specific sampling problems and requirements (e.g., special deep-water, experimental, or targeted nonrandom stations).

2.7.1 Planned Cruise Track

On the day of sailing, the Chief Scientist will consult with vessel command and produce a partial cruise track list that determines the order in which preselected stations will be occupied. The planned cruise track will be updated by the Chief Scientist and provided to vessel command as necessary throughout the cruise. Unanticipated issues, such as weather, may force changes to the planned cruise track. The Chief Scientist will consult with vessel command to determine the most efficient and productive alternate plan.

3.0 SURVEY OPERATIONS

Each randomly preselected station location is defined by a single latitude and longitude point. A 1 nm radius around the point defines the area in which survey operations commence. Upon arrival on station, the officer on deck (OOD) must assess conditions at the station including depth contours, vessel traffic, navigational hazards, fixed fishing gear, and sea conditions and then determine the specific location at which the trawl will be towed. A standard survey station consists of a hydrographic profile by Conductivity, temperature, and depth (CTD) cast; a plankton sample by bongo net tow (at a subset of stations); and a bottom trawl haul. A standard bottom trawl haul is 20 min long (on-bottom) and is towed at 3.0 kts speed over ground (measured by Differential Global Positioning System). A standard trawl haul begins when the trawl first touches bottom, as determined by the winch operator via trawl mensuration equipment, and ends when the winches are reengaged at haul back.

3.1 Oceanographic Sampling

Conductivity, temperature and depth (CTD) sampling must occur at all station locations. The purpose of the CTD sampling on the survey is to collect hydrographic profile data that are representative of the haul location. To meet this purpose, the CTD should be deployed to within 5 m of the bottom and as close as operationally efficient to the actual haul location. A trawl-mounted temperature sensor collects temperature data along the trawl track.

Close to the actual haul is defined as:

Within **3 hours** of the start of a trawl haul (“Start Trawl”);
and
Within **3.0 nautical miles** of the mid-point of the on-bottom tow path;

If the CTD sample is not close to the haul or the CTD operator loses signal or is otherwise unable to collect CTD data, the cast will be repeated; only the Chief Scientist of the cruise can make an exception from this protocol. If the CTD is not functioning, the Watch Chief should be notified about the time needed for repairs. The Chief Scientist or Watch Chief will then determine if the repeat CTD cast will occur before or after the haul is conducted. Under no circumstances should the pressure rating of the CTD exceed 600 m.

3.1.1 Plankton Sampling

At a subset of the preselected stations, bongo tows will be conducted to survey plankton and larval fish resources. For stations at which plankton sampling is planned, a bongo net tow will occur in tandem with the CTD cast. The maximum depth rating for the bongo net is 200 m. If the bottom depth of the station is greater than 210 m, a dedicated CTD cast will be made to within 5 m of the bottom, but no deeper than 500 m.

3.2 Determination of Tow Path and Direction

Survey tow path should be along a consistent depth contour. For much of the survey region, mainly the southern portion, finding consistent depth contours is not problematic. If multiple tow directions achieve consistent depth, the default tow direction is toward the next planned station.

Consistent depth is defined for mean bottom depth over the tow duration as follows:

Mean bottom depths less than 50 m must be within ± 5 m of set depth.

Mean bottom depths 50 m and greater must be within ± 10% of set depth.

The OOD is encouraged to scout an optimal tow path. It is acceptable to make gentle course changes resulting in a nonlinear tow to achieve a viable tow path. All tows must be planned to be on-bottom for a 20 min duration.

3.2.1 Factors Affecting Tow Path and Direction

a. Hazards or obstructions. Before arrival, the vessel command will identify any obstructions or navigational hazards that may affect tow direction, location, or duration. Towing should be avoided in areas of known ship wrecks. If hazards or obstructions prevent the station from being occupied within the 1nm radius of the randomly selected location, the protocols detailed in section 3.3 must be followed, and the Chief Scientist or the Watch Chief must be informed.

b. Conditions at the station. Conditions at the station may affect tow direction. These include the presence of fixed fishing gear, vessel traffic, sonar targets indicating significant bottom obstructions, weather, and sea surface conditions. In some cases, i.e., the presence of fixed gear or significant sonar targets, the vessel may be required to scout a towable path.

c. Stratum boundaries. Stratum boundaries shall not be crossed during a tow unless all other options for tow direction are exhausted. Greater than 75% of the on-bottom tow distance must be within the initial stratum for the tow to be considered valid.

d. Presence of protected species. Refer to Appendix D regarding procedures for scouting the area prior to gear deployment and actions to be taken if protected species are detected in the sampling area.

e. Bottom currents. The design of the NEFSC BTS attempts to randomize tow direction relative to current direction. The trawl gear must be set initially according to the specified protocol for determination of tow direction without concern for bottom currents. The vessel's autotrawl system can partially compensate for bottom currents; however, this trawl gear does not perform well when towed in areas of strong currents. When towed into the current, gear takes a long time to settle and bottom contact is lost. When towed with the current, door spread varies. If the Chief Scientist determines these conditions are obtained during a tow and the tow will not be

considered valid, they will decide to abort the tow. Trawl performance on the repeat tow should be improved according to the following procedures:

i. The vessel's Acoustic Doppler Current Profiler (ADCP) may be used to aid the decision regarding the repeat tow direction.

ii. Towing in the opposite direction of the original planned tow path may be possible, but tow depth tolerance protocols must be maintained. If towing in the opposite direction is unlikely to improve trawl performance, the course of the repeat tow path should be altered by approximately 30° to offset the magnitude of the current flow relative to trawl direction. 30° is a suggested course change. The altered course tow path must still adhere to the tow depth tolerance protocols. The ADCP may be a useful tool to determine the actual course change in such situations.

iii. When settling times are long or bottom contact cannot be maintained because of strong currents, the repeat tow may be conducted along the original tow path with an increased wire length longer than designated on the Standard NEFSC Scope Table (Appendix E). Wire length must be increased quickly to avoid the trawl fishing near the bottom for an extended period of time, and the length increase must be completed before the beginning of the standard timed tow duration. The Chief Scientist and Winch Operator will determine the appropriate amount of wire increase. The increased wire length must not exceed **20%** more than the designated wire out listed on the Standard NEFSC Scope Table at **Depths Less Than 100 m,** or **50 m** more than the designated wire out listed on the Standard NEFSC Scope Table **at Depths 100 m and Greater**.

iv. These steps to improve trawl performance may not be possible because of high sea state, vessel traffic, or inconsistent bottom morphology. Under those conditions, the station location shall be moved according to the protocols outlined in section 3.3 Moving preselected station locations.

3.2.2 Deepwater Continental Shelf Edge Strata Sampling

Strata boundaries were determined in part by depth, but areas within a particular stratum that are shallower or deeper than the stratum depth range (because of holes or humps) are still considered representative of that stratum, regardless of depth. For the offshore strata on the continental shelf edge from eastern Georges Bank to Cape Hatteras, the stratum boundary lines are defined by the 110 m, 183 m, and 366 m depth contours. Since available bathymetry data were limited in these regions at the time that survey stratification was completed (1962 - 1963), the coordinates for stratum boundary lines may not actually represent the true depth contours associated with these strata. To ensure sampling occurs within the true depth boundaries of these strata, the sampling protocols must be altered at the continental shelf edge strata from Georges Bank south to Cape Hatteras. Gulf of Maine strata will follow the protocols outlined in section 3.2.

a. For offshore shelf edge strata defined by the 110 – 183 m contours:

   i. Begin operations within a 1 nm radius of the randomly preselected station location.

ii. Search within a 3 nm radius for a feasible tow path that achieves consistent depth within the depth zone of the stratum (110 - 183 m). Consistent depth is defined in section 3.2.
iii. If no feasible tow path is found within the depth range after 1 hour, the OOD will navigate from the original 1 nm radius perpendicular to the existing depth contours until reaching a towable area within the depth range of the stratum.
iv. During such occurrences, strata boundaries that were intended to delineate depth contours may be ignored; strata boundaries that were intended to create latitudinal/longitudinal separation between similar depth zones are to be observed.

b. For offshore shelf edge strata defined by the 184 - 366 m contours:
i. Begin operations within a 1 nm radius of the randomly preselected station location.
ii. Search within a 3 nm radius for a feasible tow path that achieves consistent depth within the depth zone of that stratum. Consistent depth is defined in section 3.2.
iii. If no feasible tow path is found after 1 hour, move the tow location according to the following methodology:
1) The Chief Scientist will subdivide the stratum into 4 distinct depth ranges: 184 - 229 m, 230 – 274 m, 275 - 320 m, and 321 - 366 m.
2) The Chief Scientist will randomly select 1 of the 4 subdivided depth zones. (NOTE: for subsequent tows in any stratum, the Chief Scientist will select 1 depth range from any of the 4 subdivided depth ranges to ensure random sampling with replacement.)
3) The OOD will navigate perpendicular to the existing depth contours from the 1 nm radius of the preselected station location until reaching a towable area within the targeted depth zone selected by the Chief Scientist.
iv. During such occurrences, strata boundaries that were intended to delineate depth contours may be ignored; strata boundaries that were intended to create latitudinal/longitudinal separation between similar depth zones are to be kept intact.
v. Subsequent tows within a stratum will follow the same methodology of initially searching for a feasible tow path within a 1 nm radius of the preselected station location. When necessary, as dictated by the protocols outlined above, the Chief Scientist will select 1 depth range from any of the 4 subdivided depth ranges to ensure random sampling with replacement.

3.3 Moving Preselected Station Locations

Tows should be made within a 1 nm radius of the preselected location, using criteria for tow path and direction described in section 3.2. A tow is considered to be within the 1 nm radius if ANY portion of the on-bottom tow distance occurs within a 1 nm radius of the preselected location.

a. If no feasible tow path is found after approximately 30 min of searching, the OOD will expand the radius to 3 nm and notify the Chief Scientist or Watch Chief. If any

portion of the on-bottom tow distance of a feasible tow occurs within the 3 nm radius, it is considered to be within the 3 nm radius.

b. If no feasible tow path is found after approximately 1 hour, the Chief Scientist or Watch Chief will identify an alternate random tow location.
c. Alternate random tow locations will be preselected for all strata by ESB personnel prior to the cruise. The number of alternate random tows per strata will be equal to the number of original random tows per strata.
d. The Chief Scientist or Watch Chief will select the alternate location that is closest to the location of the vessel.
e. Alternate locations must be within the same stratum as the original preselected tow location and adhere to the protocols outlined in section 3.2.

3.4 Standardized Trawling Procedures

A standard trawl haul is 20 min long at 3.0 kts (speed over ground, measured by Differential Global Positioning System [DGPS]). A standard trawl haul begins when the trawl first touches bottom, as determined by trawl mensuration equipment, and ends when the winches are reengaged at haul back. Fundamental activities associated with bottom trawling operations are time-stamped and recorded in the FSCS Operation Event Logger (FSCS OEL) by the OOD. Accurate recording of these event times is critical to the data quality of the survey. These time-stamps, commonly termed button presses, dictate streamed data capture periods and are used to calculate summary statistics on gear and vessel performance during a tow and are used to validate standard survey tows. Refer to section 4.0 Data Collection for more detail regarding event logging.

3.4.1 Setting the Trawl

a. The FSCS OEL must be opened and be ready to begin data collection before setting the trawl. The OOD will select the preplanned trawl site location in FSCS OEL and start the operation.
b. The vessel must set the course in accordance with the planned tow direction, leaving enough room for streaming the net so that the trawl does not over or undershoot the planned tow path.
c. The OOD will check for vessel traffic and fixed gear to ensure it is safe to deploy the trawl. Vessel maneuvers are done at the discretion of the OOD and Chief Bosun/Lead Fisherman to facilitate gear deployment.
d. The vessel will maintain a speed of approximately 3.0 kts to begin streaming the net. Once the vessel is at speed, the OOD will notify the winch operator to stream the net. The “Stream Net” FSCS OEL button must be pressed upon initialization of the deck crew streaming the net. Speed may be altered to facilitate streaming the net.
e. The winch operator and deck crew will monitor the gear during deployment to avoid snags and other potential damage to the gear. The winch operator and deck crew will ensure the gear is streamed in the proper configuration, all floats clear the webbing, and there are no twists in the rigging.
f. Once the net is fully streamed, the vessel speed will be increased to 5.5 kts for wire payout.
g. The “Setdepth” reading will be taken from the EK60 18 kHz transducer when the net is fully streamed, the vessel speed is 5.5 kts and the wire must be payed out in order

to sample the planned towpath. In the event the EK60 18kHz transducer is not functioning, the EK60 38 kHz transducer will be used.

h. The designated wireout length will be determined based upon the "Setdepth" reading and the Standard NEFSC Scope Table (Appendix E). If a planned tow path has been scouted, the designated wireout will be determined by the median depth over the planned on-bottom tow distance.
i. The winch operator will deploy the gear with the winches in "Auto Pay Out" mode. The "Auto Pay Out" mode on the auto-trawl winch system must be set at 50 – 100 m per minute.
j. Vessel speed must be decreased to the standard tow speed over ground of 3.0 kts by the time the last 50 m of cable is being deployed. The winch operator will inform the OOD at the point when the last 50 m is reached.
k. Upon completion of wire payout, the winch operator will engage the "Autotrawl Mode."

3.4.2 Standardized Towing

a. The winch operator will determine the start of the timed tow based on trawl sensor data, which must be monitored from a display at the winch console. The trawl sensors will be used to determine when the trawl sweep has settled on the bottom. Upon determination of bottom contact the winch operator will inform the OOD. The OOD will then immediately press the "Start Trawl" FSCS OEL button, thus beginning the standard timed tow duration.
b. The vessel speed must be maintained at 3.0 kts over ground for the duration of the tow.
c. The tow duration will be exactly 20 min from the time the "Start Trawl" button is pushed. Tows must always be planned for the full 20 min duration.
d. The winch operator is responsible for monitoring the gear and its performance (trawl mensuration data) throughout the tow.
e. At exactly 20 min, the OOD will inform the winch operator to haul back the net.

3.4.3 Haul Back

a. Haul back must commence with the winch operator stopping "AUTOTRAWL MODE" and engaging "HAUL MODE" on the auto-trawl system, at which time the OOD will press the "Haul Back" FSCS OEL button. The "HAUL MODE" on the auto-trawl winch system must be set at 50 -100 m per minute.
b. Vessel speed during haul back must be approximately 3.0 kts. The exact haul back speed may vary depending on catch size or sea conditions and may be increased to avoid vessel traffic or other navigational hazards. Caution must be used when increasing speed greater than 5.0 kts as this may cause damage to gear in tow behind the vessel.
c. Upon reaching the last 50 m of wireout length, the winch operator will inform the OOD.
d. Upon completion of wire retrieval, the doors must be secured and the net brought aboard the vessel. The OOD will press the "Net On Deck" FSCS OEL button when the cod-end is fully on deck.

3.4.4 Trawl On-Deck Post Tow

a. Catch will be emptied into the hopper by the vessel crew. When necessary, extremely large catches will be emptied on deck.
b. The vessel crew must shake and pick through the trawl to remove all organisms caught in the meshes of the body of the net and caught in the cod-end liner. These organisms must be given to the scientific party for sampling. This activity must be given a high priority by the deck crew. The goal is to avoid contaminating the next haul with organisms caught in the current haul, which may happen if organisms are retained in the trawl and then washed down into the next haul's catch. Vessel crew must inspect the survey gear for any damage and notify the Watch Chief or Chief Scientist of any damage and/or malfunction observed.
c. The Chief Bosun/Lead Fisherman will notify the Watch Chief or Chief Scientist of any repairs made to the survey gear. Notifications must be as descriptive as possible. The Watch Chief will record all survey gear damage/malfunction detail in the tow evaluation software.
d. The vessel crew will visually inspect the shine pattern of the trawl doors to ensure that the doors did not collapse during the tow.
e. The vessel crew will secure the survey gear and retie the cod-end and liner in preparation for the next station.
f. Once the survey gear and crane have been secured and the OOD is ready to move on to the next station location, the OOD will press the "Crane Secure" FSCS OEL button. The OOD will then press the "Stop the Operation" FSCS OEL button to exit the FSCS OEL program.

3.5 Survey Tow Evaluation and Validation

All standard survey tows are evaluated by tow evaluation software immediately post tow and are validated based on 4 categories, Type, Operation, Gear, and Acquisition (TOGA). TOGA is a detailed analysis of survey trawl and vessel performance during each tow, based on data from trawl mensuration systems and vessel sensors routinely logged by SCS. Tolerance limits and optimal values were calculated from data collected during the NEFSC calibration experiments. These tolerance limits are intended to promote consistency of trawl geometry and towing procedure to ensure comparability of the collected trawl survey data with results from the calibration experiments. Refer to Appendix F for additional details regarding tow validation and TOGA.

3.5.1 Repeating Tows

Any decision to repeat a tow must involve the Chief Scientist or Watch Chief and the OOD and should consider the following factors:

a. The probability of the same or greater damage to the gear. If probability is high, the station location should be moved.
b. Whether or not the catch is a representative sample or if the damage/malfunction significantly altered catch efficiency.
c. The time into the tow when the damage or malfunction occurred. If the damage/malfunction occurred after 16 min and did not significantly alter catch efficiency, the tow should be considered valid and the damage coded accordingly.

d. The current progress of the cruise as a whole (when time remaining in the cruise threatens the completion of the entire survey area).
e. If the OOD has any concerns regarding the Chief Scientist's decision, the CO should be consulted for discussion with the Chief Scientist.

When an invalid tow will be repeated, catch from the invalid tow will still be sampled by the scientific party at the discretion of the Watch Chief or Chief Scientist.

3.6 Intercepted Fixed Gear

Survey operations regularly occur in the vicinity of fixed fishing gear. Searching and scouting should be undertaken when planning a tow path to avoid interacting with fishing gear. When possible, any fixed gear entangled in the survey gear must be retained by the deck crew. Although fixed gear interceptions are often safety hazards, it is valuable to obtain as much information as possible on the extent of the intercepted gear, amount of damage, its status as actively fished or abandoned, its effect on trawl performance, and any indications of ownership such as registration numbers when it is safe to do so. The Chief Bosun/Lead Fisherman will report this information to the Watch Chief and to the OOD. The OOD will record all available information regarding the vessel's location and activities during the gear interaction in the FSCS OEL bridge comments. The Watch Chief will record all available information from any retained gear and detail all information regarding the gear interaction's effects on trawl performance in the Tow Evaluation software. The Chief Scientist is responsible for notifying shore-based personnel of fixed fishing gear interactions. ESB shore-based personnel are responsible for handling all tort claim activities.

3.7 Cessation of Operations Due to Weather or Sea Surface Conditions

Survey operations should cease any time the CO, OOD, or Chief Scientist believes the safety of personnel or the vessel is compromised. In certain instances, trawl performance is significantly affected before any safety concerns of the vessel are identified. Survey operations should be ceased any time the Chief Scientist, Watch Chief, or Winch Operator believes trawl performance is significantly altered by weather or sea conditions. During marginal weather conditions, bottom trawl performance should be closely monitored with net sensors and TOGA summaries.

4.0 DATA COLLECTION

Bottom trawl survey data are collected in a standard format using standard procedures to ensure accuracy and comparability of survey data throughout the time-series. The Chief Scientist and the FSCS Administrator have the primary responsibility for proper collection of data during the cruise. All station data are collected with sensor input from the SCS as well as metadata input by the OOD through the FSCS OEL. FSCS OEL incorporates SCS station data which are linked to all collected biological data. Oceanographic data are recorded in a separate database and are linked to the station and biological database. Data linkage is necessary for data integrity.

4.1 FSCS OEL Station Data Collection

The vessel's nonbiological sensor data are recorded continuously throughout the cruise by the vessel's Scientific Computer System (SCS) and loaded, in real-time, to an Oracle database through the FSCS OEL application. A subset of sensor data relevant to the standard survey tow are logged at specific time intervals, initiated by button presses that log events representing standardized towing operations (i.e., start of timed tow, haul back). These data are stored in an Oracle database and are referenced by the site and operation. The FSCS OEL data collection format is standardized and must not be altered in any way without agreement from ESB personnel.

4.1.1 Bridge Responsibilities

During standardized trawling operations, the OOD is responsible for executing the FSCS OEL Bottom Trawl Operations event. At each sampling site, the OOD launches the FSCS OEL program, enters all necessary data, and presses all required event buttons. FSCS OEL data are used to validate all standard survey tows for the timed tow duration, based on event button presses (Start Trawl to Haul Back). Accurate timing of event button presses is critical to the quality of collected SCS sensor data and proper evaluation of standard survey tows. Communication between the OOD, Chief Scientist and Watch Chief before conducting survey operations is encouraged to eliminate sources of error. The Watch Chief and/or Chief Scientist must be notified of all errors associated with FSCS OEL data collection. If errors occur with pressing of event buttons, (i.e., button pressed more than once or button press does not represent actual event occurrence), the time of the actual event occurrence should be documented, and the Watch Chief shall be notified of the error. Additionally, the OOD must detail all errors in the FSCS OEL "Comment," when applicable.

4.1.2 FSCS OEL Bottom Trawl Operations

The sequence of Bottom Trawl Operations event logging must be as follows:

a. Open FSCS OEL: The OOD will open the program and enter the necessary information, including vessel, cruise, operation type, project, and site.
b. Start Operation: Launch the program.
c. Bridge Officer: Select the current OOD by clicking "Bridge Officer=" on the right side of the screen.
d. Weather: The OOD will input the wave height, swell direction, and swell height by clicking each one on the right side of the screen.
e. Comment: Enter all comments relative to the current operation, when appropriate. Multiple comments may be entered.
f. Stream Net: The "Stream Net" button will be pressed at the time the gear is being set into the water. This begins the streamed data collection into the Oracle database.
g. Start Trawl: The "Start Trawl" button will be pressed when the trawl sweep has settled on the bottom, as determined by the Winch Operator's interpretation of trawl mensuration equipment. This begins the timed tow duration. This button may be pressed more than one time, when necessary, to capture the accurate start of the timed tow duration (e.g., if the button was initially pressed too early).
h. Hang: The "Hang" button will be pressed at the moment survey gear has hung on the bottom or encountered an obstruction, when applicable. This button may be pressed as many times during a tow as necessary.

i. Haul Back: The "Haul Back" button will be pressed when the winches are reengaged to retrieve the gear. This ends the timed tow duration. This button may be pressed more than one time, when necessary, to capture the accurate haul back time (e.g., the button was initially pressed too early). Start Trawl must be pressed prior to Haul Back.
j. Net On Deck: The "Net On Deck" button will be pressed when the gear has been retrieved and the cod-end is on deck. This ends the streamed data collection into the Oracle database.
k. Crane Secure: The "Crane Secure" button will be pressed when the back deck crane is secured.
l. Stop Operation: End data collection for the Bottom Trawl Operations event.
m. Exit OEL: Exit the program. Stop Operation must be pressed prior to Exit OEL.

4.2 Biological Data Collection

All biological data are collected with the Fisheries Scientific Computer System (FSCS).

4.2.1 Catch Processing

Catch processing will occur under the supervision and direction of the Watch Chief. The following basic operations shall occur:

a. Calibration of scales. At the start of each watch, the electronic scales must be calibrated. During a watch, additional calibrations may occur under the direction of the Watch Chief.
b. Sorting. Sorting will precede all biological sampling, except in special cases where subsampling methods are utilized. The majority of catch will be sorted to species and in some cases to sex within a species.
c. Weighing. All sorted samples will be weighed (in aggregate) with calibrated scales.
d. Measuring. All sorted samples will be measured; or partially measured, with subsampling methods.
e. Special sampling. Selected special sampling beyond weighing and measuring may take place through the authority of the Chief Scientist via approved requests from the ESB Chief. The primary vehicle for these requests will be, but is not limited to, the ESB Sampling Request Booklet and associated protocol sampling tables in FSCS.
f. Disposition of catch. The Watch Chief will supervise the disposition of the catch. Catch disposal will occur only after all pertinent data have been collected and/or verified. No catch will be disposed of while a net is in the water, to ensure that previously sampled organisms are not recaptured at subsequent stations. In certain cases, the disposal of the catch may be restricted, and in these instances the Chief Scientist will consult with the vessel command on how to adjust procedures.
g. Protected Species. Protected species will be handled according to NOAA and/or NEFSC protocols.

5.0 POST-CRUISE ACTIVITIES

5.1 Vessel Cleanup

At the end of each cruise leg, the scientific party will clean all scientific areas (lab space, ready room, lounge, hopper, offices, and berthing). The scientific party will clean all scientific equipment as well, including all FSCS hardware, measuring devices, and scales.

5.2 Sample Offload

The scientific party will organize and inventory scientific samples at the end of each cruise leg. Samples will be offloaded from the vessel at the discretion of ESB staff. Any offloading requiring the use of vessel equipment, such as cranes, must be coordinated between the Chief Scientist and the Chief Bosun.

5.3 Data Offload

The FSCS Administrator will create a copy of all data collected after each cruise leg and is responsible for transport of these data from the vessel to the lab.

5.4 Equipment Offload

Offload of survey trawl gear will be coordinated between the ESB warehouse staff and the vessel's Chief Bosun. Gear offload may occur between survey legs to maximize available storage space. Scientific equipment, such as FSCS hardware, will remain on the vessel until the end of the cruise season (unless damaged or otherwise necessary to remove).

5.5 Post-Cruise Meeting

Upon completion of each cruise leg, a post-cruise meeting will be held and attended by the vessel's officers, Chief Scientist, Chief Bosun, members of the scientific party, the NEFSC Vessel Coordinator, and the Port Captain to review the cruise. Concerns regarding safety, efficiency, and suggestions for improvements for future cruises should be discussed. Minutes of the post-cruise meeting will be distributed to all participants via email and to the CO.MOC.Atlantic@noaa.gov and ChiefOps.MOA@noaa.gov. The Port Captain, if attending, is responsible for recording and distributing the minutes. In his/her absence, the Operations Officer will be responsible for the minutes.

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